SIGN AND COSTING OF SMALL SCALE CHROME ELECTROPLATING PLANT.

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BEING A THESIS SUBMITTED TO THE POST GRADUATE IOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, IN ARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE WARD OF THE DEGREE OF MASTER OF ENGINEERING (M.ENG) IN CHEMICAL ENGINEERING

APRIL, 2008

CERTIFICATION PAGE

This thesis entitled "DESIGN AND COSTING OF A SMALL SCALE CHROME ELECTROPLATING PLANT", by BABALOLA RASHEED meets the regulation governing the award of degree of master of Engineering (M. Eng. Chem.) at Federal University of Technology, Minna and is approved for its contribution to knowledge and literary presentation.

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DECLARATION

by declare that this work was carried out by me and it is a record of my research work.

not been presented in any previous application for higher degree. All the sources of nation are duly acknowledged by means of references.

14/04/08

Date

Iola Rasheed

DEDICATION

vork is dedicated to the memory of my late mother Mrs. Sariyu Olalonpe Ayoka bla and to my daughter Maryam Omomayowa Babalola and my yet unborn children.

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ABSTRACT

This project work was based on the designing of 2000kg/day of chrome electroplating plant for wrist watch chains. The design was carried out with the aid of an Engineering software and the various results of the equipment designed are shown in tables 4.1 to 4.4. A summary of the overall economic analysis has been presented in tables 4.6. The cost of equipment was \$21,220 (Twenty One Thousand Two Hundred and Twenty Dollars). The profit after tax (PAT) was \$61, 851 (Sixty One Thousand Eight Hundred and Fifty One Dollars); the pay back period (PBP) was 3 years and six months and the rate of return on investment was 27.28%.

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CHAPTER ONE

1.0

INTRODUCTION

This project work tilled Design and Costing of small scale chrome electroplating plant is fully discussed accordingly.

Chrome electroplating is the covering of thin layer of chrome metal on a material usually a metal, plastic or other material in order to provide resistance to corrosion, wear, special appearance such as colour or luster or increase dimension, e.t.c. Thus, chrome electroplating is an electrolytic process whereby a chrome metal is cathodically deposited into another metal or a surface that has been made conductive. This process is done to import certain desirable properties while avoiding the prohibited cost of fabrications of the part entirely from chrome metal.

1.1 Background

Electroplating started as far back as 1800 when a chemist, Lugi Brugnatelli, carried out electroplating by making some metallic material surface to be coated with gold.

In 1805 a more refined electroplating process was conducted by a group of scientists in Britain and Russia when a printing press plate was electroplated with copper. By 1840 the process was refined and used for gold and silver plating.

In 1850 electroplating of bright nickel, brass, tin, and zinc on engineering material and other specific purposes was carried out by

scientists in great Britain. The years 1870 to 1940 were a quiet period for electroplating as no new scientific discoveries were made until the year 1945 when heavy gold plating for electronic components was discovered. In 1956 the "User friendly" plating bath that is based on formulae was developed for large-scale commercial use. (htt://electrochem2002).

Nickel was the most widely used metal for corrosion resistance and shining property but the metal does not retain its luster for long.

Chrome metal thus quickly replaces nickel because it combined all other properties with the ability to retain luster for long.

Electroplating is the covering of a thin layer of metal on a material usually a metal plastic or other material in order to provide resistance to corrosion, special appearance such as colour or luster or increase dimension. Thus electroplating is an electrolytic process whereby a metal is cathodically deposited onto another metal or a surface that has been made conductive. This process is done to import certain desirable properties while avoiding the prohibitive cost of fabrications the part entirely from the metal used for coating other desirable characteristics of electroplating includes improved solder ability of the base metal (substrate), wear resistance, electrical conductivity, contact resistance and lubricity depending on their use. (Fowke et. al 1962).

Electroplated coating may be classified as either decorative or engineering but some fall into both.

Usually in electroplating a cheaper material is used as the basis material and plating technique is used to cover the surface of the material with an expensive material.

A typical example of the technique used to have expensive material is gold plating which is often found on religious articles.

Conventionally iron was and is still the most popular basis material for plating. We can therefore understand rust preventive technique easily when we concentrate on metal material, such as copper, brass, lead, zinc, as it's variations. Zinc plating is the most popular rust preventive plating method, followed by copper-nickelchromium or nickel-chrome platting.

There are also alloys like brass, bronze plating as well as gold and silver plating.

Summarily, plating technique can be defined as applying thin coating and evenly deposited on the surface of base material. (Fowke et. al 1962).

1.2 Statement Of The Problems

Modern living conveniences such as wrist watches, spoons, openers, key holders, oven trays and transportation equipment such spare parts, car bumpers, bicycles and motorbikes parts are made

up of iron and steel, which are liable to corrosion and this can be prevented by painting, or electroplating.

In the recent years, the output of chrome plated product is increasing tremendously as paints peel off, Nickel does not retain its luster for long from the base material yet, only few industries are into chrome electroplating. Out of these few, most are not servicing the public, thus the need to have more chrome electroplating plant in Nigeria; Most people are in doubt what chrome plating plant entails and its financial feasibility. This project work is therefore aimed at:

- a. Carrying out a design of 2000kg/day of a small-scale chrome electroplating plant that is friendly to both human life and environment.
- b. To chrome plate wrist watch chains and other related materials.
- c. Prepare a financial feasibility profile for the plant operation.

1.3 Scope of Design work

- i. Material and Energy balance
- ii. Equipment Design, Type and Specification.
- iii. Equipment Cost and Economy Analysis.

iv. Cost Analysis

1.4 Limitations

Findings of previous researchers were adopted

1.5 Approach

The approaches used in meeting these aims are as follows:

- 1. Source for local and international material on chrome electroplating.
- 2. Produce a flow diagram.
- 3. Carrying out material balance of the plant using MathCAD.
- 4. Carrying out energy balance on the plant using MathCAD.
- 5. Costing the plant using HYSYS/

CHAPTER TWO

LITERATURE REVIEW

2.1 Brief History

2.0

The early history of electroplating may be traced back to around 1800. A University Professor, Luigi Brugnatelli, is considered as the first person to apply electrodeposition process to electroplate gold. Brugnatelli was a friend of Allisandro Volta (after whom the electric unit "volt" has been named) who discovered the chemical principles that would make possible the development of electrical cells.

Volta's first actual demonstration of that was called. As a consequence of his development, Brugnatelli's early work using voltanic electricity enable him to experiment with various plating solutions.

By 1805 he had refined his process enough to plate a fine layer of gold over large silver metal objects. He wrote in a letter to the Belgian Journal of Physics and Chemistry (later reprinted in Britain), which reads:

"I have lately gilt in a complete manner two large silver metals, by bringing them into communication by means of a steel wire, with a negative pole of a voltanic pile, and keeping them one after the other immersed in amount of gold newly made and well saturated".(http://eleectrochem,2002).

Unfortunately for Brugnatelli, a disagreement or falling out with the French Academy of Science, the leading scientific body of Europe at the time, prevented Brugnatelli's work from being published in the scientific journals of his day. His work remained largely unknown outside of his native Italy except for a small group of associates. By 1839, however, group of scientist in Britain and Russia had independently devised metal deposition processes similar to those of Brugnatelli's for copper electroplating of printing press plates. By 1840, this discovery was adapted and refined by Henry and George Elkington of Birmingham, England for gold and silver plating.

Collaborating with their partner John Wright and using formulae developed by the later potassium cyanide plating baths, the Elkingtons were able to have the first viable patents for gold and silver electroplating issued on their name. From Great Britain the electroplating process for gold and silver quickly spread throughout the rest of Europe and later to United States. By the 1850's electroplating method of bright nickel, brass, tin, and zinc were commercialized and were applied for engineering and specific commercial purposes. In time, the industrial age and financial capital had expanded from Great Britain to the rest of the world. As a result, electrodepositing process expanding in scope and found more and more usage in the production of a variety of goods and services.

While this expansion was taking place, no significant scientific discoveries were made until the emergency of the electronic industry in the mid forties of the last century. The years from 1870 to 1940 were a quiet period as far as electroplating was concerned, significant only in gradual improvement in larger scale manufacturing processes, and reaction principles and plating bath formulae. During the later years of the forties, rediscovery of heavy gold plating for electronic components took place. In comparison to that, during the mid to later fifties the usage of new and more "user friendly" plating baths based on formulae were developed and introduced for large scale commercial use.(htt// electrochem 2002).

2.2 An Over View Of Electroplating

Electroplating is electrodeposition of metals on metals alloys and non-metals. The objects of electroplating are as follows: -

- i. To charge the surface properties of metals and non-metals.
- ii. To get improved appearance on basic metals.
- iii. To obtain improved resistance to corrosion, tarnish, chemical attack and wear.

Electroplating is performed in a liquid solution called the "plating bath". The bath is a specially designed chemical solution that contains the desired metals (such as gold, copper, or nickel) dissolved in a form of submicroscopic metallic particles introduce in the bath to obtain smooth and bright deposits. The object that is to

be plated is submerged into the electrolyte (plating bath). Place usually at the center of the bath, the object that is to be plated acts as the Cathode, and the Anode placed at the opposite edges of the plating tank. It is then connected to the power supply (rectifier) thus causing film deposit on both sides of the cathode. In the bath, the electric current is carried largely by the positively charged ions from the anode(s) toward the negatively charged cathode. This movement makes the metals ions in the bath, to migrate toward extra electrons, that are located at or near the cathodes surface outer layer. (Adegoke R. 2001).

2.3 Theory Of Electroplating

If we have a solution of metallic salt and a potential difference is applied to this salt solution by means of two electrodes, it is ionized thus the metals ions migrate to cathode and are deposited there. If the anode is of the same metal of which the salt in solution is the anode metals passing into the solution in ionic form reform the salt. In this way there is a continuous deposition of metal on the cathode. (Fowke D. G. 1962).

For ZnC1₂ solution in water it is ionized as given below

 $ZnC1_2 \longrightarrow Zn^{2+} + 2C1.....2.1$

Zinc will go to cathode and will get deposited there. Cathode ion will go to anode metals and will react with it to from zinc chloride.

2.3.1 Principles of chrome electroplating

The article to be electroplated is immersed in a solution containing dissolved chrome metal and made the cathode by connecting it to the negative lead of a low voltage D.C. supply(rectifier). The circuit is completed by immersing the Anodes e.g. wrist watch, into the solution and these are connected to the positive lead. Dissolved chrome ions are driven by a D.C. electrical current of low voltage and high amperage. The ions gain electrons at the cathode, causing the wrist watches to be plated. The potential difference applied between anode and cathode which is usually between 2 and 16 volts D.C. is the driving force for the transfer of charge ions across the metal solution interfaces.(Joe I. et al 1979).

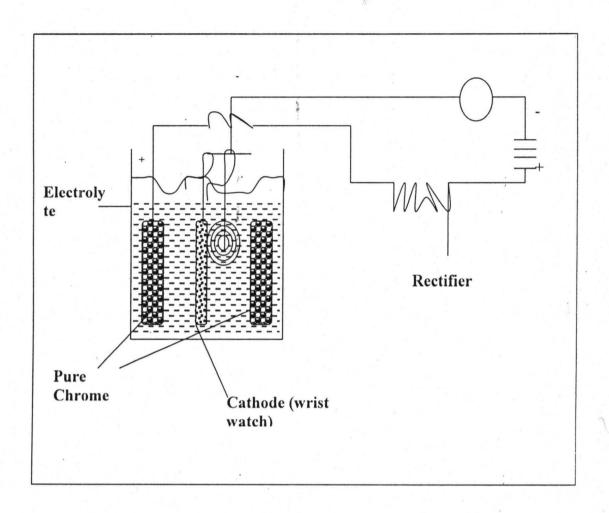


Fig 2.1 Schematic diagram of chrome electroplating of wrist

watch chains

2.3.2 Table 2.1 Electrochemical series

Manganese	1.18
Zinc	0.76
Chromium	0.56
Iron (ferrous)	0.44
Cadium	0.40
Indium	0.44

ELECTRONEGATIVE METALS More cathodic potentials less noble potential more noble potentials

ELETROPOSITIVE

METALS

Cobalt	0.28
Nickel	0.25
Tin (stannous)	0.14
Lead hydrogen	0.12
Copper (cupric)	+0.34
Copper (cuprous)	+0.52
Silver	+1.50
Gold	+1.6

The electrochemical series lists the element in the order of their standard electrode potentials and to a degree, indicates the ease with which they ionize. As displacement series; usually a metals with a higher negative value will displace one lower in the series.

(M. M. Upper 1995). For example, if a piece of zinc is immersed in a solution of copper sulphate, copper is immediately deposited upon the zinc by chemical action without the assistance of applied current. Electropositive metals are deposited in preference to more electronegative metals.

2.3.3 Quantity of metal deposited

Faraday's laws of electrolysis guide quantity of metals deposited. According to these laws, the quantity deposited depends on the quantities of electricity passed per second and the chemical equivalent of these substances. (Joe L. et al 1979).

2.3.4

Rate of deposition

The minimum quantity 'of electricity require to deposit the equivalent weight in gramme of metals is 96500 coulombs. For instance, 96500 coulombs will discharge 1 mole of hydrogen; this quantity of electricity is called Faraday. One faraday is equal to one mole of electron since, the discharge of one mole of single charge ions involved the transfer of one mole of electron which contains Avogadro's number i.e. 6.02×10^{23} of electrons

Thus: W=ItA/ZF.....2.2

Where A is the atomic weight of metals deposited, ZF is a faraday constant. The relation between atomic weight and chemical equivalent is atomic weight=equivalent weight x valency.

The valency may be defined as being the number of atoms of hydrogen with which one atom of the element combines, or which it replaces. The figure is always a whole number, for example silver is monovalent and cadmium divalent, or in other words, have valencies of one and two respectively.

2.3.4.1 electrolytes

The electrolyte is the medium that carries the current by means of ions. It is the ability of a solvent especially water to ionize substances, i.e. split them into two components which carries negative and positive charge that make electroplating possible.

2.3.5 Presence of ion and electrical conductance

When an electric field is applied to metals, according to the direction of applied field, electrons start moving from negatively charged end of metal to its positive end, this way current flows in metals. Thus, a substance conducts electricity when an electron or some other electrically charged particles like ion has to move through it. In all electrically conducting solution, the solute molecules give rise to two types of electrically charged particles or ions. The negatively charged types of ions are called anions and the positively charged ones are called cations.

2.3.6 Electrolysis

When a direct electric current is passed through an electrolyte (such as a molten salt or an aqueous solution of a salt, acid or base), chemical reactions take place at the contacts between the circuit and the solution. This process is called electrolysis. Electrolysis takes place in an electrolytic cell.

The components, which make contact with the electrolyte, are called electrodes. The electrode which is attached to the negative pole of the battery, and which supplies electrons to the electrolyte, is called cathode. Reduction takes place at the cathode.

The electrode which is attached to the positive pole of the battery, and which accepts electrons from the electrolyte is called the anode.

Various reactions take place at the electrodes during electrolysis. In general, reduction takes place at the cathode, and oxidation takes place at the anode. (Ollord et .al 1974).

2.3.7 Faraday's laws

In 1883, Michael Faraday explained the nature of electrolysis. Faraday's law is basic to the understanding of all electrolytic processes and may be summarized by the two following statements: 1. The amount of chemical change (metals deposited) that is produced by an electric current passing through solution in a cell is directly related to the quantity of electricity that flows.

2. The amount of substance liberated (i.e. metal deposited) by a given quantity of electricity is directly related to the gram equivalent weight of the substance. More specifically, 96,500-ampere seconds (or coulombs) reduce one gram equivalent of metals ions to metals atoms.

Faraday's law is used by the plater to determine the plating time and current required to deposit a specified weight (and considering the specific gravity and surface area, also a specified thickness) of a metal. Table 2.1 gives the electrochemical equivalents for some typically electroplated metals. The amount of time required to deposit a certain thickness at a specific current density can be calculated from this data. Q = IT2.3 where Q is the qty of electricity passed, I is current and T is time.(upper, 1995).

2.3.7.1 Cathode efficiency

Faraday's law states that the total amount of chemical change at an electrode is directly related to the quantity of electricity (that is, the current flowing). In plating, however, the main concern is the quantity of metal deposited. Any other reactions, such as the liberation of hydrogen at the cathode, decrease the cathode efficiency. The average cathode efficiency percentage is determined by dividing the actual weight of metals deposited by the theoretical weight and then multiplying by 100. Change in solution composition and other external factors can improve cathode efficiencies to some degree; however the solution used is the major factor for determining efficiency.

2.3.7.2 current distribution

Current density is the applied current divided by the total surface area of the work piece.

Table 2.2: Electrochemical Equivalent And Deposit Metal Weight

Calculated from Faraday's Law

(Uppal, 1995)

					(0000)				
METAL VAL	ENCE	ATOMI	C SPECII WEIGH		тніск со	ATING	WEIGHT IN 1 (0z/ft ²)	MIL WEIGHT GRAVITY	
Cadmium (Cd)	2	112.40	8.65		0.074 (2.09	07) 0.7	71 (8.659)	9.73 (4.125)	
Chromium (Cr)	6	52.01	7.1		0.011 (0.32	23) 0.5	59 (7.146)	51.8 (22.110)	
Cobalt	3		7.1		0.023 (0.64	6) 05	9 (7.146)	25.9 (11.060)	
Copper (Cu)	2	58.93	8.9		0.039 (1.09	9) 0.7	4 (8.719)	19.0 (7.926)	
Gold (Au)		1	63.54	8.96	0.084 (2.37	'0) 0.7	4 (8.935)	8.84 (3.770)	
Indium (In)		2	63.54	8.96	0.042 (1.18	6) 0.7	4 (8.935)	17.8 (7.540)	
Iron (Fe)	1	197.0	19.3	0.236	(7.348)**1.4	47 (19.32))**	6.2 (2.631)	
Lead (Pb)		3	197.0	19.3	0.079 (2.44	9)** 1.4	7 (19.32)**	18.6 (7.887)	
Nicket (Ni)		3	114.82	7.31	0.045 (1.42	8)** 0.5	6 (7.278)**	12.0 (5.092)	
Palladium (Pd)	2	55.85	7.86	0.037 (1	.042) 0.6	65 (7.868))	17.9 (7.54)	
Platinum (Pi)	2	207.19	11.34	0.136 (3	.865) 0.9	94 (11.35	0)	6.9 (2.936)	
Rhodium (Rh)	2	58.71	8.90	0.039 (1	.095) 0.7	74 (8.880)		19.0 (8.044)	
Silver (Ag)		2	106.4	12.0	0.064 (1.98	5)** 0.8	6 (24.34)**	13.5 (6.045)	
Tin (Sn)	4	195.09	21.41	0.058 (1	.819)** 1.6	60**		27.9 (11.77)	
Zinc (Zn)		3	102.9	12.4	0.041 (1.28	0)** 0.9	5 (8.29)**	22.9 (9.73)	
	1	107.87	10.5	0.129 (4	1.042)** 0.7	79 (10.5)*	*	62 (2.605)	
	2	118.69	7.30	0.078 (2	.214) 0.6	61 (7.30)		7.8 (3.30)	
	4	118.69	7.30	0.039 (1	.106) 0.6	61 (7.30)		15.6 (6.6040	
	2	65.38	7.14	0.043 (1	.219) 0.5	59 (7.15)		14.3 (5.8630	

*Assume 100% cathode efficiency for metal deposition

Current Density is usually measured in A/ft² or /dm². Depending on the system of units.

In Electroplating, current is concentrated at edges and points as well as in area closer to the opposite electrode (anode) and these latter areas consequently receive a greater deposit thickness (see fig 2.1). Normally, a part is plated to meet a minimum thickness specification. Since the excess metal thickness in high current density areas is usually not desired, the throwing power is defined as the electrolyte's ability to minimize the difference in deposit thickness between high and low current density areas.

Plating solution in which the cathode efficiency decreases with an increase in current density, generally displays better throwing power because less metal will be deposited in the less efficient high current density areas. Cyanide zinc is an example of such a bath. Chromium plating, on the other hand, becomes more efficient with an increase in current density and consequently has poor throwing power.

2.3.8 Introduction to basic electroplating process

In the simplest terms, plating transfers metals from positive Anode to the negative Cathode following Faraday's law.

Objects are immersed into chemical baths or vats to change their surface condition. Every plating is UNIQUE and the number of tanks and their chemical make up differ based on desired result. Metal slabs or balls (Anode) are placed in an electrolyte solution.

Dissolved metal ions are driven by a DC electrical current of low voltage and high amperage (Rectifier). During electroplating pure metal dissolving from the anode is deposited on the cathode by an electron gain – transfer method which can be represented thus: -

M⁺ + e`►	Μ	2.4
Cu⁺ + e`	Cu	2.5
Ni ²⁺ + 2e`	Ni	2.6

M⁺ represents metallic ion required Cu[⊤]and Ni⁺ represent copper and nickel ions, and Cu and Ni represent deposit of copper and nickel.

Objects to be plated are placed on racks or perforated barrels and immersed in a series of chemical solutions to prepare them for plating. The objects to be plated must be "SURGICALLY" clean in order to be successfully plated.

2.4 Plating Process Line

the second

Plating process can be divided into 3 basic units namely:-

i.	P	r	e-	tr	e	a	tr	n	e	n	t
••			•	•••	-	~	•••	••	~		•

ii. Plating

iii. Post-plating

2.4.1 Pre-treatment

Each material has its own treatment procedure. It is therefore necessary to know the nature of material or basis metal. Aluminum for example, cannot be cleaned in solutions formulated for cleaning steel. The nature of contamination and an incorrect identification may result in destruction or damage of the parts. Cleaning affects adhesion, appearance, composition and corrosion resistance of final deposit. The plater must therefore, be informed about pre-existing contamination. Such as inclusions in the base materials. Information supplied often help a customer – client relation resulting in successful metal finishing. The material is therefore, derusted or cleaned using necessary acid and depending on the base material. Acids used are sulfuric, hydrochloric, nitric or a combination of these. This removes rust, scale or smuts.

Depending on the material and configuration, it is polished or buffed/mopped. After proper rinsing, it is transferred to the degreaser tank where oils and greases are removed from the surface, then rinsed and ready for plating. Sandpapering is another manual method of polishing the surface of materials. These pretreatment processes of pickling and degreasing can also be achieved by electrolysis called Electrolytic degreasing or pickling. The composition of materials or chemical used is based on the material being cleaned and it is unique for each base material. It is

commonly accepted and often quoted by electroplaters that can make a poor coating performed with excellent pretreatment, but one cannot make an excellent coating perform with poor pre-treatment. Surface pretreatment by chemical and or mechanical means is important not only in the case of preparations for electroplating but is also required in preparation for painting. In either of these, methods are designed to ensure good adhesion of the coating the processes include solvent degreasing, alkali cleaning and acid dipping which are described below (Adegoke R. 2001)

2.4.1.1 polishing

This is mechanical cleaning of the substrate to remove surface defects (scratches, etc) by polishing and buffing.

2.4.1.2 swirling

This is a process of rinsing the pretreated articles in cold distilled water in order to avoid contamination of the electrolyte.

2.4.1.3 solution heating

For many of the processes associated with electroplating it is necessary to heat the solution. The available methods of heating include steam, hot water, gas and electricity.

2.4.1.4 solution cooling

A number of processes in which heavy current densities are employed or are operate at fairly low temperature may required

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well water, recirculated water chilled water and brine.

2.4.2 Engineering application

Plating for appearance (decorative plating).For Decorative Plating Metals Used are gold, Nickel, brass/radius and copper. For special decorative effects tin, zinc, cadmium, lead, palladium and platinum, etc are also used.

2.4.2.1 plating for protection

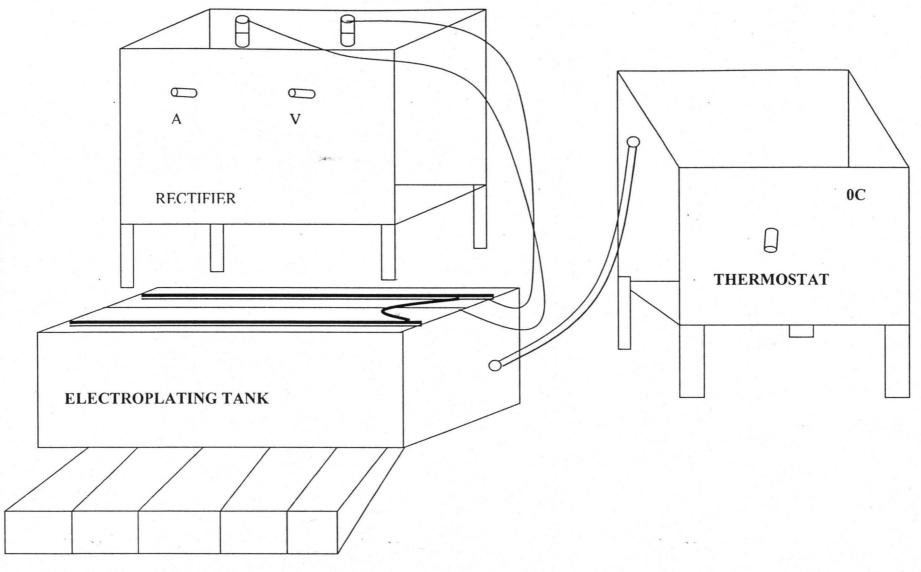
Steel must be protected from rusting chemical attack and so it is electroplated. Protective metals applied are zinc, cadmium and tin, etc. where both protection and good appearance are desired steel is given successive coating layers of copper, nickel and chromium. Copper and Nickel provide protection against rusting and chemical attack. The chromium plate above all plate, gives clean metal appearance. Nickel dulls by tarnish when exposed to atmosphere and chromium does not. 

Fig. 2.2: Schematic Diagram of Electroplating Equipments.

2.4.2.2 plating bath constituent

Although it is often possible to electrodeposit metal from a simple solution of a metallic salt alone, it is rarely a practicable commercial process. Modern plating baths are somewhat complex and may contain as many as six or eight constituents, all which play an important part. Chlorides, for example, are added to nickel sulphate solutions to promote anode dissolution. Boric acid acts as 'buffer' and maintain p^H equilibrium Colloids to refine the texture of the deposit, other metals and organic Brightnener to give luster, and anti-pitting agent to prevent 'pin-holing' due to hydrogen bubbles and Leveler allow even deposit on irregular object.

Operating Condition

For optimum plating some parameters such as pH, temperature, current etc. P^{H} should be in range of 3-4, temperature from room temperature to 60^oc depending on anode metal and a battery or rectifier to supply low voltage of 2-8v.

2.4.2.3 solution agitation

With many processes it is necessary to keep the solution well mixed in order to prevent local variation in concentration. Unless the solution is agitated there will be a reduction in the metal content of the solution surrounding the cathode, which will result in the production of a rough or "burnt" deposit.

2.4.2.4 electroforming

By electro-forming is meant formation of articles by electrodeposition of metal. In electroforming the layer of electrodeposited

25.

metal is quite thick. Automobile, aircraft, radio, adar and ammunition industries use parts made entirely by electroplating. Mandrels are used for depositing metals over it. The electro-form is removed without damage from its mandrel after obtaining the desired thickness

2.4.2.5 electroless plating

Electroless plating is a process of plating by chemical reduction. For example, nickel can be plated by the addition of a reducing agent, such as sodium hypophosphate, a solution, to nickel salts. The nickel ion is reduced to the metals, which under proper conditions is deposited as a coherent and adhesive plate rather than simple as a powder throughout the solution. It is used, where electroplating is impossible, example plating the insides of pipes.

2.4.2.6 displacement placing

Displacement plating occurs when the metal deposited is nobler than the substrate, and the substrate dissolves. The reaction ceases when the substrate is completely covered by a pore-free deposit.

2.4.3 Electroplating equipment

Electroplating may be divided into barrel, rack and strip continuous (reel-to-reel) plating. Barrel plating is used for plating smaller parts in some electrolytes. Rack plating is used for larger parts and for chromium plating. (Adegoke R. 2001).

2.4.3.1 barrel plating

Barrel plating is usually performed in either horizontal or oblique barrels constructed of polypropylene or other suitable plastics. The walls of the barrels are perforated, and the barrel is plated during plating. Electrical contact is obtained via oxible conductor known as a dangler. Some barrels are not perforated, but contain the plating solution and an anode.

Mixed leads are not recommended in barrel plating unless the plater is not too concerned about plating thickness and distribution, or unless the parts require just a flash plate. Longer or larger parts in the mixture will usually receive the greater deposit and buildup on high current density areas will be increased. In addition, sorting the parts after plating is time consuming.

Larger pieces weighing more than 1 lb (0.5kg) and containing sharp edges should not be barrel plated because they will be damaged in the tumbling action of the barrel and the barrel itself may be damaged. Flat and lightweight parts should not be barrel plated because they tend to stick together and do not tumble properly. Wire forms are more easily rack plated than barrel plated.

2.4.3.2 rack plating

Rack plating is usually employed in the processing of parts that are too heavy, too large or too complex in shape to be barrel plated. The parts can vary from a small knob that is to be nickel-chromium plated, to a large roller, weighing a ton or more for hard chromium plating. Rack plating is used with manual, semiautomatic and fully automatic machines.

One of the most important considerations in designing a plating rack is that the rack must have adequate current carrying capacity. Racks are usually constructed of copper because of its high current

carrying capacity, ease of fabrication, and relatively high strength. After fabrication, the racks are covered with an inert insulating material to protect them and prevent metal plating on them, and to keep the plating solutions from becoming contaminated. Parts are hung or dipped to the insulated rack. The contract to the part should be made on a non critical area of the part such as the back, inside, or through a hole.

Another important factor in designing a plating rack is the position of the work on the rack. It must be positioned to obtain the most uniform current distribution possible and to prevent entrapment of air or gas in holes or pockets, which will restrict deposition of metal in these areas, resulting in non uniform thicknesses. The position of the plating rack in the processing track is also important for obtaining as uniform a plating deposit as possible. If the work is located too close to the anodes, excessive buildup of plating thicknesses, known as burning occurs in the high current density areas of the part. The parts are usually tracked so that they tend to shield the edges of adjoining parts, and are frequently racked back to back to increase the capacity of the rack and at the same time reduce the deposition of the metal in non critical areas. If a particular part has a deep recess, an auxiliary anode can be used to ensure the deposition of the required thickness in the recessed area.

2.4.3.3 strip plating

Strip plating is a plating process whereby the work piece is a continuous strip being pulled through each process station (tank) by a take-up null. Wire and lead frames are commonly strip plated with tin,

tin lead, nickel, and precious metals. Steel sheet may be continuously zinc, tin, chromium, copper, brass, nickel iron or nickel zinc plated. The strip may be plated at specific points as it goes through the cycle, such selective plating is very common with precious metals.

2.4.4 Process tank

Tanks may be fabricated of hot rolled low-carbon steel and protected with a rubber or other suitable liner rated to withstand the bath's corrosive action and to keep the steel tank from contaminating the solution. Polypropylene and other high-strength plastics may be used for smaller tanks. Alkaline-cleaner tanks and some plating solutions do not require liners. Rinse tanks may be equipped with spray nozzles and the water counter-flowed back into the previous rinse tank to reduce water usage.

2.4.5 Temperature control

Temperature control is important in most plating solutions. Some require cooling heating or both. For cooling, cold water piped through reeling coils of suitable construction may be sufficient or heaters dangers may be required. Heat may be provided by steam through heating coils or by electric immersion heaters. Instruments are commonly used to automatically control plating bath temperatures.

2.5 Power Supplies

Alternating current is converted to direct current by means of a rectifier or motor generator set, with rectifiers being preferred. Regulated and unregulated power supplies are available that provide filtered direct current with good reliability. A regulated power supply may be of the silicon-controlled or saturable reactor type. These power supplies maintain constant current or voltage under varied loads and are generally used in large operations. The more common unregulated types include the tap switch and manual powerstat Both air and liquid cooled rectifiers are available. The major advantage of the more expensive liquid-cooled type is that the unit is completely sealed so that rectifier components are not exposed to the atmosphere, which may be very corrosive in a plating shop. As a general rule, a rectifier should be operated at a minimum of 50% of its maximum rated output current to provide low-nipple direct current.

2.5.1 Anodes

The anode carries a positive charge and completes the electrolytic circuit. In most cases, the anode is fabricated of the metal being plated and serves to replenish the solution with metal ions. However, insoluble (metal) anodes are used in some applications, such as chromium plating and with precious metals. Anodes may be fabricated metal slabs or balls, or chips contained in an inert basket. The metallurgical structure and composition are important considerations for proper anode performance. Titanium is often used for the baskets because of its inert oxide film.

Most modern nickel plating installation use nickel chips in titanium backsets, shut, or cathode-deposited shapes. Zinc is usually plated from ball anodes, and copper from ball or bar anodes.

2.5.2 Automated control

Electroplating is subject to a wide variety of variables that frequently change. Automatic controllers add stability and consistency to the operation and should be used wherever possible. Automatic ampere hour feeders monitor the plating time and may be used to approximate thickness as well as automatically feed addition agents. Solutions pH may be controlled automatically with a relatively inexpensive piece of equipment, such control is especially useful in electrolytes where the pH tends to rise due to generation of the hydroxyl ion, such as in nickel and chloride zinc solutions. Rinse waters may be controlled by automatic conductivity meters connected to solenoid valves, these ensure good rinsing with reduced water consumption.

2.6 Substrate Preparation

In preparing the substrate for plating, it is important to properly select the correct pretreatment method. Pretreatment influences the adhesion, appearance, composition and corrosion resistance of the deposit.

Some of the factors that should be considered when selecting the pretreatment cycle are type of substrate, nature of the contamination, how the part is used, and part geometry. Each basis metal may require a different pretreatment. Aluminum, for example, cannot be properly processed in solutions formulated for steel. Even variations in alloy may cause the finisher to change pretreatment. (Adegoke R. 2001)

Typical Processing Cycles for Substrate Preparation for

Electroplating.

- I(a) Low-carbon steel-oily, not rusted
 - 1. Soak clean, 180[°]F (82[°]C), 2-3 minutes.
 - 2. Cold water rinse, 30 seconds.
 - 3. Anodic electro clean, 180°F (82°C).
 - 4. Rinse
 - 5. Acid dip, 30 seconds
 - 6. Cold water rinse, 30 seconds
 - 7. Plate
- I(b) Low-carbon steel rusted
 - 1. Soak clean, (180°C), 2-3 minutes.
 - 2. Cold water rinse
 - Periodic reverse electroclean, room temperature, 30-60 A/H²
 (3.2 & 4A/din²).
 - 4. Plate.
- II. Stainless steel and high-nickel alloys.
 - 1. Soaked clean, 1-5 minutes
 - 2. Cold water rinse, 30 seconds
 - Periodic reverse electroclean (10 seconds anodic, 7 seconds cathodic), room temperature, 30-60 A/H² (3.2-6.4 A/dm²). 3-5 minutes
 - 4. Cold water rinse, 30 seconds.
 - 5. Hydrochloric acid dip. 30% by volume, room temperature, one minute.

- 6. Wood's nickel strike, 20-60 A/H² (2.2-6.4 A/dm²). 1-3 minutes
- 7. Cold water rinse, 30 seconds
- 8. Plate.

III Cast Iron

- 1. Soak clean, 103 minutes
- 2. Cold water rinse.
- Periodic reverse electro clean (7 seconds anodic, 5 seconds cathodic), 5 minutes
- 4. Warm water rinse.
- 5. Cold water rinse
- Hydrochloric acid, 30% by volume, room temperature in seconds.
- 7. Cold water rinse
- 8. Plate
- IV. Cast iron alternate method
 - 1. Cathodic electro clean, 1-3 minutes
 - 2. Warm water rinse
 - 3. Cold water rinse
 - 4. Hydrochloric acid dip. 10% by volume, 5-10 seconds
 - 5. Cold water rinse
 - 6. Plate.
- V. Wrought aluminum alloys most alloys
 - 1. Soak clean, nonetch cleaner, 1-1 minute
 - 2. Cold water rinse
 - 3. Alkaline etch clean

- 4. Cold water rinse
- Desmut in a solution containing 50% by volume nitric acid,
 25% by volume sulfuric acid, 25% by volume water, and 1
 Ib/gal (120 g/l) fluoride salt at room temperature for 20-45
 seconds.
- 6. Cold water rinse.
- 7. Zancate, 5-30 seconds.
- 8. Rinse.
- 9. Plate, preferably first in a cyanide copper strike.
- VI. Wrought aluminium alloys 5000 and 6000 series
 - 1. Soak clean, nonetch cleaner, 1-3 minutes.
 - 2. Cold water rinse.
 - 3. Acid etch, 160°F (70°C) 1-3 minutes.
 - 4. Cold water rinse.
 - 5. Nitric acid, 50% by volume, room temperature, 30 seconds.
 - 6. Cold water rinse.
 - 7. Zincate, 5-30 seconds.
 - 8. Cold water rinse.
 - 9. Plate, preferably first in a cyanide copper strike.
- VII. Sand or die-cast aluminium alloys
 - 1. Nonetch soak clan, 1-2 minutes
 - 2. Cold water rinse
 - 3. Alkaline etch clean.
 - 4. Cold water rinse

itors contributing 50% by volume nitric acid, _

- Desmut in a solution containing 50% by volume nitric acid, 25% by volume sulfuric acid, 25% by volume water, and 1 lb/gal (120 g/l) fluoride salt at room temperature for 20-45 seconds.
- 6. Cold water rinse
- 7. Zincate, 5-30 seconds
- 8. Rinse
- 10. Plate, preferably first in a cyanide copper strike.
- VIII. Copper and Copper alloys
 - 1. Soak clean, 3-5 minutes
 - 2. Cold water rinse
 - Electro clean (cathodic or anodic depending on formulation),
 30-90 seconds.
 - 4. Cold water rinse.
 - 5. Acid dip, 10% sulfuric acid or dry acid salt, 30 seconds.
 - 6. Cold water rinse.
 - 7. Plate.
- IX Zinc-based die castings
 - 1. Soak clean, 3-5 minutes.
 - 2. Cold water rinse.
 - 3. Spray alkaline clean, 30-60 seconds.
 - 4. Cold water rinse.
 - Anodic electro clean, 10-25 A/H² (1.1-2.7/dm²), 25-50 seconds.
 - 6. Cold water rinse.
 - 7. Acid dip. 30 seconds

8. Rinse

9. Plate, preferably first in a cyanide copper strike.

2.6.1 Product finishing

- The acid dip may be 10% sulfuric acid at 122.180°F (50 ox/gal (120 g/l) dry acid salt at 77-140°F (25-60°C).
- > The two most widely used processes for the pretreatment of aluminium alloys before electroplating are the zincate process and the stannate process.
- On difficult to plate alloys, use double zincate with an intermediate nitric acid dip to improve deposit adhesion.
- Acid dip may be 1% hydrofluoric acid, 1% fluoboric acid or a dry acid salt.

Table 2.3: American Society for Testing and Materials Recommended

Policies for Preparation of Substrates to be Electroplated.

(Fowke, 1962)

	(10446, 1
Metal Substrate	Standard Number
Low-carbon steel	B.183
High-carbon steel	B.242
Zinc alloy disc castings	B.252
Aluminium alloys	B.253
Stainless steel	B.254
Copper and copper-based alloys	B.281
Lead and lead alloys	B.319
Iron castings	B.320
Nickel	B.343
Magnesium and magnesium alloys	B.480
Titanium and titanium alloys	B.481
Tungsten and Tungsten alloys	B.482
Nickel alloys	B.558

Several stages are generally required to provide adequate cleaning of the substrate and activation pre-cleaning, intermediate alkaline cleaning and electro cleaning. Pre-cleaning is designed to remove a large excess of soil, especially deposits of butting compound or grease. It is also useful in reducing the viscosity of waxes and heavy oils to enable later cleaning stages to be more effective, or to surround fingerprints and dry dust with an oily matrix to facilitate removal by alkaline cleaners. Intermediate alkaline cleaning removes solvent residues and residual soil that has been softened or conditioned by precleaning. Spray or soak alkaline cleaning may also be used as a precleaning stage, followed by additional alkaline cleaning, if the soil and metal lend themselves to this treatment. Electro-cleaning is soak cleaning with agitation provided by the upward movement of bubbles of hydrogen or oxygen formed by the electrolytic decomposition of water in the solution.

Some parts cannot be etched because surface finish must be maintained, just as part used in structural applications should not be subjected to pretreatments that may cause hydrogen embrittlement. The design of the work may require special handling and surface treatment. For example, a large part may require external manual finishing or parts with deep recesses or blind holes may require special handling and drainage techniques to avoid excessive drag-out and crosscontamination.

2.6.2 Operating parameters

The four main concerns in electroplating are temperature, pH, and chemistry of the plating bath as well as current density. Most plating solutions have an optimum temperature range for producing best results, and close control of temperature is important for proper current control. As the temperature of the solution increases, conductivity increases, and therefore the current increase for a fixed applied voltage, the converse is also true. Over plating or under plating occurs if the temperature is not maintained properly.

The pH control of plating solutions is necessary to maintain the acidity or alkalinity that has been determined to produce the best results. Appearance, stress, leveling, electrode efficiency and coating hardness are influenced by the pH of the solution. Current density is a very important variable in all electroplating operations. The character of the deposit, its distribution, the current efficiency, and perhaps whether a deposit forms at all may depend on the current density employed.

2.7 Comparison of product with its competitors

The competitors of chrome are: Nickel, zinc, gold, tin, and copper. Amount all the competitors chrome stands Out as the most durable of all and that which give the best satisfaction on Metal because of its shinning and wear resistance properties any chrome Plated materials do not loose their appearance and never break, these make It has higher quality than its competitors e.g. Chrome plated jewelries, Automobile, motorcycle and bicycle part last longer and regains its shining ability.

2.8

Quality Control Aspect of Electroplating Technology

Since the main purpose of electroplating is to get a rust-free, lustrous finish on the object, apart from other engineering application of increasing surface thickness, a deviation from this target, is a deviation from excreted result.

Quality control therefore in planting starts from the beginning to the end to get customer fully satisfying and satisfied.

Material to be plated must be specified since some finishes cannot be applied to certain materials. Metals fabricators and spare parts manufactures must clearly understand the coating needed rather

than what they just thought they wanted.

While designers are expected to know what the conditions the plated product will survive, engineers must also know and understand coating's limitation.

Since each of the coating; zinc, nickel, copper, chrome has unique properties with respect to use and environment, selection of a single coating or a combination for a given application is never a matter of chance, aesthetic nature or serious economic of financial consideration. Expected coating and selection require specialized knowledge as to use, application and shelf life.

To become a better customer and quality control conscious, the quotation that "the requirement of a supplier must be established long before he produces any material", by W Edwards Denning, out of the Crisis of quality control theorem must be followed.

Therefore, nickel plating is the best for food equipment/ material like oven trays, and the like, while chrome is acceptable for car bumpers.(Ollord, E.A. 1974)

In effect, quality specification and control is to make both plater and client a synergy of successful ventures. From the start therefore fabricators, engineers and benefactors of plating process will not choose high carbon steel, instead of low carbon steel, defective, pin-holed and scratched, pitted, scrapped metal, under the guise or disguise of "no-fund" will be a penny wise, pound foolish situation.

From quality assurance stand point, platers will use his science of

materials knowledge to help client in the right choice of materials, dimensions, tolerance, and even in designing for improved palatability. Product starts receiving good control and specification from inception or conceptualization stage.

Plating quality is also controlled if the following salient point and actions are taken from the shop floor. Plating solutions are given preventive maintenance approach which makes plating to be cost effective, efficient, interesting and satisfying. Platers therefore tend towards zero control commandments to make plating profitable.

Tanks or Vats must be designed to specification with regard to lining. Most of the plating tanks are lined with polypropylene, rubber or fibre-glass materials with no outlet taps or valves.

There is need to periodically filter the solutions. Nickel solutions are regularly filtered or ultra filtered.

Air agitation and cathode rod movement are needed plating solutions like nickel to reduce hydrogen-oxygen embrittlement (covering) on the plated objects.

Some good plating will not take place unless at temperature above room temperature. Nickel plating and some cleaning (degreasing) processes are few examples.

During plating, operation conditions are religiously adhered to. The current voltage, current density. pH, temperature are closely monitored for good plating to take place.

Some shop floor problems reduced to the bearest minimum as a result of these quality control measures.

Constant addition (little) as the plating is done daily. Such daily addition of individual or formulated "propriety" salt are expected to keep platers out of trouble. Large addition of salt or additives like levelers, brighter, conducting salts are regarded in modern plating as poisonous additions.

Bus bars, anodes must be periodically wire brushed, cleaned and kept in a conducting state.

Plating time (duration) must be strictly adhered to, to avoid burning and uneconomical coating. (Lesile,1986)

Equipment must be given periodic servicing and on-line daily, weekly, and monthly maintenance.

To maintain uniform coating, chemical composition of the electrolyte's as well as electrochemistry of the bath must be maintained.

This is not least exhausted but proper adherence to these as well as good house keeping will lead to trouble-free plating.

2.9 Health and Safety Aspect

The very nature of Electroplating processes, products, and by products makes health and safety a primary consideration in setting up an electroplating plant of this nature. Most important fundamental principal is that the safe handling of chemicals, operation of plant and processes is a management responsibility.(Lesile,W.Flott 1986)

Proper facilities, and wares provided must be used judiciously, appropriately and correctly. General precautions must be adhered to properly.

In addition to the wok shop and laboratory design which must

comply with health and safety regulation and requirements, a well organized medical service plays an important role in having efficient and effective workforce. A periodic medical examination is necessary in order to maintain the general good health of employees,(Adegoke R.,2002)

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Enforcement of safety rules and regulations, mixing, and preparation technique of plating solutions, proper operating technique of machines and laboratory equipments and safe handling of chemical and waste are all necessary for a productive and profitable plating shop.

In addition, employees should be encouraged to be interested, alert and observing. Demonstration of respect for safety measures against fire, explosion and other hazards does much to endanger the same attitude amongst those who later carry out electroplating processes as operatives.

Chemical used in electroplating are toxic, carcinogenic and harmful. Cyanides must be stored away from acids and careful storage technique must be emphasized.

It is necessary that one of the supervisors should be trained in first aid or as a safety officer and there is a need to train all workers on matters of health and safety.

2.10 Important Uses and Application of Electroplating Technology

Modern living conveniences and transportation equipment are made up of coated iron since iron is corrosive to air, moisture and fumes. With the remarkable increase of iron products, in recent years, the output of plated products is also increasing tremendously. As

electroplating technique has made great advances, the importance, uses and application of electroplating in industries has widely come to be recognized.

Although plating is applied commercially to copper, brass, nickelbrass, zinc, zinc-base die-casting the greatest proportion is applied to steel.

A small amount of plating is applied to non metals such as plastics, but these must first be coated with some electrically conductive materials. The plating materials are tin, zinc, silver. Nickel and chromium.

However, except in connection with production of tin plate for can industry most plating is done with nickel and chromium. Nickel plating is widely used for corrosion resistance, but since it does not retain its luster for long, it has been replaced to a great extent by chromium. However, chrome is seldom used alone and most chrome plating is a three layer process consisting first of a layer of copper, then one of nickel and finally, a thin layer of chrome 0.0001 inch or 0.00025cm.

The purpose of electroplating is to protect, beautify and also used to build up worn parts to larger dimension. It is also to coat the face of cutting tools to reduce friction and wear and to resist wear on the surface or gauges.

Generally, plating is used to save resources as new functions are added to base materials. This can enhance higher conductivity, improve resistance to corrosion economic and artistic losses. In printed and integrated circuit which is a semi conductor, the chip is surface

treated and gold plated on its lead frame.

The terminal of lead frame is always tin plated or solder plated. Plating is basic industry that supports various other industries. It is not gainsaying or an exaggeration to say that modern industries cannot exist or thrive without plating techniques. The main uses and applications of plating with examples are shown in tables (A) and (B).

Table 2.4A Main Uses Of Plating

PURPOSE	AIM	EXAMPLE OF PLATING	EXAMPLES OF PLATED PRODUCT
DECORATION	Beautify the surface and prevent rust at the same time	Gold, silver, copper, nickel, chromium, zinc (chromate treated)	Bicycles, automobiles, motorbikes, sewing machines, clocks and watches, electric irons, tosters, personal accessories
Corrosion	Prevent rust and discoloration. To serve as undercoat plating for paints	Zinc, cadmium, lead (chromate treated) thodium	Electrical appliances, bolts, nuts, washers
Surface Hardening	Harden the surface to prevent abrasion and enhance duration	Chromium nickel	Chafing parts of energies, various types of rollers
Easing friction	Improve fitting between surface and prevent scratches and disfigurement	Tin	Pistons, piston rings, engine cylinders
Bonding	Ensure close adhesion to prevent exfoliation	Brass	Parts of engines
Preventing cementation and nitriding	Prevent hardening	Copper, tin	Various machine tools
Building up	Match measurements	Chromium nickel, copper	Same as above
eeproducing the surface	Reproduce the same surface (known as electroforming)	Copper, nickel	Matrices for gramophone records
Coloring	After plating, coloration in preferred colors is carried out (sometimes referred to as bronzing)	Copper, brass, zinc, silver, gold, (iron), (stainless steel), (aluminum)	Personal accessories, furniture.

(Fowke D .G 1986)

es:	
EXAMPLES	EXAMPLES OF APPLICATION
Lead, niobium tantalum	General, motor, magnetic levitation train
Quartz, glass, silicon, germanium, indium-gallium arsenic	Fiber optic communications, light measurement video disc computer terminal
Copper, aluminum silver gold sodium	Wire print circuit terminal
Silicon, germanium selenium, gallium arsenic, cadmium sulfide	Transistor, diode, electronic copying machine, IC
Nitrogen, freon, mica, ceramics, glass, bakelite, silicon oil	Insulator, condenser, transformer, breaker
Nichrome, tantalum, manganin, constantan graphite	Resistor, potentiometer, electric furnace, electric heater, transducer
Pure iron, perm alloy, silicon steel	Transformer, motor, generator, relay.
KS steel, MK steel, fernate, alnico	Magnetic head, speaker, cartridge
Platinum, nickel, platinium rhodium	Thermocouple, temperature regulator, temperature measurement
Solder, silver solder, aluminum solder	Wining of parts, assembling of parts, joining of wires
Tin lead, silver , brass	Power fuse, temperature fuse
Gold silver, platinum, tungsten	Switch, jack, relay, switchboard
Tungsten, molybdenum, nickel	Vacuum tube, discharge .tube, X-ray tube.
	EXAMPLES Lead, niobium tantalum Quartz, glass, silicon, germanium, indium-gallium arsenic Copper, aluminum silver gold sodium Silicon, germanium selenium, gallium arsenic, cadmium sulfide Nitrogen, freon, mica, ceramics, glass, bakelite, silicon oil Nichrome, tantalum, manganin, constantan graphite Pure iron, perm alloy, silicon steel KS steel, MK steel, fernate, alnico Platinum, nickel, platinium rhodium Solder, silver solder, aluminum solder Tin lead, silver , brass Gold silver, platinum, tungsten, molybdenum,

Table 2.4B: Classification Of Main Electronic And Application Examples: Examples:

11 General Description Of Electrodepositing Process

The main points of electrophoresis painting are:

 It is a process by dipping: It needs a container or bath of paint the volume of which being large enough to completely immerse the part to be coated: from few liters in a laboratory for painting small panels, the volume may reach several tens of m3 for cap-parts (roof, bonnet) till several hundred m3 for cars.(PAN,1997)

Dipping into the paint tank is proceeded automatically either vertical and discontinuous dip, or continuously by the means of a conveyor which carries the car-bodies into the tank inlet, each one after the other and get it out after needed time at the outlet of the tank. That way the paint is progressively consumed during the dipping of parts; the consumption has to be compensated by addition of equivalent quantity and quality of fresh product to maintain constant paint guality all time along its exploitation.

It is a process involving electricity: A direct current generator is necessary, the negative terminal of which is connected to the part to be painted (cathode) and positive one to anodes+.

2.11.1 Electrochemical Reactions

Electro deposition process may occur if:

- The paint to be coated is electrically conductive.
- Its viscosity is low enough to let the part to be printed completely submerged.
- The part itself is metallic.
- Another metallic contrary electrode is also submerged in the paint bath.
- The part to be painted and the contrary-electrode are connected to a direct current generator

The hereunder plan represents an electrodeposition installation:

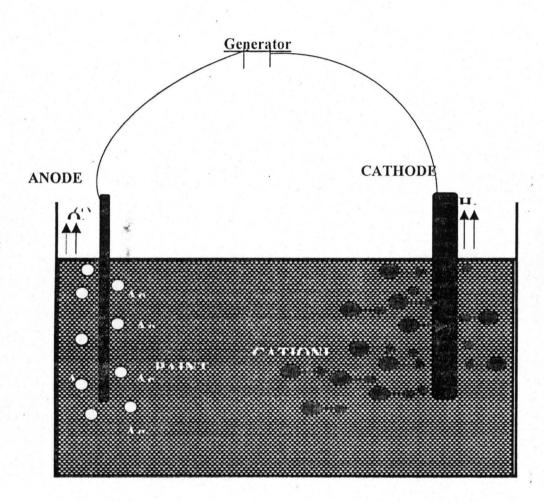


Fig. 2.3: Electro deposition of Paints

Paint is in fact polyelectrolyte in water and behaves, as it is when electrical current passes through. When a voltage input is applied between anode and cathode previously immerged in electrolytes aqueous solution (Paint), electrical field is created from electrons motion.(PAN, 1997)

The electrolyte milieu is here the ionized polymer previously described: Ac; water electrolysis takes place together with ions migration (it is the actual electrophoresis) towards the electrodes: anions Ac to the anode, cations H+ to the cathode.

Reactions at the electrodes occur as soon as a potential difference is applied on terminals of current generator; there are 3 types.

1. Water Electrolysis

At the anode:	$2H_2O$ (1) $O2$	+	4H	+ 4e ⁻
At the cathode:	• 4H₂O+4e ^{_(2)} →	2H2	+	40H ⁻

Obviously Oxygen gassing is produced at the anode, Hydrogen gassing, twice the volume of previous one, at the cathode. Reaction (1) is an oxidation with acidification at the interface anode-paint: reaction (2) is a reduction with alkalinisation at the interface paint-cathode. Both are essential to realize the second type of reactions:

2. Electrodeposition (2) At the anode: $4Ac^{+} + 4H^{+} \rightarrow 4AcH$ + (3)

+

The main side reaction is promoted by the acid created in the anode neigourgh; if this last is made of corrodable material; it is oxidized and constituent metal dissolves. Dissolution promotes metallic cations going to the cathode:

OH

H₂O

At the anode: Me(metal) \longrightarrow Me⁺⁺ + 2e⁻ At the cathode: Me⁺⁺ + 2e⁻ \longrightarrow Me

From all those reactions follows that:

At the cathode

- a. At the same time the paint lays over the steel is produced hydrogen gas form. If this gassing becomes excessive, deposition is obstructed; then too powerful electrical field privileges water electrolysis to the detriment of paint electrodeposition, rupture is occurring.
- b. If the resin is highly ionized, rupture becomes worse because NH+ groups on a given molecule need identical number of OH- groups.

49.

To create OH-, same number of voltage electrons is consumed and proportional quantity of hydrogen escapes.

Moreover it is not necessary to neutralize all amine groups 'n' in NH+' to make the cationic polymer water soluble; minimum neutralization reaction is related to the polymer molecular weight. Excess of electricity consumption (electron volt 'e' = 96.500 Coulombs) + risk of rupture even with low powerful electrical field + enough solubility in water are the 3 reasons why cationic binder is always under-neutralized: neutralization reaction (number of equivalents of Ac-/number of equivalent of N) is generally managed between 40 and 60%. Control of this ratio is mentioned.(PAN,1997)

There is a strong risk of anode corrosion, the reason why it is necessary to use non-corrodable material for anode, like graphite stainless steel.

Hence depositing of paint is the result of 4 connected events:

- Water Electrolysis
- Cations migration; is electrophoresis.
- Polymer coagulation on the cathode-liquid interface; is electrodeposition.
- Water shrinkage from that interface by osmotic pressure to let an homogeneous coat of coagulated polymer be deposited; is electrolysis.

2.12 Description Of The Product

Chrome is a blue white metal that takes on a high polish. It is hard, malleable, ductile, somewhat ferromagnetic and a fair conductor of electricity and heat.

The atomic mass of natural chrome is 24 and mass no of 51.996g, a member of the block and a group II of the periodic table of elements. It has melting point Of 187^oC and boiling point of 2672^oC. Chrome is of moderate strength and Hardness, when viewed as very small particles chrome appears black as do Metals in general.

Chrome has the following physical properties tensile strength of 600N/mm², Proof stress of 132 N/mm², modulus of electricity of 220kn/mm², hardness Between 80 – 150 and specific gravity of 8.80 chrome plating is applied over underplated layers of copper and nickel for decorative purposes and directly on the base metal for engineering purpose.

Chrome may be either shiny or dull and often tends to highlight imperfections In the base metal only very thin amount of chrome is coated on the metal. The usual thickness for bright chromium deposits is 0.25 to 0.8 microns (0.00001 to 0.00003 In²). hardchrome is applied for wear resistance, or to restore an old warn out part to its original dimensions. It is general applied directly onto the base metal.

Chrome plated products are wrist watches chains, screw drivers, spanners, steel (car bombers), key Holders, keys, jewelry, padlocks, wheels, rim, bicycle part etc.(JOE L. et al 1981).

Table 2.5 Trouble Shooting Grade for Chrome Electroplating

PROBLEM	POSSIBLE CAUSES	SUGGESTED SOLUTION
Poor chromium coverage	i. Decorative Chromium Rectifier failure.	Check rectifier meters for stable operation. AC ripple should not exceed 5%. Rectifier should operate at 38% traced amperage.
	ii. Poor electrical connection	Check electrical connections for lightness and contact.
	Inactive anodes	Check coating on anodes. A yellowish lead chromate coating indicates that the anode is inactive. A black-brown lead peroxide coating is on active anodes. Make sure proper current is used. When plating inside diameters. Use largest anode possible.
	Incorrect bath temperature.	Check bath temperature. Check bath agitation.
	Incorrect bath concentration.	Mix bath thoroughly and take bath sample. Analyze chromium and sulfate content. Adjust accordingly.
	iii. Improper racking	Check rack-to-fixture connection.
	Poor cleaning or rinsing.	Incorporate shields or rubbers in racking to direct current to specific areas.
	Copper or nickel roughness	Check temperature of raising water and maintain between 70 and 750F (21 and 240C).
	Passive nickel	Check copper or nickel plate for roughness.
	Chloride contamination	Dip nickel-plated part in 50% by volume solution of hydrochloric acid. If part brightness increases, correct nickel-plating bath. Dammy with high anode current density and agitation or treat with
	Improper current density.	silver oxide. Add sulfate acid to lower ratio and

		barium carbonate to increase ratio.
	Incorrect chronic acid to sulfate catalyst ratio.	Limit metallic impurities to less than 0.5 oz/gal (3.75 g/l). increase chronic acid concentration.
	Impurities.	Add sulfuric acid to lower ratio and barium carbonate to increase ratio.
	*	Limit metallic impurities to less than 0.5 oz/gal (3.75g/l). increase chronic acid concentration.
Burned chromium deposits	iv. Passive nickel deposit	Current nickel brightener
		concentration increase density in nickel bath.
	Incorrect bath temperature	Correct bath temperature.
	Improper bath concentration.	Analyze chromium and sulfate content. Correct if necessary.
	Inactive anodes.	Check anode color. Inactive anodes are coated with a yellowish lead chromate.
	Incorrect anode length.	Anode should be $2-4^{0}$ (50-100mm) shorter than cathode. Mask anodes that are too long with suitable insulator or cut to proper length.
	Current interruption.	Check racking of parts and electrical contacts.
	Improper Racking.	Check rack to fixture connection. Incorporate shields or rubbers in racking to direct current to specific areas.
	High current density.	Place work 3^{0} (75mm) below surface of plating solution.
	Sulfate de-concentration or other catalyst too high.	Add barium carbonate to bath to lower sulfate concentration. Ratio should be 2.1.
	High or low concentration	Check ratio and adjust accordingly.

	ration.	
Dull chromium deposit.	v. Dull or passive nickel.	Correct nickel brightener concentration. Increase current density in nickel bath.
	Excessive ripple in current.	Check rectifier operation. Ripple should not exceed 50%.
	Current interruption.	Check racking of parts and electrical contracts.
	Incorrect bath temperature.	Correct bath temperature.
	Low current density.	Adjust current density to bath temperature and concentration. Check rinsing procedures.
	Impurities.	Limit metallic impurities to less than 0.5 oz/gal (3.75 g/l). increase chronic acid concentration.
	Excess fluoride catalyst or fluoride contamination.	Add boric acid to reduce catalyst or use high anode current density dummy.
	High or low concentration ratio.	Check ratio and adjust accordingly.
White Motching	vi. Film of immersion nickel on work piece.	Rinse work piece thoroughly.
	Passive Nickel.	Check nickel plating bath or proper concentration.
	Excessive ripple in current.	Check rectifier operation. Ripple should not exceed 5%.
*	Bipolarity caused by rapid work movement in automatic machines.	Reduce speed of work movement through machine.
	Bipolarity caused by dead entry into chromium.	Use live lead at reduce current.
	Bipolarity caused by dead entry into chromium.	Use live exit-lead from nickel.

	Bipolarity caused by dead exit from nickel tanks.	Check rinsing procedures.
	Impurities especially chloride.	
Deposit roughness.	vii. Poor basis metal finish.	Reject parts with rough finish.
	Copper or nickel roughness.	Check copper or nickel-plating for roughness.
Poor Chromium adhesion.	viii. Poor nickel adhesion.	Refers to solutions for bipolarity conditions under "white blotching".
No Chromium Plate.	ix. Rectifier failure.	Check operation of rectifier. Rectifier should operate at no less than 75% rated amperage.
	Poor electrical connections.	Check connections for good contact.
	Missing anodes.	Check for replacement of anodes after they have been removed.
	Passive nickel.	Check nickel bath.
	Low current density.	Adjust current density to bath temperature and concentration.
	Incorrect catalyst concentration.	Analyze chromium-plating solution and adjust accordingly.
Poor Chromium brightness.	x. Hard Chromium.	
	xi.	,
	xii. Poor basis metal finish. Excessive reverse etching.	
	Improper bath temperature.	Correct bath temperature. Check bath agitation.
	Improper bath concentration.	Take Bauman reading of bath and correct.
	Improper current density.	Adjust current density to bath
	High concentration ratio.	temperature and concentration.
		Check ratio and adjust accordingly.
Chromium roughness.	xiii. High trivalent chromium.	Check color of chromium solution; a black color indicates trivalent chromium contamination. Electrolyze chromium-plating solution.

1.	Magnetic particles.	Attach a magnet to a piece of wood and then drag through solution to remove particles.
	Excessive reverse etching.	Adjust current density to bath temperature and concentration.
영상에 가슴을 많다.	High current density.	Check ratio and adjust accordingly.
	Improper concentration ratio.	
Bauer Chromium deposit.	xiv. Improper concentration ratio.	Check ratio and adjust accordingly.
	xv.	Check rack design and contacts.
	xvi. Poor fixturing. xvii. xviii.	Use shield to direct current to specific areas.
	xix. xx.	Anode should be shorter than cathode. Mask anodes that are too long with suitable insulator.
	xxi. Incorrect Anode length. xxii. xxiii. xxiv. xxv. xxv. xxvi. Improper anode- cathode relationship. xxvii.	For outside diameter plating. Anode cathode distance should be approximately 4" (100mm). For inside diameter plating. The distance should be from ¹ / ₂ or 1 (12-25mm).
Poor Chromium adhesion.	xxviii. Improper cleaning or rinsing.	Follow recommended cleaning procedure.
	Improper reverse etching.	Do not reverse etch in plating bath. Current used in reverse etching should be proportionated to work areas. Work should be at bath temperature before applying current.
	Current interruption.	Check racking of parts and electrical contacts.
Burned Chromium deposits.	xxiv. Etching in alkaline cleaner	Check cleaner concentration.
	Improper fixturing.	Racks should be made from copper for best results. Check rack design and contact.

No Chromium plate.	xxxii. Reculfier failure.	Cheek operation of rectifier.
No Chaming Int	Incorrect fume suppressant.	Eliminate use of fume suppressant that lower surface tension.
	Incorrect catalyst suppressant.	Analyze chromium plating solution and adjust accordingly.
	Improper cleaning.	Check cleaning procedures.
Fitting	xxxi. Poor basis metal and rework.	Check metal prior to plating.
	Insufficient deposit thickness.	Check deposit thickness.
	High ratio.	Check ratio and adjust.
	Improper bath concentration.	Take Baume reading of bath and correct.
hardness.	temperature.	
Lack of chromium	xxx. Incorrect bath	Check bath temperature and agitation
	Excess catalyst or chloride contamination.	김 관계의 영제를 많이 많다.
	Impurities.	
	High current density.	Adjust current density to bath temperature and concentration.
	Low bath concentration.	Adjust current density to bath temperature and concentration.
	Improper bath temperature.	Mix bath thoroughly and take sample to obtain baume reading. Adjust accordingly.
	Inadequate stop-off anodes.	Correct bath temperature.
	Improper anode length.	Anode should be shorter than cathod
	Improper solution level.	Work should be 3" (75mm) below surface of plating solution.
	Improper anode cathode relationship.	See "uneven chromium deposit".

ŝ

	Poor electrical connection.	Check connections for good contact.
	Missing anodes.	Check if anodes are properly placed.
	Inactive anodes.	Check anode colour reactive anodes and coated with a yellowish lead chromate.
	Incorrect catalyst	Analyze chromium plating solution
	concentration.	and adjust accordingly.
PROBLEM	POSSIBLE CAUSES	SUGGESTED SOLUTION
Poor chromium coverage	i. Decorative Chromium Rectifier failure.	Check rectifier meters for stable operation. AC ripple should not exceed 5%. Rectifier should operate a
	ii. Poor electrical	38% traced amperage. Check electrical connections for
	connection	lightness and contact.
	Inactive anodes	Check coating on anodes. A yellowish lead chromate coating indicates that the anode is inactive. A black-brown lead peroxide coating is on active anodes. Make sure proper current is used. When plating inside diameters. Use largest anode possible.
	Incorrect bath temperature.	Check bath temperature. Check bath agitation.
	Incorrect bath concentration.	Mix bath thoroughly and take bath sample. Analyze chromium and sulfate content. Adjust accordingly.
	iii. Improper racking	Check rack-to-fixture connection. Incorporate shields or rubbers in racking to direct current to specific areas.
	Poor cleaning or rinsing.	Check temperature of raising water and maintain between 70 and 750F (21 and 240C).
	Copper or nickel roughness	Check copper or nickel plate for roughness.
	Passive nickel	Dip nickel-plated part in 50% by volume solution of hydrochloric acid.

L +	-	If part brightness increases, correct
		nickel-plating bath.
승규는 것은 것을 가지 않는 것		Dammy with high anode current
한 것은 것에서 관련하는 것이 같은 것을 가지?		density and agitation or treat with
[16] 다섯 않은 4 - 14 상태로		silver oxide.
이번 물란이 많은 것이 많을 것이다.		승규는 것은 것이 다시 않는 것을 것을 하는 것을 하는 것을 수 없다.
그는 이 가지 같은 것, 여름한 동안 생각	Chloride contamination	Add sulfate acid to lower ratio and
		barium carbonate to increase ratio.
	Improper current density.	Limit metallic impurities to less than
방법에서 방문에서 동물이 주네.		0.5 oz/gal (3.75 g/l). increase chronic acid concentration.
		acid concentration.
	Incorrect chronic acid to	Add sulfuric acid to lower ratio and
	sulfate catalyst ratio.	barium carbonate to increase ratio.
	surface cataryst ratio.	
	Impurities.	Limit metallic impurities to less than
		0.5 oz/gal (3.75g/l). increase chronic
£		acid concentration.
Burned chromium deposits	iv. Passive nickel deposit	Current nickel brightener
		concentration increase density in
		nickel bath.
	To a local de marca antenno	Compatibath tomporatura
생동 방문에 왜 힘든 것같다.	Incorrect bath temperature	Correct bath temperature.
	Improper bath	Analyze chromium and sulfate
	concentration.	content. Correct if necessary.
		물건 아버지는 말을 다 친구가 한다.
	Inactive anodes.	Check anode color. Inactive anodes
이 모양 집안에서 잘 수 있는~~	김 영제 가장 가지, 김 영제 영제	are coated with a yellowish lead
		chromate.
ž	영상 이 같은 것을 많이 같아.	
	Incorrect anode length.	Anode should be $2-4^{\circ}$ (50-100mm)
		shorter than cathode. Mask anodes
		that are too long with suitable
		insulator or cut to proper length.
	Current interruption.	Check racking of parts and electrical
	aprom	contacts.
, 영소방법을 많이 한 모그럼		
변화 병가 성내용을 입니었다. 이상	Improper Racking.	Check rack to fixture connection.
성 방법방법 아직의 경험을 하는		Incorporate shields or rubbers in
		racking to direct current to specific
화장이 이는 사람님이 다 가 있어?		areas.
전화 방송 동안 제 영요	High ourrent density	Place work 3^0 (75mm) below surface
L	High current density.	Flace work 5 (75mm) below surface

		of plating solution.
	Sulfate de-concentration or other catalyst too high.	Add barium carbonate to bath to lower sulfate concentration. Ratio should be 2.1.
	High or low concentration ration.	Check ratio and adjust accordingly.
Dull chromium deposit.	v. Dull or passive nickel.	Correct nickel brightener concentration. Increase current density in nickel bath.
	Excessive ripple in current.	Check rectifier operation. Ripple should not exceed 50%.
	Current interruption.	Check racking of parts and electrical contracts.
	Incorrect bath temperature.	Correct bath temperature.
	Low current density.	Adjust current density to bath temperature and concentration. Check rinsing procedures.
	Impurities.	Limit metallic impurities to less than 0.5 oz/gal (3.75 g/l). increase chronic acid concentration.
	Excess fluoride catalyst or fluoride contamination.	Add boric acid to reduce catalyst or use high anode current density dummy.
	High or low concentration ratio.	Check ratio and adjust accordingly.
White Motching	vi. Film of immersion nickel on work piece.	Rinse work piece thoroughly.
	Passive Nickel.	Check nickel plating bath or proper concentration.
	Excessive ripple in current.	Check rectifier operation. Ripple should not exceed 5%.
	Bipolarity caused by rapid work movement in automatic machines.	Reduce speed of work movement through machine.

	Disalation and have dead	The line land at and the assument
	Bipolarity caused by dead entry into chromium.	Use live lead at reduce current.
ð	Bipolarity caused by dead entry into chromium.	Use live exit-lead from nickel.
*	Bipolarity caused by dead exit from nickel tanks.	Check rinsing procedures.
	Impurities especially chloride.	
Deposit roughness.	vii. Poor basis metal finish.	Reject parts with rough finish.
	Copper or nickel roughness.	Check copper or nickel-plating for roughness.
Poor Chromium adhesion.	viii. Poor nickel adhesion.	Refers to solutions for bipolarity conditions under "white blotching".
No Chromium Plate.	ix. Rectifier failure.	Check operation of rectifier. Rectifier should operate at no less than 75% rated amperage.
	Poor electrical connections.	Check connections for good contact.
1	Missing anodes.	Check for replacement of anodes after they have been removed.
	Passive nickel.	Check nickel bath.
	Low current density.	Adjust current density to bath temperature and concentration.
	Incorrect catalyst concentration.	Analyze chromium-plating solution and adjust accordingly.
Poor Chromium brightness.	x. Hard Chromium. xi.	
	xii. Poor basis metal finish. Excessive reverse etching.	Correct bath temperature. Check bath agitation.
	Improper bath temperature.	Take Bauman reading of bath and correct.
	Improper bath concentration.	Adjust current density to bath temperature and concentration.
	Improper current density. High concentration ratio.	Check ratio and adjust accordingly.

Chromium roughness.	xiii. High trivalent chromium.	Check color of chromium solution; a black color indicates trivalent chromium contamination. Electrolyze chromium-plating solution.
	Magnetic particles.	Attach a magnet to a piece of wood and then drag through solution to remove particles.
	Excessive reverse etching.	Adjust current density to bath temperature and concentration.
	High current density.	Check ratio and adjust accordingly.
	Improper concentration ratio.	
Bauer Chromium deposit.	xiv. Improper concentration ratio.	Check ratio and adjust accordingly.
	xv.	Check rack design and contacts.
	xvi. Poor fixturing. xvii. xviii.	Use shield to direct current to specific areas.
	xix. xx.	Anode should be shorter than cathode. Mask anodes that are too long with suitable insulator.
	xxi. Incorrect Anode length. xxii. xxiii. xxiv. xxv. xxv. xxv. xxvi. Improper anode- cathode relationship.	For outside diameter plating. Anode cathode distance should be approximately 4" (100mm). For inside diameter plating. The distance should be from ½ or 1 (12-25mm).
Poor Chromium adhesion.	xxvii. xxviii. Improper cleaning	Follow recommended cleaning
	or rinsing.	procedure.
	Improper reverse etching.	Do not reverse etch in plating bath. Current used in reverse etching should be proportionated to work areas. Work should be at bath temperature before applying current.
	Current interruption.	Check racking of parts and electrical contacts.

Burned Chromium deposits.	xxiv. Etching in alkaline cleaner	Check cleaner concentration.
	cleaner	Deales should be made from conner
	Improper fixturing.	Racks should be made from copper for best results. Check rack design and contact.
	Improper anode cathode relationship.	See "uneven chromium deposit".
	Improper solution level.	Work should be 3" (75mm) below surface of plating solution.
	Improper anode length.	Anode should be shorter than cathode.
	Inadequate stop-off anodes.	Correct bath temperature.
	Improper bath temperature.	Mix bath thoroughly and take sample to obtain baume reading. Adjust accordingly.
1. 1.	Low bath concentration.	Adjust current density to bath temperature and concentration.
	High current density.	Adjust current density to bath temperature and concentration.
	Impurities.	
	Excess catalyst or chloride contamination.	
Lack of chromium	xxx. Incorrect bath	Check bath temperature and agitation.
hardness.	temperature.	말 다 하는 것 같아. 아이는 것 같아. 말 하는 것을 가 봐.
	Improper bath	Take Baume reading of bath and correct.
	concentration.	
	III also media	Check ratio and adjust.
	High ratio.	Check deposit thickness.
이 같은 것은 가지 않는 것이 있다. 같은 것은 것은 것이 같은 것이 있는 것이 같은 것이 같이 있다. 같은 것은 것은 것이 같은 것이 같은 것이 같은 것이 같이	Insufficient deposit thickness.	Check deposit unexiless.
Fitting	xxxi. Poor basis metal and	Check metal prior to plating.
i nung	rework.	Check metal pror to plating.
김 국민은 그는 것이 같아.		Check cleaning procedures.
영양 안에 없는 것이야?	Improper cleaning.	B Proceduros.
	<u> </u>	Analyze chromium plating solution
	Incorrect catalyst suppressant.	and adjust accordingly.

	Incorrect fume suppressant.	Eliminate use of fume suppressant that lower surface tension.
No Chromium plate.	xxxii. Rectifier failure.	Check operation of rectifier.
	Poor electrical connection.	Check connections for good contact.
	Missing anodes.	Check if anodes are properly placed.
	Inactive anodes.	Check anode colour reactive anodes and coated with a yellowish lead chromate.
	Incorrect catalyst concentration.	Analyze chromium plating solution and adjust accordingly.

2.13 Small Scale Industries

2.13.1 Definitions

It will be vague to offer a precise definition of the terms "small scale" business because the expression covers a wide range of activities that are related to social and economic development of a given nation, even among researchers and practitioners, There has been no consensus as regards what constitutes a small scale business. The multiplicity of definition relates to the culture and peculiar circumstances of the person(s) attempting the definition. (Adama et al, 2003).

Hence, there is no single yardstick for classifying a business unit as small scale. The classification essentially varied according to time and setting. Since attempts in the past to produce a universally accepted definition of what business unit can rightly be referred to a small scale, industry had caused some confusion and protracted debate among discussant. So the solution to this multiplicity of definition or criteria employed would seem to be in the revision of whatever definition is used from time to time based on specific objective as to what these micro economic unit are meant to achieve (Blunt et at, 1990).

The central Bank of Nigeria in its 1998 operational guidelines defined small-scale business with reference to two Financial Institutions; the Merchant Bank, a small scale business is the "one with a capital investment of more than N200,000 excluding the cost of land and annual turnover of N500,000". But for Commercial Banks, a small scale business is "one with maximum annual turnover not exceeding

N500,000(Koh,1988).

The center for management science development at the University of Netherlands, defines a small-scale business as a business in which manager personally perform at the function of management. These centers classifies small scale business as an establishment employing not more than 99 persons, while the employment of 1-9 persons is regarded as cottage industry (Blunt et al, 190).

The United Nations industrial development organization (UNIDO) classified small scale enterprises as those with less than 150 employees on its pay roll. Such enterprises can be classified into two:

i. The traditional craftsmen and artisan and

ii. The small manufacturing enterprises which produce a variety of consumer and simple producer goods.

The Nigeria Bank for commerce and industry (NBCI) in 1987, defined small enterprises as those with total cost of not more than 750,000.

This definition which is expected to be valid until 1990 before it is reviewed has been accepted by the government (Central Bank of Nigeria, 1995).

However, the definitions of small scale enterprises as those whose total cost, excluding cost of land but including working capital is above N1,000,000 but does not exceed N10,000,000 has irraddvertently left out credit-worthy cottage industries. This has created problems for the category of enterprises and banks that are other-wise disposed to granting credit to them. For this purpose therefore, small scale enterprises shall include cottage industries and defined as enterprises whose total cost, excluding cost of land but including working capital does not exceed N10,000,000 (Oladeepo, 1998).

Finally, according to National Council of Industrial/Federal Ministry of Industry, 2002 gives the following definition as regards various sectors of industries.

- Cottage Industry: This is any firm with total cost including working capital but excluding cost of land below N1.5 million and labour size below 11 workers.
- Small Scale Industry: This is any firm with total cost including working capital but excluding cost of land above N1.5million but not exceeding N50 million and labour size between 11 and 35 workers.
- iii. Medium Scale Industry: This is any firm with total cost including working capital but excluding cost of land above N50,000,000 but not exceeding N200,000,000 and labour size of between 36 and 100 workers.
- iv. Large Scale Industry: This refers to any firm with total cost including working capital but excluding cost of land above N200 million and labour size above 100 workers (Onyeneke, 2002).

Furthermore, the revision of these definitions are done from time to time to enable many more unit of small scale industry to modernize their operation and following the trend of change within the sector.

2.13.2 Cost indices

A cost index is merely an index value for a given point in time, showing the cost at that time relative to a certain base time. If the cost at some time in the past is known, the equivalent cost at the present time can be determined by multiply the original cost by the ratio of the present index value to the index value applicable when the original cost was obtained (Peters and Timmerhaus, 1991).

Present Cost = (Original Cost) x (Index value at preset time) / (Index value at time Original cost was obtained).

Statements of cost are based on the value of the dollar at a given year, and a cost index is needed to compare cost, which are presented on different bases. The uses of cost index to express the changing purchasing power of the dollar dates back to 1913 with the ENR cost index which is a weighted average of the cost of steel, lumber, cement and common labour (Rudd and Watson, 1968).

Cost Indices can be used to give a general estimate, although, no index can take into account all factors, such as special technological advancement, or local conditions.

The common index permits fairly accurate estimates if the time period involved is less than 10 years.

Many different types of cost Indices are published regularly. The most common of these Indices which can be used for estimating equipment cost are the Marshall and Smith Equipment Cost Index, and the Chemical Engineering Plant Cost Index. For the purpose of this work, the latter shall be used.

2.13.3 Chemical engineering plant cost index

Construction cost for chemical engineering plants form the basis of the Chemical Engineering Plant Cost Index. The four major components of this index are weighted by percentage in the following manner: equipment, machinery and supports, 61; erection and installation labour, 22; building materials and labour, 7' and engineering and supervision, 10. The major component, equipment, is further subdivided and weighted as follows:

Fabricated equipment, 37; process machinery, 14; pipes, valves and fillings, 20; process instruments and control, 7; pumps and compressors, 7; electrical equipment and materials, 5; structural supports, paints and instrumentation, 10. All index components are based on 1957-1959 = (Peter and Timmerhaus).

2.14 Process Simulation

This is an act of representing some aspects of the real world by symbols that may be easily manipulated to facilitate their study. The important steps of process simulation are therefore, description of the part of the "real world" that needs to be simulated, representation of this part of the 'real world' in terms of a model (mathematical or symbolic), and finally, solution of the mathematical model to obtain numbers or symbols. With respect to chemical engineering, the real world is a chemical process described by a process flow sheet. Typically, process simulation is needed to solve problems related to process design, process analysis, process control and many more. Depending on the type of the problem, different types of process

simulation problems are formulated. For example, verification of design or for inventory control (mass and energy balance) requires the solution of steady state simulation problems while verification of the control system or analysis of the effect of disturbances requires the solution of dynamic simulation problems.

Obviously, each simulation problem is associated to a corresponding mathematical model. In steady state simulation, the mathematical model is usually represented by a mixed set of algebraic equations and ordinary differential equation. For complex or rigorous simulation problems, the mathematical model may even be represented by a mixed set of algebraic equations. Each mathematical model, therefore, is associated to a corresponding method of solution.

Since there can be many way to solve a set of equat6ions representing a mathematical model, it is necessary to have a simulation strategy which ensures that the simulation problem is solves efficiently and that the simulation results are reliable. Reliability also depends on the model accuracy. Use of inappropriate models or modes parameters may result in erroneous simulation results. (floudas, 1995).

As described above, process simulation requires a number of important steps that are linked to each other. Each step, however, can be large enough to justify the use of a computer to solve the problem. A computer problem that combines the important steps into a single program package is called a process simulator. The process simulator is designed to help the user in performing the important steps without the need to develop new computer programs for solving new

problems.

In the solution of problems related to process synthesis or design, control or operation, analysis etc., the user needs to provide sufficient information to properly specify the simulation problem. Typically, a simple steady state simulation of a process flow sheet requires a description of the process flow sheet (including an identification of the compounds present in the system and unit operations present in the flow sheet), choice of method of solution, specification of equipment parameters and input streams and many more. Solution of a process design problem may require many solution of the process simulation problem (for each trial, a different simulation problem may need to be solved). User does not have all the information necessary to specify the simulation problems, in order to assist the user; the concept of an integrated simulation system has been introduced.

The objective of integrated system is to help the user to generate the necessary information so that a simulation problem can be properly defined and solved. Usually, the time spent on collecting the information necessary to defined a simulation problem is much greater than the time spent by the process simulator in finding the solution. By reducing the time spent by the user in defining the simulation problem, the integrated system helps to improve the work efficiency or user. In the integrated system, the user has available, computational tools that can be used to generate the missing information.

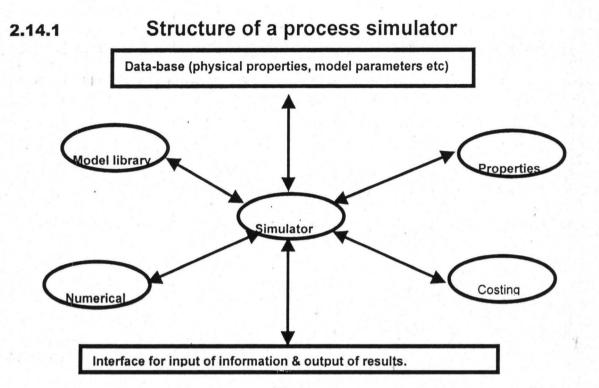


Figure 2.4 Main features of a process simulation

2.14.2 Commercial process simulators

The three common commercial process simulator are;

ASPEN Plus - Aspen Technology, USA.

Pro-II/Provision – Simulation Sciences, USA (Seibe, UK)

HYSIS-Hypro tech, Canada (AEA Technologies, UK).

ASPEN and Pro-II are steady state process simulators with process optimization feature. Both of them employ a sequential modular approach. HYSIS provides both steady and unsteady simulation features. It employs a mixed simulation strategy. ASPEN has the largest number of users followed by pro-II and then HYSIS. All the three simulators have windows-based PC-versions. All have extensive data for compound and physical properties, it has a large collection of unit operation models and thermodynamic models.

Computer application to chemical engineering

Computer can be applicable to the following chemical engineering subject: Heat transfer, process dynamic and control, introduction to Chemical Engineering, , chemical reaction engineering, fluid mechanics, mathematical methods, thermodynamics, separation process, process design and electrochemical processes.

2.14.4 Hysys

This simulator provides you with an intuitive and interactive approach toward process modeling, simulation and optimization.

This software lets you to create detailed high-fidelity plant simulations for analyzing and optimizing your plant's operation. Through the completely interactive HYSYS interface, you have access to a fine level of equipment geometry, performance detail as well as the ability to completely customize your simulation using its extensibility capability.

This program is used by industry to design and simulate process plants such as oil and gas refineries, chemical and pharmaceuticals production and electrochemical facilities. (HYSIS Simulation Manual, 2004).

2.14.5 MathCAD

MathCAD provides a rich problem-solving environment that gives you a wide choice of tools and supports a variety of analysis and visualization techniques. MathCAD is used by hundreds of thousands of engineers, scientists, and students across a broad range of technical disciplines to perform calculations, to interface with other engineering,

2.14.3

drawing and business applications and to publish their "live" documents on the web.

In the most general sense, you can think of MathCAD as a combination of;

 A powerful technical computing environment centered on real math notation.

And

(ii) A flexible, full-featured technical word processor.

This means that with MathCAD the tasks of performing computations and documenting them are integrated into one seamless process, resulting in substantial increases in productivity.

2.14.5.1 features of the mathCAD window

Before you move on to learning more about MathCAD's features and especially about building math and text in your own MathCAD worksheets, take a moment to look at the MathCAD application window in front of you.

(a) The Main Menu

<u>F</u> ile	<u>E</u> dit	View	Insert	<u>F</u> ormat	
Math	<u>Symbolic</u>	Window	<u>H</u> elp		

This gateway to math, graphics, and functions provides the commands that handle the details of editing and managing your worksheets. Click on the menu to see the array of computational and formatting functionally available to you.

2.14.5.2 the math toolbar

Choose Toolbars Math from the View menu to see a tear-away bar whose buttons bring up toolbars of math operators. You can click the bar under the main menu. If you let your mouse however each of the buttons on the bar in turn, you will see a tool tip telling you what menu each button brings up:

Calculator toolbar Boolean toolbar Graph toolbar Programming toolbar Greek toolbar

Calculus toolbar

Matrix toolbar

Click on one of these buttons in the bar to bring up the associated operator toolbar. You can then use the operator toolbar to insert math symbols right into your MathCAD worksheet.

2.15 Costing

It is an economic fact that the purchasing power of the monetary unit, no matter what the currency is, erodes and depreciates with time, and there is little if any reason, to suggest that this trend will change in the future. This depreciation in the value of money is termed inflation. Inflation is the rise in price level or fall in the purchasing power, or the rate of increase in some national price level. The official rate of inflation is based on a specified mixture of goods required in cash outlay required to purchase this basket of goods is the official rate of inflation.

Due to inflation and other factors, the economic environment in which a chemical plant (Chrome Electroplating Plant) operates is a dynamic and not static one, and it undergoes continuous change, as will the factors that determine its profitability, e.g. labour, raw materials and utilities. The overall cost of establishing such a plant will equally change upwards, as the years slowly go by. One of the most important factors contributing to the changes above is inflation, which will also seriously affect the cost of equipment.

2.15.1 Equipment cost estimation

There are methods of estimation of equipment costs of the Chrome Electroplating Plant amongst are the method of Cost Index, the Six-Tenth-Factor Rule Method, and method of Cost Index and scaling.

2.15.2 The method of cost index

If the cost of each piece of equipment at sometime in the past is known, then the equivalent cost at the present time can be determined by multiplying the original or historical cost by the ratio of the present index value to the historical index value applicable when the historical cost was obtained (See Table 3.1 for cost data).

Let historical cost (Original) cost of each equipment be HC, say; the historical cost index be HI; the current cost index be CI, and the current cost of the current cost of the equipment be CC.

Therefore, the current cost of any equipment was given by the following equation:

2.15.3 Six-tenths factor rule method

It is often necessary to estimate the cost of a piece of equipment when no cost data are available for the particular size of operational capacity in question. Good results can be obtained by using the logarithmic relation known as the six-tenth-factor the cost data are available. According to this rule, if the cost of a given equipment at one capacity is known, the cost of a desired similar unit with X times the capacity of the first equipment is approximately $(X)^{0.6}$ times the cost of the original equipment.

Let HCB – historical cost of equipment B (desired).

HCA – historical cost of equipment A.

QA – known capacity of equipment A.

QB – capacity of equipment B.

Therefore, the historical cost of equipment B that is not available in literature is given by:

 $HCB = HCA (QB/QA)^{0.6} \dots 2.8$

The current cost of equipment A is given by the following cost index equation:

From equation 3.2, it follows that the current cost of the desired equipment B is given by:

 $CCB = HCA (CIA/HIA)(QB/QA)^{0.6}$

Combining equation 3.1 and equation 3.4 obtain.

CCB = HCA (CIA/HIA)(QB/QA)^{0.6}.....2.11

2.15.4 Method of cost index and scaling.

This method is similar to the Six-Tenth-Factor Rule method, but different in the fact that whereas the index to which the equipment capacities are raised was constant (0.6) for the former method, it varied for this method depending on the equipment. Secondly this method is used when cost data for a particular size of operational capacity of the same equipment is available, but lack for the desired size.

The current cost of a piece of equipment of desired size B was given by the following equation:

CCB = HCA (CIA/HIA) (QB/QA)^{EI}.....2.12

Cost data for this equation is given in Table 3.1.

2.15.5 Estimation of the delivered purchased equipment cost

The cost of delivered purchased equipment is the basis for estimating Capital Investment. This was computed here as a summation of the individual equipment costs determined by any of the three equipment cost estimation methods discussed in 3.2.1.

Therefore,

 $\Sigma_{i=1}$ PECT = CC₁.....2.13

Cost data for this equation is given in Table 3.1.

2.15.6 Estimation of the fixed capital investment

This consists of manufacturing fixed-capital investment, which represents the capital necessary for the installed process equipment with all auxiliaries that are needed for complete process operation are typical examples of costs included in the manufacturing fixed-capital investment.

Fixed capital required for construction of overheads and for all plant components that are not directly related to the process operation is designated as the non-manufacturing fixed-capital investment. These plant components included the land, processing buildings, administrative and other offices, warehouses, laboratories, transportation, shipping and receiving facilities, utility and waste disposal facilities, shops and other permanent parts of the plant. The construction overhead costs consist of field-office and supervision expenses, home-office expenses, engineering expenses, miscellaneous construction cost, contractor's fees, and contingencies (Peters and Timmerhaus 1991).

The fixed-capital investment shall be determined by means of the factored estimate method, which is a method by which the investment cost in a completed system can be extrapolated from the delivered cost of the major items of processing equipment (Rudd and Watson, 1968).

It has been observed that the cost of the other essential items needed to complete the process system can be correlated with the investment cost in major items of equipments, and the capital investment can be estimated by the application of experience factors to the base investment of delivered purchased equipment cost (Rudd and Watson 1968).

Thus, the factored estimate equation below results. The experience factors f are obtained from a study of many similar processing systems. Values for the directs and indirect factors are given in Table 3.2.

FCAPN = [PECT + (Σf_1 PEECT)] f_12.14 Where $f_1 = (1 + \Sigma f_1)$.

2.15.7 Computation of the total and working capital investments.

Total capital investment consists of fixed capital and working capital investment.

The fixed-capital investment was taken as eighty five percent of the total capital investment, while the remaining fifteen percent became the working capital investment.

Thus, the total capital investment given by;

And, the working capital investment was given by:

Cost estimation of equipment and economic acceptable plant design must present a process that is capable of operating under conditions which will yield profit when the cost for any type of commercial process is to be determined, sufficient accuracy has to be provided for reliable decision.

There are many factors affecting investment and production cost. These are:

i. Company Policies

Source of equipment

ii. Price fluctuation

iii. Operating and rate of production

iv. Government Policies

(Peters et al, 1991)

Before an industrial plant can be put into operation, a large sum of money must be supplied to purchase and install the necessary machinery and equipment. (Gaeul, 1977).

Hysis cost estimation and Marshal and Smith cost estimation index were used and the summary of result for the cost can be seen in chapter four.

Cost of equipment from hysis online cost.

Simulator and cost are in Dollar.

Exchange rate ER is 150 Naira = 1 Dollar

This cost estimation is based on cost data of 2006 and is available in dollar.

Exchange rate (ER) 130 Naira = 1 Dollar

Data for cost of Acid pickling tank' Degreasing Tank, Electroplating tank and washing tanks are estimated using Marshall and Smith cost index. However this cost estimation method cannot be used for some equipment e.g. cooler, rectifier, tank mixers, heaters, and air dryer. direct online costs were used.

Pc = M.S (101.9) 1.066

Where D = Diameter of the tank/column in ft.

H = Height of the tank/column in ft.

M.S = Marshall and Smith index = 110

Fc = 1.00 + Fm + Fp

(Gealu, etal, 2006)

The material of construction selected for most equipment is carbon steel because of its corrosive resistance.

Hence, Fm = 1.00

Fc = 1 + Fm + Fp

14

12

Fc = 3

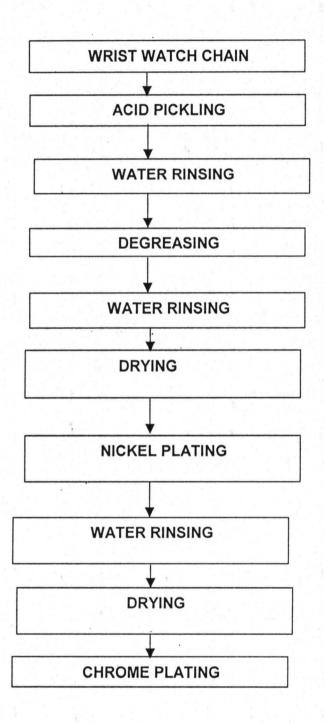
Diameter = D

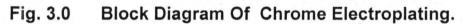
Volume = V

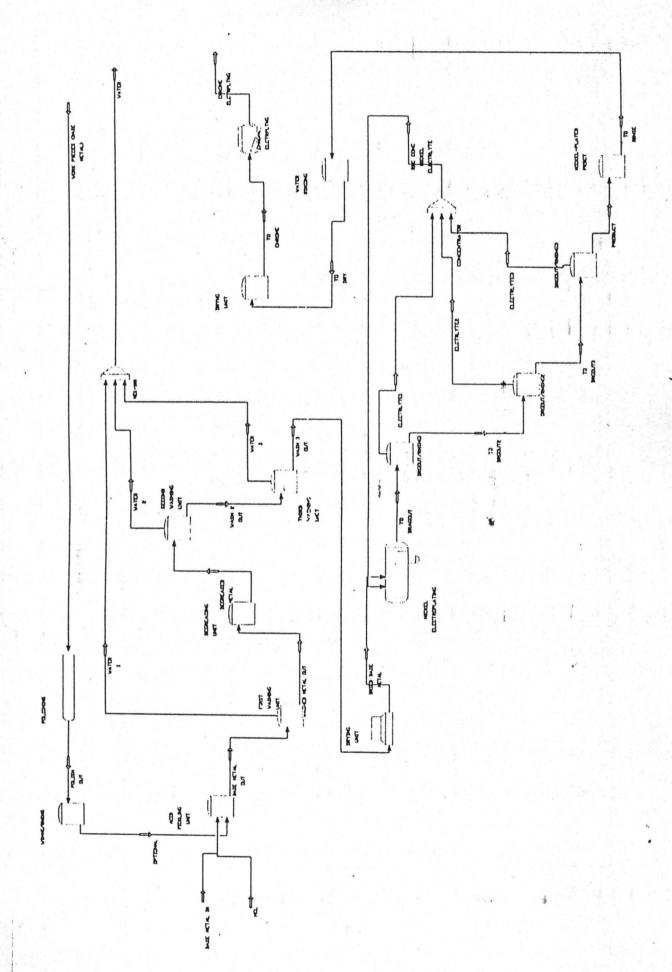
Height = H

CHAPTER THREE

3.0 METHODOLOGY







FLOW DIAGRAM OF COM

3.1 Process description

3.1.1 Acid pickling

In this process, oxides are removed from surface of the basis metal for steel, warm, dilute sulfuric acid is used in large-scale operations because it is inexpensive; but room temperature, dilute hydrochloric acid is also used for pickling of steel, attack of the metal is retarded while the oxide is being dissolved. In addition to rough pickling acid treatment to activate the surface just prior to plating are often used. When an inhibitor is added to acids, it covers the exposed iron material and thus inhibits excessive corrosion by acids.

The following reaction took place

 $Fe_2O_{3(s)}^+$ 6 HCL (aq) $FeCl_{3(aq)} + 3 H_2O.....3.1$

3.1.2 Water rinsing

Cold distilled water is used for rinsing of the product from Acid pickling to avoid contamination of the electrolyte, by removing the iron III chloride formed and at the same time reduces the traces of acid on the work pieces before degreasing.

3.1.3 Degreasing (alkaline soak cleaning)

This process generally involves the use of chlo rinated hydrocarbons in either the heated or vapour form. The solvents commonly used are Trichloroethylene, perchloroethyene and 1,1,1trichloroethyene. This process is basic, and therefore a very important process in the plating process The degreasing salt is dissolved in water and the solution is heated to a temperature of between 50°c to 80°c. After ward the object is suspended in the solution and left for about 15 minutes by which time all the dirt and grease would have been completely removed. The degreasing speed tend to become faster when the product to be plated is stained by an highly viscous oil, since the oil will soften faster under a higher temperature. Saponification process is the basic reaction here

3.1.4 Water rinsing

Similarly cold distilled water is used to rinse off the soaps, emulsified products and left over sodium hydroxide on the product.

3.1.5 Drying

The water on the base metal is dried to avoid further dilution of content of the electroplating bath .

3.1.6 Nickel electroplating

Nickel plating solutions, nickel anodes are used to provide the necessary anode surface to secure as possible distribution of the electro deposit on the work and to maintain the nickel content for the plating solution. A typical electrolyte for Nickel plating can be made by dissolving the following salts

Nickel Sulphate	225 – 357g/L,	Mean 291g/L
Nickel Chloride	30 – 75g/L,	Mean 52.5g/L
Boric acid	30 – 55g/L,	Mean 42.5g/L

2-3 droplets of H₂So₄ at a P^H 0f 3.6.

The nickel anodes are enclosed in cotton polypropylene or

terylene bags.

3.1.7 Operating condition for Nickel plating solutions.

Cathode Current density	4.0 to 6.5amp/dm2 (40 to 60	
	amp/ft ²)	
P ^H Value	4.0 to 4.8	
Voltage	3 to 4 volts	
Temperature	55 to 65⁰c	
Anode	nickel	

3.1.8 Chrome electroplating

In Chrome Electroplating, chrome anodes are used to provide the necessary anode surface to secure distribution of the electro deposit on the work and to maintain the nickel content for the plating solution. A typical electrolyte for chromium decorative plating can be made by dissolving the following salts

Chrome Sulphate	200 – 300g/L,	Mean 250g/L
Ratio of chromic acid	100:1 to 125:1	
chrome Chloride	30 – 75g/L,	Mean 52.5g/L

3.1.9 Operating condition for chromium plating solutions.

Cathode Current density	8.0 to 12amp/dm2 (75 to 110 amp/ft ²)
Voltage	4 to 5 volts
Temperature	35 to 40°c
Anode:	lead/antimony.

3.1.10 Dragout/Water rinsing tanks

The dragout/water rinsing tank does two things;

To capture the dragout volume and also rinse the works pieces(wristwatches) from concentrated Nickel solution and subsequently from concentrated chrome solution. The tanks are connected to each other and Nickel and chromium plating tank by drop board.

3.1.11 Concentrator

Concentrator helps to recover Nickel and chrome metal from plating rinse waters (Dragout tanks). However, chemical precipitation, solvent extraction, ion exchange of reverse Osmosis will recovered metal as concentrated solutions or sludges, which can be recycle back for reused. Also, where the metal form plating rinse water is required as pure metal then an electrolytic. Extraction may be used for this design ion exchange with reverse Osmosis concentrator is used.

3.1.12 Air drying

The work piece (base metal) after electroplating was spread to dry under atmospheric air before packaging.

3.2 Equation of The Reactions

The equation of the reaction is obtained based on the anodic and cathodic half reactions. Electrochemical deposition of nickel and chrome from typical electrolyte is a relatively slow process compared to the speed at which their ions moved in the bath. This fact is possible to use very high current densities at direct current conditions, and even higher current densities using pulse plating.

The deposition of nickel takes place through a number of intermediate steps, as indicated below,

Ni ²⁺ + H ₂ O	Ni OH ⁺ + H ⁺	3.3
Ni OH⁺ + e⁻ ◀	Ni OH _{ad}	3.4
Ni OH _{ad} + H ⁺ + e [−] ◀	Ni + H₂O	3.5
Similarly the deposition of ch	rome takes pla	ce as follows:
Cr ³⁺ + H₂O →	Cr ³⁺ OH +H ⁺	3.6
Cr OH + e- →	Cr OH _{aq}	3.7
Cr OH _{aq} + H ⁺ + e− →	Cr + H₂O	3.8

From the reaction above, it can be seen that that pH value in the bath is of great importance. Since free hydrogen ions play an important role in the deposition mechanism. The bath temperature is also an important parameter, since the speed of the reaction is all dependence on temperature (but some more than others).

Also the concentration of nickel and chrome ions at the cathode, and the current density (available electrons) has influence on the deposition process.

Also, noted is the equation of reaction at the positive and negative poles respectively.

 $4Ni \longrightarrow 4Ni^{2+} + 2e- \dots 3.9$ In the electrolyte, the dissociation is $Ni SO_4 + 6H_2O \longrightarrow Ni^{2+} + SO_4^{2-} + 6H^+ + 6OH^- \dots 3.10$ $Ni Cl_2 + 6H2O \longrightarrow Ni^{2+} + 2Cl^- + 6OH^- \dots 3.11$ $Ni_3 Bo_3 \longrightarrow 3H^+ + BO3^{3-} \dots 3.12$ $H_2 SO_4 \longrightarrow 2H^+ + SO_4^{2-} \dots 3.13$

The net reaction is given as (overall equation), this involve the combination of equation 3.6 - 3.10

 $Cr^{3+} + 4Ni + Ni SO_4 + 6 H_2O + Ni CL_2 + 6H_2O + H_3BO_3 + H_2 SO_4 6Ni^{2+}$

2SO4²⁻ + 2CL⁻ + BO3³⁻ + 18H⁺ 11 OH⁻3.14

3.2.1 Anodic reaction

2Ni + SO4 ²⁻ + 2CL ⁻ 12H ⁺ + 12OH ⁻	NiSO ₄ .6H ₂ O+NiCL ₂ .6H ₂ O
2Cr + SO4 ²⁻ + 2CL ⁻ 12H ⁺ + 12OH ⁻	Cr ₂ SO ₄ .6H ₂ O+NiCL ₂ .6H ₂ O

3.2.2 Cathodic reaction

6Ni ²⁺ + 6 H ₂ O	>	6 Ni OH ⁺ + 6H ⁻	3.15
6Ni OH ⁺ 6e ⁻		6 Ni Oh _{ad}	3.16

6 Ni Oh_{ad} + 6H⁺ + 6e⁻ → 6Ni + 6H₂O3.17

Similarly, for chrome:

In the electrolyte, the dissociation is

CrSO₄+6H₂O →	$Cr^{3+} + SO_4^{2-} + 6H+ +$	6OH3.19
Cr Cl₂+6H2O →	Cr ³⁺ + 2CL- + 6OH-	3.20
H ₂ SO ₄	2H+ + SO4 ²⁻	3.21

The net reaction is given as (overall equation), this involve the combination of equation 3.18 – 3.21

 $Cr3+ + Cr SO_4 + 6 H_2O + Cr Cl_2 + 6H_2O + H_2 SO_4 \longrightarrow Cr3^+ + 2SO_4^{2^-} + 2CL^+ + 18H^+ 11 OH^- \dots 3.22$

3.3 Material Balance

A computer aided design was used for this plant, MathCAD was chosen to carry out the material balance . The basis chosen was 2000kg/day of wrist watches, Rust of 0.05% and grease of 0.02% were used. The mass flow rates of the materials were calculated: rust (Fe₂O₃) was 1.0kg/day and grease was 0.4kg/day and reacting mass of rust was 6.25 x 10^{-3} kg. The volume of the metal base was 254.0L and for the acid pickling vessel was 304.8L and acid concentration was 0.148mol/m3. These were followed with the evaluation of material balances for the various pre plating and plating units starting from acid pickling vessel to dragout tanks where the input stream of previous unit is made to serve as an input stream to the next unit finally, 1998.6kg/day of wrist watches goes for electroplating and 351.62kg of nickel metal was required and 187.888kg of chrome metal was required for this task.

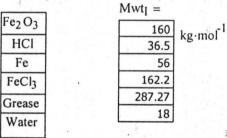
Overall Material balance

 $Basis = 2000 \frac{kg}{day}$ 1 day = 8 hoursRust := 0.05% · Basis Grease := 0.02% · Basis Iron := Basis - (Rust + Grease)Mass flowrate of Rust := Rust Mass flowrate of Grease := Grease Mass_flowrate_of_Grease = 0.4 kg

3.4.2 Material balance around the acid pickling unit

3.4.2.1 input streams





= 1 kg / dayMass_flowrate_of_Rust

$$Mole_of_Rust := \frac{Rust}{160\frac{kg}{mol}}$$

 $Mole_of_Rust = 6.25 \times 10^{-3} mol$

Mole_of_HCl:= 6.Mole_of_Rust

HCI:= Mole_of_HCI36.5 kg_mol

	_
Fe ₂ O	3
HCI	
Fe	
FeCl	3
Greas	e
Wate	r

SPECIESI :=

Inlet_Mass_1_I :=

Rust HCl Iron 0 Grease 0

	6	
Unit_one_input :=	Σ	Inlet_Mass_11
	l = 1	

Unit_one_input= 2×10^3 kg

3.4.2.2 evaluation of HCI concentration

Mass_of_metal_base := Basis

Density_of_metal_base := $7874 \frac{\text{kg}}{\text{m}^3}$

Volume_of_metal_base:= $\frac{Mass_of_metal_base}{Density_of_metal_base}$ Volume_of_metal_base= 254.001L

Tank_Volume := 1.2. Volume_of_metal_base

Tank_Volume= 304.801L

Conc_{HCl}:= <u>Mole_of_HCl</u> Volume_of_metal_base

 $Conc_{HC1} = 0.148 \frac{mol}{m^3}$

3,4.2.3 output stream

Mole_of_Water := 3. Mole_of_Rusi

Mole_of_FeCl3= 0.013 mol

 $Mole_of_Iron := \frac{Iron}{56\frac{kg}{mol}}$

Mole_of_Water = 0.019 mol

Outlet_Mass_11 := Outlet_Molq Mwtj

Mole_of_Grease :=
$$\frac{Grease}{287.27 \frac{\text{kg}}{\text{mo}}}$$

ş

 $Mole_of_Grease = 1.392 \times 10^{-3} mol$

Mole_of_Iron = 35.689mol SPECIES_I :=

Outlet_Mole I
0.0
0.0
Mole_of_Iron
Mole_of_FeCl3
Mole_of_Grease
Mole_of_Water

SPECIES_I :=

Fe ₂ O ₃
HCI
Fe
FeCl ₃
Grease
Water

4 =	Outlet_Mass_1
kg	0
	0
	1.9986?103
	2.0275
	0.4
	0.3375

Unit_one_output := $\sum_{I=1}^{6}$ Outlet_Mass_1

Unit_one_output = 2×10^3 kg

3.4.3 Unit two

Estimation of the amount of washing Water

From solubility curve; solubility of FeCl₃ at 25°C Solubility:= $4.3 \cdot 10^{-3} \frac{\text{mol}}{\text{m}^3}$

Volume_of_Water_Required:= Mole_of_FeCl3 Volume_of_Water_Required= 2.907× 10 L

 $\rho_{water} = Density_of_water$

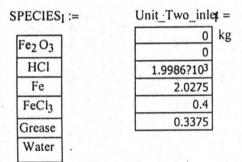
$$\rho_{\text{water}} := 997.99 \frac{\text{kg}}{\text{m}^3}$$

Mass_of_water := $\rho_{water} \cdot Volume_of_Water_Requirec$

Mass of water = 2.901×10^3 kg

unit two inlet 3.4.3.1

Unit_Two_inlet := Outlet_Mass_l1



Total_mass_inlet :=
$$\left(\sum_{I=1}^{6} \text{Unit_Two_inlet}\right) + \text{Mass_of_water}$$

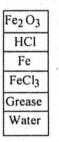
Total_mass_inlet = 4.9×10^3 kg

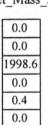
3.4.3.2 unit two output

SPECIESI :=

*

Outlet Mass 2a1 :=





Outlet Mass 2b1 :=

	0.0
	0.0
	0.0
	2.027
	0.0
2.	.901·10 ³

Total_mass_outlet := $\sum_{I=1}^{0} \left[(Outlet_Mass_2a_I + Outlet_Mass_2b_I) \cdot kg \right]$ Total_mass_outlet = $4.9 \times 10^3 \text{ kg}$

3.4.4 Unit three

Degreasing unit

Stearic Acid + NaOH ------ Soap + Water

Mass_of_Grease := Grease

 $Mwt_{Grease} := 287.27 \frac{kg}{mol}$

1

 $Grease_Reacting_Mole := \frac{Mass_of_Grease}{Mwt_{Grease}}$

Grease_Reacting_Mole = 1.392×10^{-3} mol

Mass_of_NaOH := Grease_Reacting_Mole40 kg mol

Mass of NaOH = 0.056 kg

3.4.4.1 inlet stream

Species $_{\kappa} :=$

Fe NaOH Grease Water

	- к
kg	1.9986?103
	.0.056
	0.4
	0

Unit_3_Inlet =

Unit_3_inlet:= $\sum_{\kappa = 1}^{4}$ Unit_3_Inlet_{κ}

Unit_3_inlet= 1.9991×10^3 kg

3.4.4.2 outlet stream

Mass_of_Soap_formed := Grease_Reacting_Mole·Mwt_{soap} Mass_of_Soap_formed = 0.427kg

mol

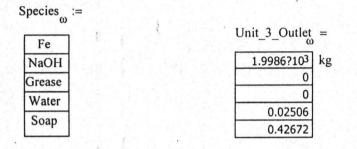
A inst soap

Mass_of_Water_formed := Grease_Reacting_MoleMwtwater

$$Mwt_{water} \equiv 18 \frac{kg}{mol}$$

Mass_of_Water_formed = 0.0251 kg

unit three outlet 3.4.4.3



Unit_3_outlet :=
$$\sum_{\omega = 1}^{5}$$
 Unit_3_Outlet

Unit_3_outlet= 1.9991×10^3 kg

3.4.5 **Unit four**

(Soap Removal) Water rinsing

Calculation of Amount of Water Required for Rinsing

Solubility of Sodium Stearate at 25° C

0.1g_{soap} (Shreves et.al) Solubility_{soap} = 100gwater Mass_of_Soap_formed Mass_of_water_required :=

Solubilitysoap

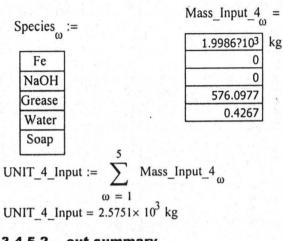
Using 35% Excess Water for Rinsing

Mass_of_water_required = 426.721kg

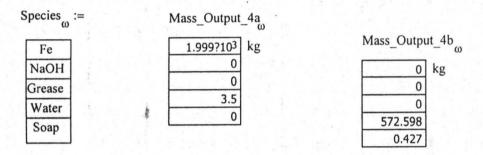
Actual_water := Mass_of_water_required + 35% · Mass_of_water_required

Actual_water = 576.073kg

3.4.5.1 input summary



3.4.5.2 out summary



UNIT_4_OUTPUT := $\sum_{\omega} (Mass_Output_4b_{\omega} + Mass_Output_4a_{\omega})$

UNIT_4_OUTPUT = 2.575×10^3 kg

3.4.6 Unit five

drying of base metal

3.4.6.1 inlet stream

(water removal)

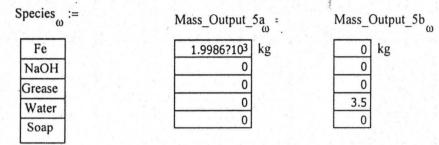
Mass_Inlet_5 := Mass_Output_4a_ ω

Species $_{\omega} :=$

Fe
NaOH
Grease
Water
Soap

=	Mass_Inlet_ $_{\omega}^{5}$
kg	1.9986?103
	0
	0
	3.5
	0

3.4.6.2 output stream



3.4.7 Calculation of the mass of nickel required per metal base

density of nickel

 $\rho_{nickel} := 8908 \frac{\text{kg}}{\text{m}^3}$

mass of nickel per metal base

 $M_{nickel} := \rho_{nickel}$ VOLUME_OF_NICKE $M_{nickel} = 0.021 \text{ kg}$

Chain_Unit_Mass := 0.1200kg

Chain_Total_Number := <u>METAL_BASE</u> <u>Chain_Unit_Mass</u>

Chain_Total_Number = 1.665×10^4

TOTAL_NICKEL_REQUIRED := Chain_Total_Number · Mnickel

TOTAL_NICKEL_REQUIRED= 351.62kg

3.4.7.1 input summary

Species=

$Unit_6_Input_{ij} =$
1.999?10 ³ kg
351.62

UNIT_6_INPUT := $\sum_{q} \text{Unit}_6_\text{Input}_q$ UNIT_6_INPUT = $2.35 \times 10^3 \text{ kg}$

Amount_of_solution := $1.2 \cdot METAL_BASE$ Amount_of_solution = 2.398×10^3 kg

3.4.7.2 output stream

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Associated_Solution := 0.95% · Amount_of_solution Associated_Solution= 22.784kg

Base_Metal	1.999?103
Nickel	. 351.62
Solution	22.784

UNIT_6_OUTPUT := $\sum_{\phi=1}^{3}$ Unit_6_Output_{\$\phi\$}

UNIT_6_OUTPUT = 2.373×10^3 kg

3.4.8 Unit seven

DRAG OUT (WATER RINSING USING FOUR CASCADE TANK)

Unit_7_Input := Unit_6_Output

Species :=

Rase Motel	Unit_7_Input =
Base_Metal Nickel	1.9986?10 ³ kg
the second se	351.6197
Solution	22.784

Solution_Solubility= $\frac{1.25g}{100g_{water}}$

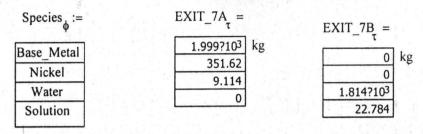
Amount_of_Water_Required:= Associated_Solution Solution_Solubility

Amount_of_Water_Required= 1.823×10^3 kg

UNIT_7_INPUT:= Amount_of_Water_Required \sum_{ϕ} Unit_7_Input UNIT_7_INPUT = 4.196× 10³ kg ϕ

3.4.8 Output streams

Associated_Water := 0.50% · Amount_of_Water_Required Associated_Water = 9.114 kg



UNIT_7_OUTPUT :=
$$\sum_{\tau} (EXIT_7A_{\tau} + EXIT_7B_{\tau})$$

UNIT_7_OUTPUT = 4.196×10^3 kg

Unit 8

Air dryer

3.4.9.1 input

 $Species_{+} :=$

3.4.9

Ψ	$Unit_8_Input_{\tau} =$	
Base_Metal	1.9986?10 ³ kg	3
Nickel	351.6197	1
Water	9.1136	
Solution	0	

3.4.9.2 output

3.4.10 Chrome plating unit

3.4.10.1 determination of the amount of chrome needed for plating using the classical exide method.

Species :=

Base_Metal	$Unit_8a_Output_{\tau} =$	Unit_8b_Output _T
Nickel	1.9986?10 ³ kg	0 kg
Water	351.6197	0
Solution	0	9.114
Solution	0	0

Total_Surface_Area = $7.9 \times 10^{-3} \text{ m}^2$

CHROME_THICKNESS:= 0.02cm

VOLUME_OF_CHROME= Total_Surface_Area · CHROME_THICKNES: (Steven S. Zumdahl, 1998.)

3.4.10.2 calculations of the volume of chrome required per metal base

VOLUME OF CHROME= 1.58×10^{-3} L calculation of the mass of chrome required per metal base 3.4..10.3

density of chrome

$$P_{chrome} := 7140 \frac{\text{kg}}{\text{m}^3}$$

mass of chrome per metal base

 $M_{chrome} := \rho_{chrome} \cdot VOLUME_OF_CHROM$

 $M_{chrome} = 0.011 \, kg$

Chain Unit Mass= 0.12 kg

Chain_Total_Number = 1.665×10^4

TOTAL CHROME REQUIRED= 187.888kg

TOTAL_CHROME_REQUIRED= Chain_Total_Number Mchrome

3.4.10.4 input summary

Species :=

Ψ :	Unit_9a_Inp
Base_Metal	1.9986?10
Nickel	351.619
Water	
Chrome	
and the second	

		-
-	1.9986?103	kg
•	351.6197	
	0	
	0	

put τ	Unit_9b_In
kg	0
	0
	0
	187.888

Unit_9_Output_ := $\sum (Unit_9a_Input_{\tau} + Unit_9b_Input_{\tau})$

Unit_9_Output_= 2.5381×10^3 kg

3.4.10.5 output summary

Unit_9_Output := (Unit_9a_Input + Unit_9b_Input) $Species_{\phi} :=$

Metal
ckel
ater
ome

Unit_9_Outpu	t =
1.9986?103	kg
351.6197	
0	
187.8884	

Unit_9_Input := $\sum (Unit_9a_Input_{\tau} + Unit_9b_Input_{\tau})$

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3.5 Energy Balance

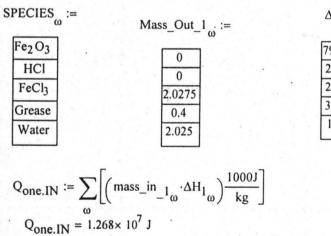
MathCAD was Similarly used to carry out the energy balance, knowing the temperature of each of the unit; from program tool bar and thermodynamic package the different change in enthalpy of formation of chemical species involved were selected and consequently, for each species the product of mass and enthalpy(Δ H) multiplied by 1000J/kg gives energy balance for each component and the MathCAD automatically calculate. This is done for each unit starting from acid pickling tank to drying unit. Finally, the time for nickel plating was 3.56hrs energy spent was 20.89 x 10⁵ j and power was 22.5 watts while time for chrome plating was 1.42hrs energy spent was 2.557 x 10⁷ j and the power was 20.5 watts.

3.5.1 Energy balance

3.5.1.1 energy balance around unit one at 25^OC

$$Q_{one,IN} = mass_in_1\Delta H_1$$

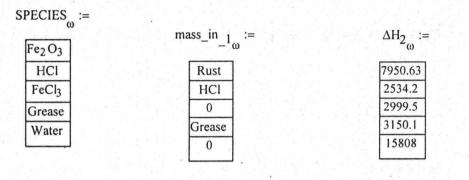
 $Q_{IN} = Q_{OUT}$



 $\Delta H_{1_{\omega}} :=$ 7950.63
2534.2
2999.5
3150.1
15808

(Steven S. Zumdahl, 1998.)

 $Q_{one.OUT} = Mass_out_1 \cdot \Delta H_2$



$$Q_{\text{one.OUT}} \coloneqq \sum_{\omega} \left[\left(\text{Mass_Out}_{1} \cdot \Delta H_{2} \right) \cdot 1000 \right]$$

 $Q_{one.OUT} = 3.935 \times 10^7 \text{ J}$

3.5.1.2 calculation of energy required

Q_{RQD} = Quantity_of_Energy_Required

 $Q_{RQD} := Q_{one.OUT} - Q_{one.IN}$

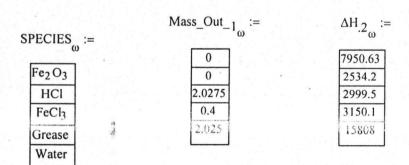
 $Q_{RQD} = 2.667 \times 10^7 \text{ J}$

3.5.2 Energy balance around unit two at 25°c

3.5.2.1 Input energy

 $Q_{two.IN} = Mass_Out_1_{\omega} \cdot \Delta H_{2_{\omega}}$

 $Q_{two.IN} = Q_{two.OUT}$



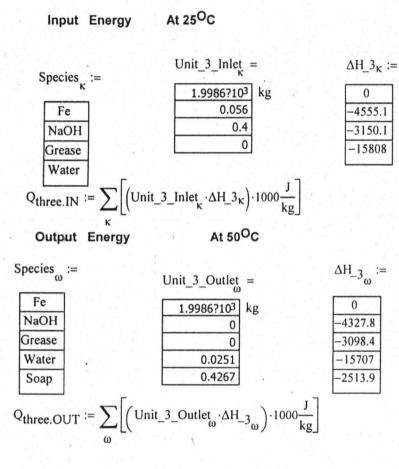
$$Q_{\text{two.IN}} := \sum_{\omega} \left[\left(\text{Mass_Out}_{-1_{\omega}} \cdot \Delta H_{.2_{\omega}} \right) \cdot 1000 \right]$$

$$Q_{\text{two.IN}} = 3.935 \times 10^7 \text{ J}$$

$$Q_{\text{two.OUT}} := Q_{\text{two.IN}}$$

$$Q_{\text{two.OUT}} = 3.935 \times 10^7 \text{ J}$$

3.5.3 Energy balance around unit three



3.5.3.1 Energy balance equation

 $Q_{\text{three.IN}} + Q_{\chi} = Q_{\text{three.OUT}}$

 $Q_{\chi} = ENERGY_REQUIRE$

 $Q_{\chi} := Q_{three.OUT} - Q_{three.IN}$

 $Q_{\chi} = 4.872 \times 10^4 \text{ J}$

$\Delta H_{4_{\omega}} :=$ Species $_{\omega} :=$ Unit_3_Outlet = 0 Fe 1.9986?10³ kg -4327.8 NaOH 0 -3098.4 Grease 0 -15707 Water 0.0251 -2513.9 0.4267 Soap

$$Q_{\text{four.IN}} := \sum_{\omega} \left[\left(\text{Mass_Output}_{4a_{\omega}} \cdot \Delta H_{4\omega} \right) \cdot 1000 \frac{\text{J}}{\text{kg}} \right]$$

Energy Output

At 25°C

Species $_{\omega} :=$ Mass_Output_4a = $\Delta H_4A_{\omega} :=$ Fe 1.9986?10³ kg 0 NaOH 0 -4555.1 0 Grease -3150.1 3.5 Water -15808 0 Soap -2534.2

$$Q_4A_{out} := \sum_{\omega} \left(Mass_Output_4a_{\omega} \cdot \Delta H_4A_{\omega} \cdot 1000 \frac{J}{kg} \right)$$

Species $= \omega$	Mass_Output_4b ω	$\Delta H_4B_{\omega} :=$
Fe	0 kg	0
NaOH	0	-4555.1
Grease	0	-3150.1
	572.598	-15808
Water	0.427	-1024.2
Soap		1024.2

$$Q_{4B.out} \coloneqq \sum_{\omega} \left[\left(Mass_Output_4 b_{\omega} \cdot \Delta H_4 B_{\omega} \right) \cdot 1000 \frac{J}{kg} \right]$$

 $Q_{four.OUT} := Q_4 A_{out} + Q_{4B.out}$

 $Q_{\Psi} := Q_{four.IN} - Q_{four.OUT}$

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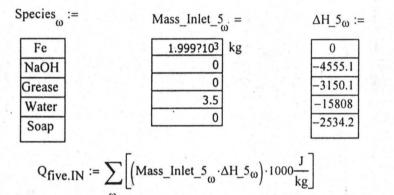
 $Q_{\Psi} = 9.052 \times 10^9 \text{ J}$

 $Q_{\Psi} = Amount_of_Energy_Removec$

3.5.5 Energy balance around unit five

ENERGY_IN = ENERGY_OU1

Input Energy At 25^OC



 $Q_R = ENERGY_REQUIRED_TO_DRIVE_AWAY_WATER_MOLECUL$

$$Q_{R} = M \cdot C_{P} \cdot \Delta T$$
$$M := 3.5 kg$$

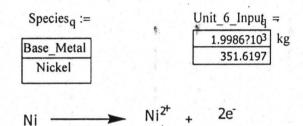
 $C_{P} := 4185 \frac{J}{kg \cdot K}$ $\Delta T := (303 - 298) K$

 $Q_{R} = 7.324 \times 10^{4} \text{ J}$

UNIT_5_EXIT_ENERGY:= $Q_R - Q_{five.IN}$

UNIT_5_EXIT_ENERGY = 5.54×10^7 J

3.5.6 Energy balance around unit six



Applying Faraday's Law

 $W_{Ni} = MOLECULAR_WEIGHT_OF_NICKE$

 $W_{Ni} := 58.69 \frac{\text{kg}}{\text{mol}}$

M_{Ni} = MASS_OF_NICKEL_DEPOSITEI M_{Ni} := TOTAL_NICKEL_REQUIRE

n_{Ni} = MOLE_OF_NICKEL_DEPOSITEI

$$n_{Ni} := \frac{M_{Ni}}{W_{Ni}}$$

 $n_{Ni} = 5.991 \text{ mol}$

 $2 \text{mol} \cdot \text{e}^- = 96486 \text{columb}$

(Faraday's Law)

 $M_{Ni} = E \cdot I \cdot T$

.....eqn_1

E is the Electrochemical Equivalence

I is the Current Density T is the time required for Plating

Calculation of Amount of Columb Required

 $I := 22.5 \frac{C}{s}$

 $\frac{M_{Ni}}{E} = I \cdot T$

A_{columb} = Amount_of_Columb

 $A_{\text{columb}} := n_{\text{Ni}} \cdot \frac{96486C}{2\text{mol}}$

 $A_{\text{columb}} = 2.89 \times 10^5 \text{ C}$

From Literature,

From eqn_1,

 $\frac{M_{\rm Ni}}{E} = A_{\rm columb}$

Then,

 $A_{columb} = I \cdot T$ Time_Required := $\frac{A_{columb}}{I}$

Time_Required = 1.285×10^4 s

Time_Required= 3.569hr

Qplating = Energy_Required_for_Plating

Q_{Plating} = I·V·Time_Requirec

V = Voltage_Require

V:= 220volt

 $Q_{\text{Plating}} = 2.89 \times 10^5 \text{ J}$

Power := $\frac{Q_{Plating}}{Time_Required}$

Power = 22.5 W

3.5.7 Chrome plating unit

Cr _____ Cr³⁺ + 3e⁻

3.5.7.1 Applying Faraday's Law

W_{Cr} = MOLECULAR_WEIGHT_OF_CHROMIU

 $M_{Cr} = MASS_OF_CHROME_DEPOSITEI$

 $W_{Cr} := 51.9961 \frac{kg}{mol}$

 $M_{Cr} := TOTAL_CHROME_REQUIREI$

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 $n_{Ni} = MOLE_OF_CHROME_DEPOSITED$

$$n_{Cr} := \frac{M_{Cr}}{W_{Cr}}$$

 $n_{Cr} = 3.614 \text{ mol}$

 $3 \text{mol} \cdot \text{e}^- = 9648 \text{columb}$

 $M_{Ni} = E \cdot I \cdot T$

 $A_{columb} = A_{mount_of_Columb}$

Calculation of Amount of Columb Required

$$Al_{columb} := n_{Cr} \cdot \frac{96486C}{3mol}$$

 $Al_{columb} = 1.162 \times 10^5 C$

Time_Required :=
$$\frac{A_{l_{columb}}}{I}$$

Time_Required = 5.165×10^3 s

Time_Required = 1.243hr

Q_{Plating} = Energy_Required_for_Platin;

 $Q_{\text{Plating}} = 2.557 \times 10^7 \text{ J}$

Power = Q Plating

Time Required

Power = 20.5

CHAPTER FOUR

4.0 EQUIPMENT DESIGN

The result of the equipment that were designed are given in Table 4.1 to 4.3 and the result of the cost can be seen in Table 4.4. Detail calculation shown in Appendix i.

Design Parameters	Acid Pickling	Washing Tank 1	Degreasing Unit	Washing Tank 2	Washing Tank 3	Nickel Plating Unit	Drag Out Tank 1
M/TYPE	Carbon Steel	Carbon steel	Carbon steel	Carbon steel	Carbon steel	Carbon steel	Carbon steel
Diameter (m)	1.200	1.198	0.3048	1.203	1.200	-	0.9405
Height (m)	1.799	1.797	1.804	1.799	1.799	-	1.411
Length (m)	4.801	3.535	1.676	1.804	2.515	3.353	0.9800
Volume (m3)	2.024	2.024	2.583	2.050	2.034	2.583	1.676
Shell thickness	6.350	6.350	6.350	6.350	6.350	6.350	6.350
Corrosion thickness (mm)	3.175	3.175	3.175	3.175	3.175	3.175	3.175
Vessel Pressure (Kpa)	100	100	100	100	100	90.00	90.00
Joint efficiency	1.000	1.000	1.000	1.000	1.000	1.000	1.000
L/D Ratio	3.000	5.000	5.000	5.000	5.000		
Allowance stress (Kpa)	9.446 e + 004	9.446 e + 004	9.446 e + 004	9.446 e + 004	9.446 e + 004	9.446 e + 004	9.446 e + 004

Table 4.1:Design Summary Vessel Parameter and Sizing for Electroplating Equipment

Design Parameter	Dragout Tank 2	Dragout Tank 3	Concentrator	Chrome Plating Tank
M/TYPE	Carbon Steel	Carbon steel	Carbon steel	Carbon steel
Diameter (m)	0.9405	0.9405	0.9405	-
Height (m)	1.411	1.411	1.411	3.535
Length (m)	1.676	1.676	1.676	2.583
Volume (m3)	0.9800	0.9800	0.1223	-
Shell thickness	6.350	6.350	-	6.350
Corrosion thickness (mm)	3.175	3.175	3.175	3.175
Vessel Pressure (Kpa)	90	90	90	90.00
Joint efficiency	1.000	1.000		1.000
L/D ratio	-	5.000	-	
Allowance stress (Kpa)	9.446 e + 004	9.446 e + 004	9.446 e + 004	9.446 e + 004

1 mil

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Table 4.2 Design Summary of Pumps Parameters and Sizing for TheEntire Electroplating Process.

	Design	Pump 1	Pump 2	Pump 3	Pump 4	Recycling
-	Parameter		1. 1. 1. A		Station and	Pump
-	Power	1.978	1.045	2.090	16.09	53.71
		kJ/h	kJ/h	kJ/h	kJ/h	kJ/h
	Pressure	0.6897m	1.012m	1.012m	1.012m	1.016m
	Heat					
	Duty	5.498e	2.903e ⁻	5.305e'004	4.470e ⁻⁰⁰³	1.480e ⁻ 002
		088kw	004kw	kw	kw	kw
	Capacity	1.560m ³	0.1002 m ³ /h	0.2004 m ³ /h	1.543 m ³ /h	5.131 m ³ /h
	Heat	017m	001m	90m	009m	007m
	Velocity	-the				
	Head	-1.48e ⁻ 017	-5.557e	-2.223e	-1.318e	-1.457e'007
	DP	10kpa	10kpa	10kpa	10.00kpa	10.00kpa
	Radius of Gyration	0.1000 0.1000	0.1000 0,1000	0.1000		,

Table 4.3 Design Summary of Parameter for Heater, Pre HeaterCooler.

Design parameter Pre heater		Heater	Cooler
Duty	5.466e+005kJ/h	6.319kJ/h	-5.251e+005kJ/h
Pressure drops	0.0000k/a	0.0000k/a	2.000k/a
Area (cm)	4.320m ²	4.650m ²	A Key A
Overall heat			

Loose (kJ/h)

Table 4.4 Design Summary of Parameter for Air Dryer

Design parameter	Sizing
Volumetric Air flow	7.200e+005 (ACT m³/h)
UA	-1625Kj/c-h
Working fluid duty	1.225kJ/h
Mass Air Flow	8.491e+005kg/h
LMTD	1.865 C

4.1 Result of Equipment Costing

Exchange rate ER as at 2006 is 130 Naira for 1 Dollar as at 2006.

Table 4.5 Costing of Equipment Using Marshall and Smith CostEstimation Index

FM			FP		
Carbon steel CS	1.00	< 50 P SIG	1.00		
Stainless Steel SS	3.67	200	1.15		
Moniel Steel	6.34	400	1.35		
Titanium	7.89	600	1.60		

Table4.6 Cost of Raw Material Using Direct Cost Estimation

Raw Material	Quantity	COST IN	Equivalent
Cr (So⁴)₃		DOLLAR	Cost in Naira
Ni SiO _{4.} 6 H ₂ O	3295 kg	234	30,500
NiCl _{2.} 6H ₂ O	10.71kg	230	21,800
H₂BO4	7.03 kg	167	1.200
H₂SO₄	1.0 x 10-2L	19.2	2,500
Dissolvable Nickel Anode	40.679Kg	98.5	12,800
HCL	8.4635 X 10-2 Kg	13.8	1800
NaOH	3.402 x 10-2 Kg	6.9	900
Water required for entire process	6.5874 x 10 3L	65.4	8,500
Wrist watches	1999.0kg	153.8	19,900

4.2 Summary OF Result

1

11- A 11 19

19 4

8,

Table 4.7 Result of Cost Estimation and Economic Analysis Using Marshal and Smith Cost Index Data

ţ

Items	Economic Anal Cost Index)	lysis Marshal and Smith
	DOLLARS	(Naira
Purchase cost of equipment	21,220.6	2,758,677
Total fixed capital cost (TFC)	212,205.9	27,586,770
Working capital (WC)	106,103	13,793,385
Total land cost (TLC)	21,220.6	2,768,677
Total fixed cost invested (Tinv)	339,529.5	44,138.832
Labour cost	12,732.4	1,655,206
Plant maintenance and repairs (MC)	16,976.5	2,206,941
Insurance InSc	2,122.1	275,867
Local Taxes (Ltxc)	4,244.1	551.735.4
Royalties (Royc)	2,122.1	275.867
Laboratory cost (Labc)	848.8	110,347.08
Supervision (Sc)	169.8	22,069.4
Plant overhead cost (POHc)	2,122.1	275,867
Administrative cost (ADMc)	1,061	137,933.85
Reaserch and development cost (RADc)	3,183.1	413,801.55
Total fixed operating cost (TFOc)	45,412	5,903,567
Total annual fixed operating cost TFO	2,270.6	295,178
Cost of raw material (CRMc)	1,134.9	147,540
Annual cost of raw material (ACRMc)	340,476.9	44,262,000
Miscellaneous (Msc)	212.2	27,586.77
Utilities Cost (utc)	84.8	11,034.7
Packaging Pac	4.2	551.7
Total variable operating cost (Tvoc)	340,778.3	44,301,173
Annual variable cost (Tvo) annual	17,038.9	2,215.058
Total annual operating cost (AOCc)	19,309.5	2,510,236
Annual production rate (APR)	-	181440000kg/yr.
Production cost per kg (PC)	0.015	2.0
Annual product sales (APS)	167,483	21,772,800
Selling price (SP)	0.09	12
Profit before tax (PBT)	148,174	19,262,563
Depreciation annual (Dep)	15,385	2,000,040
Tax payable (TP)	86,312.6	11,220,639
Profit after tax (PAT)	61,851	8,041,923
Net Income (NIN)	77,245.8	10,041,964
Pay Back Period (PBP)	-	3.5 years
Rate of return on investment ROR	-	27.28%

4.3 Discussion Of Results

The small scale chrome electroplating plant was designed with the aid of computer program and process simulator. MathCAD was used to carry out the material and energy balance, Hysys was used to obtain the equipment design and process flow sheet.

The results of the equipment designed shows that the Acid Pickling unit, washing tanks, degreasing unit, Nickel plating unit, dragout unit concentrator and chrome plating unit are all rectangular shape tanks as shown in Table 4.1 to 4.13 and the corresponding result of the costing were shown in Tale 4.14 to 4.26. Marshall and Smith Cost Estimation Index approach was used for the cost estimation and economic analysis for the plant and are has shown in table 4.28. Details are shown in Appendix III.

The purchase cost of equipment was \$21,220 (Twenty One Thousand Two Hundred and Twenty Dollars) and the total fixed cost to be invested on the plant was \$339,529 (Three hundred and Thirty Nine Thousand Five Hundred and Twenty Nine Dollars).

Also the annual cost of raw materials was \$340,476 (Three Hundred and Fourty Thousand Four Hundred and Seventy Six Dollars), the annual production rate was estimated as 181440000kg/yr and was as shown in table 4.28. The cost of chrome electroplating of 0.12kg of iron wrist watch chain was N2 and the selling price was N12 each respectively.

The plant has an annual operating cost of \$2,270 (Two Thousand Two Hundred and Seventy Dollars) and the profit after tax (PAT) was \$61,851 (Six One Thousand Eight Hundred and Fifty One Dollars) while the profit before tax (PBT)) was \$148,174 (One Hundred and Forty Eight Thousand One Hundred and Seventy Four Dollars. The pay back period of the capital invested on the plant was 3 ½ years and the rate of return on investment (ROR) was 27.28%. However, in this design work attention was given to the process aspect while datas are provided in Appendix I for Mechanical Technicians and Fabricators. The general observation of table 4.28 shows that electroplating is a very lucrative business the any intending business man can venture into and make handsome profit.

CHAPTER FIVE

5.0 CONCLUSION

A powerful technical computer environment (MATHCAD) was used to carry out the material and energy balance of this design work while process simulator (HYSYS) was used for the equipment design and flow sheet construction. The Marshal & Smith cost index estimation approach was used. This design of 2000kg/day of chrome electroplating of a wrist watch chain plant, was made to develop a cost effective, user and environmental friendly plant, that takes into consideration the technological development of a viable economy and market structure for an electroplating plant.

The economic analysis as shown in table 4.28 shows that the cost of equipment was \$21,220 (Twenty One Thousand Two and Twenty Dollar). the profit after tax of \$61,851 (Sixty One Thousand Eight Hundred and Fifty One Dollars) with pay back period of 3 ¹/₂ years and rate of return (R)OR) of 27.28%. In view of all these it can be concluded that this project is economically viable.

Recommendation

The under listed recommendation are of paramount importance for any potential businesspersons or government bodies. Interested in electroplating business.

- 1. The design of the plant should be supervised by a technical personnel.
- 2. An adequate safety measure should be put into consideration.
- 3. A good electroplating bath maintenance culture ensured.
- 4. A Proper statistic of bath technological parameters should be kept to ensure quality product.
- Further work remains to be done on optimization of electroplating plant.

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APPENDIX I EQUIPMENT DESIGN DETAILS

	Case Name: C:\Pro	ogram Files\Hyp	rotech\HYSY	S 3.11CasesIMR. BABALOLA.2.	
TEAM LND Calgary, Alberta	Unit Set: SI			- 17	
CANADA	Dale/Time: Thu D	Dec 21 16:45:40	2006	· · · ·	
Tank: ACI	D PICKLING UNIT		į.		
	CONNECTIONS				
•	Inlet Stream				
Stream Name	2	From Un	t Operation		
METAL					
	Outlet Stream	1. C. 799 (S.)		· · · · · · · · · · · · · · · · · · ·	
Stream Name	Т	To Unit	Operation		
R					
METAL	Tank:			WASHING L	
2.	Energy Stream				
Stream Name		From Un	it Operation		
	PARAMETERS				
Volume: 2.034 m3 * Lev	el SP:	50 00 %	Liquid Volume	. 10	
Pressure: 100,0 kPa Pressure Drop:	0,0000 kPa * Duty.	0.0	0000 kJ/h	Heat Transfer Mode H	
	User Variables				
	RATING	•	1		
	Sizing	1			
Cylinder	Vertical		Separator h	as a Boot: No	
2.034 m3 * Dia		1 200 m	Height		
5.	Nozzles				
evation Relative to Ground Level	0.0000 m * Diameter BASE METAL		1.200 m	Height WATER	
21 ^{° (} (m)	8.997e-002	and the second	ICI 7e-002	8.997e-002	
n (Base) , (m)	0.8997	the state of the s	997	1.799	
n (Ground) (m)	0.8997	0.8	997	1.799	
n (% of Height) (%)	50.00	50	.00	100.00	
	BASE.METAL				
<u>ه (m)</u>	8.997e-002				
n (Base) (m)	0.0000				
n (Ground) (m)	0 0000				
n (% of Height) (%)				·····	
	Detailed Heat Loss Parame			·	
Heat Loss (kJ/h)	0.0000 Area (m2) Temperature Profile	· · · ·			
	.00 Outer Vessel (C) 25.00	Outer Insul	ation (C)	25 00 Ambient (C)	
	Conduction	1 00107 11301			
	Metal			Insulation	
55 (m)	1.000e-002			3 000e-002	
	0.4730	<i>f</i>	0 8200		
(kJ/kg-C)				520 0	
(kg/m3)	7801				
	45.00			0 1500	
(kg/m3)				O 1500 Outside U (kJ/h-m2-C)	
(kg/m3) iviiy (W/m-K) ap Phase U (kJ/h-m2-C) 7200	45.00 Convection	ication			
(kg/m3) ivily (W/m-K) ap Phase U (kJ/h-m2-C) 7200	45.00 Convection Inside Lig Phase U (kJ/h-m2-C)		- OP High		
(kg/m3) ivily (W/m-K) /ap Phase U (kJ/h-m2-C) 7200 L pp PV High	45.00 Convection Inside Lig Phase U (kJ/h-m2-C) evel Taps: Level Tap Specif	1	– OP High	Outside U (kJ/h-m2-C)	
(kg/m3) iv/ily (W/m-K) 'ap Phase U (kJ/h-m2-C) 7200 L ap PV High	45:00 Convection Inside Lig Phase U (kJ/h-m2-C) Level Taps: Level Tap Specif	1	- DP High	Outside U (kJ/h-m2-C)	

17	TEAM LND	Case Na	me: C:\Program Files\Hyprote	ch/HYSYS 3.1/Cas	esWR. BABALOLA.2.hsc			
AYPROTECH	Calgary, Alberta Unit Se		Jnit Set: SI					
(1)1000011 10000000	CANADA	Date/Tim	e: Thu Dec 21 16:45:40 200	06				
	Tank: ACI		G UNIT (continue	ed)				
PV Work Term Contribution	(%)	100.00 *						
		DYNA	MICS					
	Vess	el Parameters: Ir	nitialize from Product					
Vessel Volume	(m3)	2 034 *	Level Calculator		Vertical cylinder			
Vessel Diameter	(m)	1.200	Fraction Calculator		Use levels and nozzles			
Vessel Height	(m)	1.799	Feed Della P	(kPa)	0.0000			
Liquid Level Percent	(%)	50.00	Vessel Pressure	(kPa)	100.0			
		Holdup: Ve	ssel Levels					
Phase	Le	evel	Percent		Volume			
		m)	(%)		(m3)			
Vapour	11 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-		1.1	0.0000			
Liquid		-	- 0.0		0.0000			
Aqueous	-		-	6 C 1 1 1 2	0.0000			
		Holdup:	Details					
Phase	Accur	nulation	Moles	187 BAR 3	Volume			
	(kgn	nole/h)	(kgmole)		(m3)			
Vapour	0.0	0000	0.0000	•	0.0000			
Liquid ·	. 0.0	• 0000	0.0000	•	0.0000			
Aqueous	00	0000	0.0000	•	0.0000			
Total	0.0	0000	0.0000	A 1947	0.0000			

-	ND	Case Na	me: C:\Program Files\Hyprolech\HYS	SYS 3.1\Cases\	MR. BABALOLA.hsc
HYPROTECH Calgary	Alberta	Unit Set	SI		a an an an tha tha an aite an tha an air an tha an air an an tha an an air an an air an air an air an air an a An an
CANAD	۹ · ·	Date/Tin	ne: Fri Feb 09 09:17:03 2007		
Vessel Si	zing: V	essel Sizing-	8	-	
	Vertical Se	perator Properties:	CHROMEPLATING TANK		
L/D Ratio		5.000 *	Demister to Top (m)	<u></u>	0.3048
Liq. Res. Time (seconds)	300.0 •		nun antin de la fa antin anne e se avec e sur provinsione se se service des	Construction of the second sec	and an and a second
(1997).		Construction	Information		
Chem Eng Fab Index	T	252.5	Allowable Stress	(kPa)	9.446e+004
Material Type	Carbon Steel		Shell Thickness	(mm)	6.350
Mass Densily	(kg/m3)	7861	Corrosion Thickness (m		3.175
FMC		1.000	Joint Efficiency	1223 3 3	1.000
		Costing C			
Shell Thick		Shell Mass	Base Cost	A	ccessories
A1: 0.4000 *	A4:	0.8116 *	A5: 8.600 *	A8:	1017
A2: 2.000 *	1.1.1.1		A6: -0.2165 •	A9:	0.7396
A3: 0.2000 •			A7: 4.580e-002 *	A10:	0.7068
		Costing	Results		
Base Cost (\$US)	7476	Associated Cost (\$US)	1658 Total Cost (FOB \$US)	9134
		' Sizing	Results		
Diameter	(m)	. 0.6096	Liquid Residence Time (see	conds)	300.0
Total Length	(m)	3.353	Liquid Surge Height	(m)	1.521
UD Ratio		5.000	LLSD	(m)	0.4572
Max. Allowable Vapour Velocity	(m/s)	0.6644	Liquid Res. Time at LLSD (see	conds)	82.94
Demister Thickness	(mm)	0.0000			
The second s		Vapou	r Space		
Sump To Inlet Nozzle	(m)	0.3048	Demister To Head	(m.)	0.3048
Sump To Inlet Nozzle Inlet Nozzle to Demister	(m) (m)	0.3048	Demister To Head Ellipsoidal Head	(m.) (m)	0.3048 0.1524

1

TEAM L	ND	Case N	lame: C:\Pro	ogram Files	Hyprotech/HY	SYS 3.1\Ca	ses\MR. BABALOLA.2.hsc			
YPROTECH Calgary. CANAD	Alberta	Unit Se	t: SI		11					
		Dale/Ti	Dale/Time: Wed Feb 07 12:29:17 2007							
Т	ank: TE	MPORARY	STORA	GE TA	NK					
		CONNE	CTIONS				3 a.			
6		Inlet S	Stream							
Stream Name			From Unit Operation CHROME SOLUTION CONCENTRATOR							
ROME SOLUTION		Separator	Stream		<u>_</u>	HROME 5	DEUTION CONCENTRATOR			
Stream Name			Stream	To U	nit Operation					
							2			
		Energy	Stream							
Stream Name				· From I	Unit Operation					
19	Ŀ	PARAM	METERS			15.5				
sel Volume:	and the second sec	evel SP:	Duta	50.00 %	Liquid Volu		-			
sel Pressure: 90.00 kPą	Pressure Drop		Duty:		0.0000 kJ/h	meat 11a	nsfer Mode: 👒 Heating			
				<u>.</u>			<u>.</u>			
			TING							
C. factor			zing							
Cylinder me	(Diameter	rtical		Height	has a Bool	: N0 -			
		Noz	zzles							
Elevation Relative to Ground Level		0.0000 m •	Diameter		••	Height				
eter	(m	and a second	.CHROME_SOLUTION 5.000e-002				5.000e-002			
alion (Base)	(m	0.0000			0.0000		0.0000			
ation (Ground)	(m (%				0.0000		0.0000			
	(70	Level Taps: Level	l Tan Specifi	cation		l				
I Тар	PV High		Low		OP High		OP Low			
	Le	evel Taps: Calcula	s: Calculated Level Tap Values							
el Tap	<u> </u>	Liquid	d Level			Aqu	eous Level			
		Opt	tions							
Nork Term Contribution	(%	6) 100.00 •								
· · ·		DYNA	AMICS							
	Ves	sel Parameters:	Initialize from	n Produc	t	1.1.1.1				
sel Volume sel Diameter	(m3) (m)		Level Calculat Fraction Calcu				Vertical cylinde Use levels and nozzle:			
sel Height	(m)	· · ·	Feed Delta P		(kPa)		Use levels and nozzles 0.0000			
d Level Percent	(%)	50.00	Vessel Pressu	ire		(kPa)	90.00			
			essel Levels							
Phase		Level (m)	Pércent (%)				Volume (m3)			
Vapour Liquid		-	e geste el dans	·+]		. 1 J	0.0000 0.0000			
Aqueous			L				0.0000			
· · · · · · · · · · · · · · · · · · ·		Holdup	: Details							
rotech Ltd.		HYSYS v3	1 (Build 4815)				Page 1 of 2			

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TEAM LND Calgary, Alberta CANADA

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Case Name: C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc

Unit Set: SI

Date/Time: Wed Feb 07 12:29:17 2007

Tank: TEMPORARY STORAGE TANK (continued)

Phase	Accumulation (kgmole/h)	Moles (kgmole)	Volume (m3)
Vapour	0.0000	0.0000 *	0.0000
Liquid	0.0000	0.0000 •	0.0000
Aqueous	0.0000	0.0000 •	0 0000
Total	0.0000	0.0000	0.0000

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^	ND		Case Na	ame: C:\	Program Files\Hyprotech	HYSYS 3.11C	ases\MR. BABALOLA.3.hsc
HYPROTECH Calgary, CANAD	Alberta		Unit Sel	: SI			
, on the			Date/Tir	me: We	ed Feb 07 12:21:17 2007		
Conversio	n Read	ctor	CHROM	E PLAT	ING TANK		
			CONNE	CTIONS			
			Inlet Stream	Connectio	ons		
SOLUTION					From Unit Oper	ation	
PLATED METAL			Tank				DRAGOUT TANK.3
			Outlet Stream	n Connecti	ions		
Stream Name		A.			To Unit Opera	tion	
CHROMED METAL			Tank:				DRAGOUT TANK 4
L.SOLN		• •	Mixer:				CHROME SOLUTION MIXER
			Energy Stream	n Connect			
Q.TH Stream Name			· · · · ·		From Unit Oper	ation	
<u>.</u>		-	DADAN	IETERS		1	
Dhusiasi D		·	PARAN	T	Online		e Heeting
Delta P		lossol	Volume		Duty	I Heat Transle	r: Healing Energy Stream
0.0000 kPa *					6.641e+006 kJ/h		Q.TH
			User V	ariables			
	•		RAT	TING			
5. 5			Siz	ing			
Cylinder		1		tical	Rea	clor has a Boo	ot: No
Volume		Diar	neler		Height		-
			Noz	zles			
Base Elevation Relative to Ground Leve	1		0.0000 m *	Diameter		Height	
a an			SOLUTIO	N	· PLATED META	L	CHROMED METAL
Diameter		(m)	5.000e-00	2	5.000e-002		5.000e-002
Elevation (Base)		(m)	0.0000		0.0000		0.0000
Elevation (Ground) Elevation (% of Height)		(m) ' (%)	0.0000		0.0000		0.0000
		(70)	 L.SOLN				-
Diameter		(m)	5.000e-00				
Elevalion (Base)		(m)	0.0000				
Elevation (Ground)		(m)	0.0000	0.0000			
Elevation (% of Height)		(%)			L		
· · · · · · · · · · · · · · · · · · ·			DYNA	AMICS			
		Vesso	el Parameters: I	nitialize fr	om Product		
Vessel Volume	(m3)			Level Calcu			Vertical cylinder
Vessel Diameter	(m)		»	Fraction Ca	the second s		Use levels and nozzles
Vessel Height Liquid Level Percent	(m)			Feed Delta		(kPa)	0.0000
LINNU LEVELE CILENI	(%)		50.00	Vessel Pre		(kPa)	90.00
Dha			Holdup: Ve	SSEI LEVE			A contraction
Phase			evel m)	Percent (%)			Volume (m3)
Vapour Liquid Aqueous			•			р 66 во	0.0000 0.0000 0.0000
			, Holdup	: Details		,	
Hyprotech Ltd.		2	HYSYS v3.	(Build 481	5)		Page 1 of 2
and the state of the second se				10010 401			1 846 1 01 2

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	, Alberta	Unit Set: SI Date/Time: Wed Feb 07 12:21:17 2007					
G/ II/IO		Date/Time					
Conversio	n Reactor: C	HROME	PLATIN	G TANK	(continu	ied)	
Phase	Accumulati (kgmole/h			Moles (gmole)	Volume (m3) • 0.0000 • 0.0000 • 0.0000		
Vapour [·]	0.0000		0	0.0000			
Liquid Aqueous	0.0000			0.0000			
Total			0.		0.0000		
	Duty Valve	e Source : D)irect_Q				
SP (kJ/h)		Min. Ava (kJ/		3		Available (kJ/h)	
	6.641e+006 ·			-			
	Liquid He	ater Height as	% of Vesse	l Volume			
Top of Heater :	5.00 %	· ·		Bollom of Heate	er: 0.00 %		
1	Heat Flow into	o the PFR: H	leating				
			#			à	
			A.				
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					J. All		
승규는 것이 같은 것이 없다.							
황역 전 그렇게 생물							
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0	TEAM LND		Case Name: C:\P	Program Files	\Hyprotech\HYSYS 3.1	\Cases\MR. BABAL	OLA.2.hsc			
HYPROTECH	Calgary, Alberta		Unit Set: SI	Unit Set: SI						
	CANADA		Date/Time: Wee	Date/Time: Wed Feb 07 12:28:27 2007						
S	Separator: C	HRO	ME SOLUTION	CONC	ENTRATO	R				
			CONNECTIONS				1			
		5.2 T T	Inlet Stream							
Stream	n Name	He	, ealer	From	Unit Operation	Pf	RE_HEATER			
			Outlet Stream							
Stream	n Name			Tol	Jnit Operation					
WATER VAPOUR										
CHROME SOLUTION	nga - ing na sana sana sana sana sana sana sana	Ta	ink:			TEMPORARY STO	RAGE TANK			
	사망가 되고		Energy Stream							
Stream	n Name			From	Unit Operation					
	•		PARAMETERS							
Vessel Volume:	0.9966 m3	Level SP:		50.00 %	Liquid Volume:		0.4983 m			
Vessel Pressure: 9	0.00 kPa Pressure D		0.0000 kPa • Duty:			Transfer Mode:	Healing			
			User Variables							
	-		RATING							
			Sizing				1.5			
Cylinde			Vertical		Separator has a l	Bool: No				
Volume	0.9966 m3	Diameter		0.8700 m	• Height	in the fact of the second	1.67			
		•	Nozzles							
Base Elevation Relative to G	round Level		0.0000 m • Diameter		0.8700 m • Heig	the second se	1.67			
Dameter		(.L		ER_VAPOUR	CHROME_SC 8.382e-0				
Diameter · · · · · · · · · · · · · · · · · · ·	· · · · ·	(m) (m)	8.382e-002 0.8382	8.	1.676	0.000				
levation (Ground)		(m)	' 0.8382		1.676	0.000				
levation (% of Height)			50.00		100.00	0.00				
			ailed Heat Loss Param	otors						
verall Heat Loss (kJ/h)	•	Det	0.0000 Area (m2)				4.58			
	1		Temperature Profile		e serve a destruit server and the server destruit server		4.00			
luid (C) 0.0000	Inner Wall (C)	25.00	Outer Vessel (C) 25.00		nsulation (C) 25.00	Ambient (C)	25.0			
			Conduction Metal		T	Insulation				
nickness	(m)		1.000e-002			3.000e-002				
0	(kJ/kg-C)		0.4730		0.8200					
ensity	(kg/m3)		7801		520.0					
onductivity	. (W/m-K)		45.00			0.1500	S			
			Convection							
side Vap Phase U (kJ/h-m2	-C)	and the second	side Liq Phase U (kJ/h-m2-C)		Outs	ide U (kJ/h-m2-C)	54.0			
vel Tap	. PV High	Level	Taps: Level Tap Speci	lication	OP High	OPLO	ow			
			ps: Calculated Level T	ap Value						
vel Tap			Liquid Level			Aqueous Level				
			Options							
Work Term Contribution		(%)	100.00 •	· · · · · · · · · · · · · · · · · · ·						
			DYNAMICS		,					
	,	/essel Pa	rameters: Initialize fro	om Produ	ict					
protech Ltd.			HYSYS v3.1 (Build 4815	5)	<u></u>		Page 1 of			
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Unit Set:

Date/Time: Wed Feb 07 12:28:27 2007

0.0000

Separator: CHROME SOLUTION CONCENTRATOR (continued) (m3) Vessel Volume 0.9966 Level Calculator Vertical cylinder Vessel Diameter 0.8700 Fraction Calculator Use levels and nozzles (m) Vessel Height 1.676 Feed Della P (kPa) 0.0000 (m) Liquid Level Percent (%) Vessel Pressure (kPa) 90.00 50.00 Holdup: Vessel Levels Phase Level , Percent Volume (m) (%) (m3) Vapour 0.0000 ----Liquid. ------0.0000 Aqueous 0.0000 ---Holdup: Details Phase Accumulation Moles Volume (kgmole/h) (kgmole) (m3) 0.0000 0.0000 Vapour 0.0000 0.0000 Liquid 0.0000 0.0000 0.0000 Aqueous 0.0000 0.0000

0.0000

0.0000

4			2.					
-	•Case Name: C:\P	Case Name: C:\Program Files\Hyprolech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc						
TEAM LND Calgary, Alberta	Unit Set: SI							
CANADA	Date/Time: Wed	Feb 07 12:27:16 2007						
Mixer: CHR	OME SOLUTION	MIXER						
	CONNECTIONS	•						
F	Inlet Stream		£					
STREAM NAME		FROM UNIT OPERATION						
OLN	Conversion Reactor		CHROME PLATING TANK					
OLN.2 ·	Tank	in a second s	DRAGOUT TANK.4 DRAGOUT TANK.5					
SOLN.3	Tank							
OLN.4	Tank	nan ya muunin taasidii ya muuninta	DRAGOUT TANK 6					
	Outlet Stream							
STREAM NAME		TO UNIT OPERATION	and the second					
ROME SOLUTION	Heater,	A CONTRACTOR OF A CONTRACTOR A	PRE_HEATER					
	PARAMETERS		1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 - 1988 -					
	User Variables							
	NOZZĻE PARAMETER	5						
e Elevation Relative to Ground Level			0.0000 m					
	L.SOLN	L.SOLN.2	L.SOLN.3					
meler (m)	5.000e-002	5.000e-002	5.000e-002					
vation (Base) (m)	0.0000	0.0000	0.0000					
vation (Ground) (m)	0.0000	0.0000	0.0000					
malas (m)	L.SOLN.4	CHROME SOLUTION						
vation (Base) (m)	5.000e-002 0.0000	5.000e-002 0.0000						
valion (Ground) (m)	0.0000	0.0000						
	DYNAMICS							
Dross	ure Specification: Set Outlet to Lo	west lolet						
FIGS	Holdup Details							
Phase Accumu	·····	Moles	Volume					
(kgmc		(kgmole)	(m3)					
Vapour 0.00	00	0.0000 •	0.0000					
Liquid 0.00	00	0.0000 •	0,0000					
Aqueous 0.00	00	• 0.0000	0.0000					

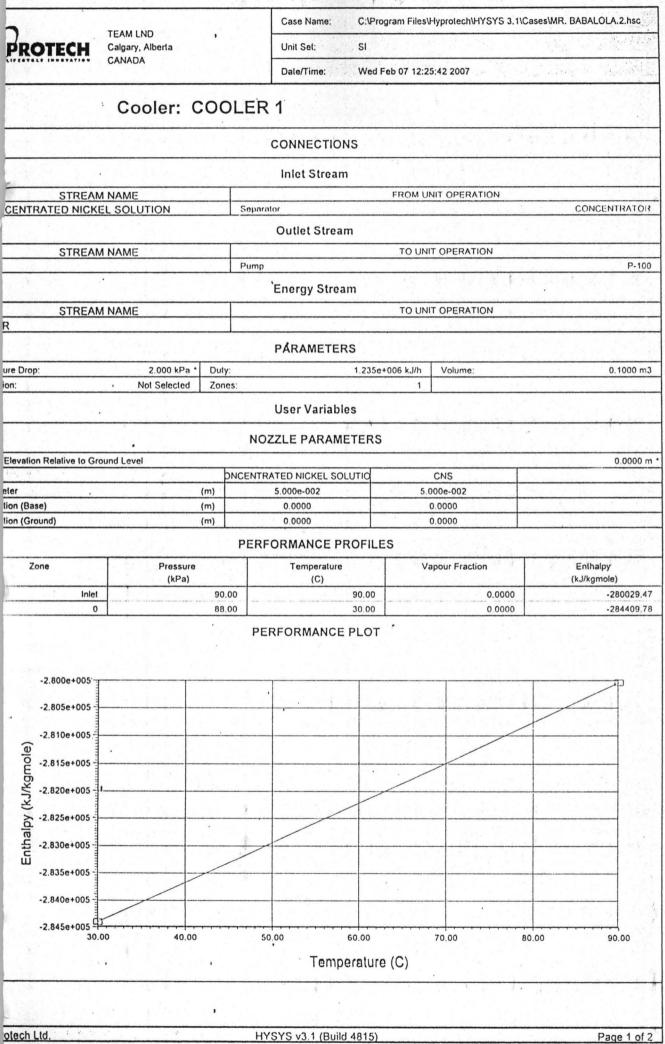
0.0000

Total

0.0000

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0.0000



ensed to: TEAM LND

-	영양 영양 문	8	Case Na	Case Name: C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc						
YPROTECH	TEAM LND Calgary, Alberta		Unit Set:	SI		n en l iteratu		e de la composition de la comp		
	CANADA		Date/Tin	ne: Wed F	eb 07 12:25:42	2007				
	Cooler:	COOLE	R 1 (co	ntinued)					
		PI	RFORMA	NCE TABLE		- Antonio -				
Temperature (C)				Flow //h)		nalpy gmole)	Vapour Fraction			
90.00 30.00		90.00 88.00	2 	0.00 -1234767.49		-280029.47 -284409.78	an an an	0.0000		
1			DYNA	MICS						
		Mod	el Details:	Supplied Du	uty					
one				Della P (kPa)		(kPa)		2.000		
/olume	(m3)	(m3) 0.1000 •			Overall K (kg/hr/sqrt(kPa-kg/m3))			117.4		
Duty	(kJ/h)		1.235e+006			5		at land		
		•	Holdup	Details						
Phase		Accumulation			Moles		Volume			
		(kgmole/h)		· (kgmole)		Sector Contract	(m3)			
Vapour I	and the state of the	0.0000	in the s	0.0000			0.0000	e		
Liquid	i den han in	0.0000			0.0000		0.0000			
Aqueous		0.0000		0.0000			0.0000			
Total		0.0000	in a start of the	0.0000 0.0000						
	Indi	vidual Zone H	loldups:	Zone 0						
		De	lta P Spec	s and Duties	5			i.		
Zone	Zone dP Value (kPa)			dP Option			Duty (kJ/h)			
0	•	2.000	•	n	ot specified		-6084			
		, Zone C	onductan	ce Specifica	tions			1		
Zone		<u> </u>		k kPa-ko/m3))			Specification			
the second s	0 .			(kg/hr/sqrt(kPa-kg/m3)) 117.4			Disabled			

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· ~ · _		Case Na	ime: C:\Pro	ogram Files\Hyprotech\HYSYS 3.1	Cases\MR. BABALOLA.3.hsc		
MYPPROTECH Calg	M LND gary, Alberta	Unit Set	SI ·				
CAN	IADA	Date/Tin	Date/Time: Thu Dec 21 17:08:03 2006				
A :							
Air	cooler: AIR D	RIER					
		CONNE	CTIONS				
		Inlet S	stream				
STREAM NAI W.B.M		Tank		FROM UNIT OPERATION	WASHING UNIT		
			Stream				
STREAM NAI	ME			TO UNIT OPERATION			
DRIED BASE METAL		Conversion React	or		ELECTROPLATING TANK		
	1.	DESIGN PA	RAMETERS				
Pressure Drop:		10.00 kPa *	UA:		-97.27 kJ/C-h		
Inlet Air Temp: Configuration:		25.00 C	Outlet Air Tem	р:	25.00 C one lube row, one pass		
	\$	PERFOR	MANCE		une luce low, one pass		
Working Fluid Duty:		147.2 kJ/h	Correction Fac	clor:	0.8111		
UA:		-97.27 kJ/C-h	LMTD:		1.865 0		
Feed Temp:		25.43 C	Prod Temp:		30.00 0		
Air Feed Temp: Volumetric Air Flow:		25.00 C +005 ACT_m3/h *	Air Prod Temp		25.00 (8 491a+005 kg/		
Volumetric Air Flow:	7.20004		Mass Air Flow	i and a second	8.491e+005 kg/		
Number of Fans		SIZ	ING				
Fan		Fan 0		Fan 1			
Speed	(rpm)		60.00	60.00	and the second s		
Speed Max Acceleration	(rpm) (rpm)		60.00	60.00			
Design Speed	(rpm)		60.00	60.00			
Design airflow	(ACT_m3/h)	and the second se	3.600e+005	3.600e+905			
Current airflow	(ACT_m3/h)		RAMETERS	3.600e+005	I		
Base Elevation Relative to Ground L	evel				0.4500 n		
D ¹		W.B.M		DRIED BASE METAL			
Diameter Elevation (Base)	(m) (m)		5.000e-002 0.0000	5.000e-002 0.0000			
Elevation (Ground)	(m)		0.4500	0.4500			
		NO	TES				
<i>v</i>							
		•		물건 물건 물건 감독			
		•					
Hyprolech Ltd.		HYSYS v3	(Build 4815)		Page 1 of		

CARADA Caratterizet SI Data Time: Touble 21 (552.35 2000 Pump: PUMP.1 CONNECTIONS Intel Stream Stream Name To (brd Operation NaO1 Outled Stream Stream Name Stream Name Stream Name Outled Stream Stream Name Outled Stream Stream Name Stream Name Outled Stream Stream Name Stream Str		Case Nar	me: C:\Program	Files/Hyprotech/HYSYS	3.1\Cases\MR. BABA	ALOLA.2.hsc
CAMADA Date // Time: Thu Dec. 21 (6/2.26 5006 Pump: PUMP.1 CONNECTIONS Inlet Stream Stream Name From Und Operation NnOH Outlet Stream Stream Name From Und Operation NnOH From Und Operation OP 1 PARAMETERS Adabate Efficency (b) 75 00 ° Decta P CurkVES 0.000 ° Conference C Operation 0.000 ° Conference C Carbon R 0.000 ° Conference C Operation From Basic Active Prov Use Variables RATING Speed Editionery (fs) NPSH NOSIE Curves NOSIE Curves Earder		Unit Set:	SI			
CONNECTIONS From Und Operation NaOl1 To Und Operation Stream Name To Und Operation NaOl1 To Und Operation Stream Name To Und Operation Stream Name PARAMETERS Adatable Efficiency (%) 7.500 ° Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2" Stream Name Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" <t< td=""><td>CANADA</td><td>Date/Tim</td><td>e: Thu Dec 21</td><td>16:52:36 2006</td><td>•</td><td></td></t<>	CANADA	Date/Tim	e: Thu Dec 21	16:52:36 2006	•	
CONNECTIONS Initel Stream NaOI From Unit Operation NaOI Outlet Stream Stream Name To bio Operation NAOIA NaOIA Stream Name To bio Operation OPERAMETERS Adabatic Efficiency (%) 7.000 IPa* Daty 6.8964e 07 Adabatic Efficiency (%) 7.000 IPa* Daty 6.8964e 07 Adabatic Efficiency (%) 7.000 IPa* Daty 6.8964e 07 CURVES Daty CORVES CURVES CURVES Contracteristic Curves main advise file Nozzle Paramaters Nozzle Paramaters Daty Colspan="2" Nozzle Paramaters <td>Pump: PUMP.</td> <td>1</td> <td></td> <td></td> <td></td> <td></td>	Pump: PUMP.	1				
Stream Name From Und Operation NAOH Outlet Stream Stream Name To fund Operation NAOH Heater Stream Name To fund Operation Stream Name From Und Operation OP.1 PARAMETERS Adabatic Efficiency (%) 75.00 ° Deta P 10.00 MP ° CURVES 6.956 e-001 V Coefficient A 0.0000 ° Obto Preferences 0.0000 ° Parameter Preferences Units for Deta P Mobile From Unit Spread Characteristic Curves 6.956 e-001 V Ocefficient A 0.0000 ° Characteristic Curves Parameter Preferences Plow Head RATING Efficiency (%) NPSH Registed NPSH Available NPSH Registed NPSH Available Nozzle Paramaters 0.0000 Base Evalue Results of gravier (m) 5.0000 0 Contract NOZZle Paramaters Base Evalue Results of gravier (m) 0.00000 Contract			CTIONS	<u></u>		
NCOT Outlet Stream Stream Name To (Mrt Operation NaOH Heater To (Mrt Operation NAOH Heater From Unit Operation OP.1 PARAMETERS Adabatic Efficient (Stream) OP.1 PARAMETERS 68564-001 Adabatic Efficient (Stream Name CURVES 68564-001 Operation 0000 Pa Duty 68564-001 Certificent A 0.0000 ° Coefficient B 0.0000 ° Coefficient C 0.000 Parametier Preferences Units for Delan P m Flow dasa Add/or Flow m Parametier Preferences Units for Delan P m Flow dasa Add/or Flow m Stream Name 0.000 Coefficient C 0.000 Coefficient C 0.000 Coefficient C 0.000 Coefficient C <td< td=""><td></td><td>Inlet S</td><td>tream</td><td></td><td></td><td></td></td<>		Inlet S	tream			
Outlet Stream To United Stream To United Stream Stream Name GP.1 From Unit Operation Open 2 From Unit Operation Open 2 Stream Adabatic Efficiency (%) 7.500 ° Date P 10.00 NPa ° Duty 6.9666.002 NP Adabatic Efficiency (%) 7.500 ° Date P 10.000 NP ° Outree 6.9666.002 NP Outree Colspan="2" Gate P Outree Colspan="2" 6.9666.002 NP Outree Colspan="2" Outree Colspan="2"				From Unit Operation		
Stream Name Te DMI Optication HEATE NaQH Heater HEATE HEATE Stream Name From Unit Optication OP.1 From Unit Optication OP.1 Adabatic Efficiency (%) 75 00 ° Deta P 10.00 MPa ° Duty 6.956e.000 M Adabatic Efficiency (%) 75 00 ° Deta P 10.00 MPa ° Duty 6.956e.000 M Centreme No. 0.0000 ° Centreme No. 0.0000 ° Centreme No. 0.0000 ° Parameter Preferences Units for Deta P m Flow Dass ActWeTow Units for Flow. ma Parameter Preferences Unes for Deta P m Flow Dass ActWeTow Units for Flow. ma Stream Name Streat Ures Stream Ma	NaOH	Outlet	Stream	11431	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	
NaOH Heater HEATE Stream Name Energy Stream From Unit Operation OP.1 PARAMETERS Adabatic Effection(%) 75.00° Deta P 10.00 MPA ° Duty 6.9664e.000 MA Adabatic Effection(%) 75.00° Deta P 10.00 MPA ° Duty 6.9664e.000 MA 6.9664e.000 MA Ceefficient A 0.000° Coefficient B 0.000° Coefficient C 0.000 Parameter Preferences Units for Deba P m Flow Ma Stor Flow m3 Genericent A 0.000° Coefficient B 0.000° Coefficient C 0.000 Parameter Preferences User Variables Flow MS Stor Flow m3 MSH Required _ NPSH AvaIsbe _ Enable NPSH Corves: No NSH Required _ NSSH Corves _ 0.0000 _ 0.0000 Evaluation Relative IG Ground Level _ NaOH _ 0.0000 _ 0.0000 _ 0.0000 _ 0.00000 _ _ 0.0	Stream Name	outier	Jucani	To Unit Operation		
Stream Name Prom Unit Operation OP.1 PARAMETERS Adabatic Efficiency (%): 75.00 ° Deta P 10.00 kPa ° Duty 6.966e.00 CURVES CURVES 0.000 ° Coefficient 0: 0.000 ° Coefficient 0: 0.000 ° Comform A 0.000 ° Coefficient 0: 0.000 ° Coefficient 0: 0.000 ° Comform A 0.000 ° Coefficient 0: 0.000 ° Coefficient 0: 0.000 ° Comform A 0.000 ° Coefficient 0: 0.000 ° Coefficient 0: 0.000 ° Comform A 0.000 ° Characteristic Curves mas mas mas Flow Mead Efficiency (%) NPSH NPSH Curves No No NPSH Required - NPSH Curves No No No No Evaluation Relative to Ground Level Nozole Paramaters 0.0000 0.0000 0.0000 Evaluation (figs) No No No Dameter (m) 5.000 0.0 (Mass (b) 5.000 ° F		ealer				HEATER
OP.1 PARAMETERS Adiabatic Efficiency (%) 75.00 ° Deta P 10.00 kPa ° Duty 6.964e.000 kPa ° CURVES CURVES 0.000 ° 6.964e.000 kPa ° Duty 6.964e.000 kPa ° Centerent A: 0.000 ° Coefficient B: 0.000 ° Ceefficient C: 0.00 Parameter Preferences Units for Delta P: m Few Banis ActVeRIve Units for Flow: ma Parameter Preferences Units for Delta P: m Few Banis ActVeRIve Units for Flow: ma Flow Head Efficiency (%) KRATING Efficiency (%) ma NPSH Required NPSH Avaalble NPSH Gurves No No NPSH Required NPSH Avaalble Nozzle Paramaters 0.0000 Cooloo Base Elevation Relative to Ground Levet No200 0.0000 0.0000 Cooloo Curreter (m) 5.000e-0.02 Elevation (floase) 0.0000 Cooloo Elevation (floase) (m) 0.0000 0.0000 0.0000 <td></td> <td>Energy</td> <td>Stream</td> <td></td> <td></td> <td></td>		Energy	Stream			
PARAMETERS 10.00 kPa ° Duty 6.9646-001 kr CURVES CURVES Duty 6.9646-001 kr Outy 6.9646-001 kr Outy 6.9646-001 kr Outy Confident C 0.000 Parameter Preferences Units for Flow m Flow Basis Active Flow Units for Flow m Flow Basis Active Flow Characteristic Curves Speed: Flow M PSH NPSH NPSH NPSH Curves No NOZIC Paramaters 0.0000 Date MPGH Curves NO NaOH NaOH NaOH Date MPGH Curves No Submeter Colspan="2" No <t< td=""><td></td><td></td><td></td><td>From Unit Operation</td><td></td><td></td></t<>				From Unit Operation		
Adabatic Efficiency (%): 75.0 ° Deta P: 10.00 kPa ° Duty 6.964e-008 kG Deta P: 10.00 kPa ° Duty 6.964e-001 0.000 0.0000 0.994e-01 0.000 0.994e-01 0.000 0.000 0.994e-01 0.000 0.994e-01 0.000 0.994e-01 0.000 0.994e-01 0.994e-01 0.000 0.994e-01 0.994e	QP.1					
CURVES Deta P: 10.00 kPa* Duty 6.964e.0f Coefficient A: 0.0000* Coefficient C: 0.000 Parameter Preferences Units for Deta P: m Flow Basis ActVoFlow Units for Flow: m Parameter Preferences Units for Deta P: m Flow Basis ActVoFlow Units for Flow: m Characteristic Curves Speed: Flow Head Efficiency (%) NPSH Required NPSH Available NPSH Curves No NPSH Required NPSH Available Nozzle Paramaters 0.0000 Base Elevation Relative to Ground Level NOCOL Start District Curves 0.0000 Levation (Ground Level 0.0000 0.0000 Diameter (m) 0.0000 0.0000 0.0000 Elevation (Ground Level 0.0000 0.0000 0.0000 0.0000 Base Elevation (Ground Level No Other Machine No Other Machine No Other Machine 0.0000 0.0000 0.0		PARAM				
Data P: 0.000 ° Coefficient B: 0.000 ° Coefficient C: <	Adiabatic Efficiency (%): 75.00 * Delta P:			kPa * Duty:	(A)-	6.964e-008 kM
Occasion Output Outpu		CUR	VES	i la contra c		
Parameter Preferences Units for Detta P m Flow Basis ActVoFlow Units for Flow: m3 User Variables RATING Characteristic Curves Speed: Flow Efficiency (%) Flow Head Efficiency (%) NPSH Required _ NPSH Curves: No NPSH Required _ NPSH Curves: No NPSH Curves _ NOZZIE Paramaters		and the second sec	Outy.			and a state of the second second
User Variables RATING Characteristic Curves Speed: Speed: Speed: PErw NPSH Required Efficiency (%) NPSH Required Nozzle Paramaters Base Elevation Relative to Ground Level NaOH NaOH NaOH Elevation (Base) (m) Source cols Elevation (Base) (m) Source cols Elevation (Bread (grand) 0.0000 Source cols Elevation (Base) (m) Soure cols Soure cols			and the second se	the second s	Inits for Flow:	0.000 m3/
RATING Characteristic Curves Speed: Speed: Flow Head Efficiency (%) NPSH Required Efficiency (%) NPSH Available Enable NPSH Curves: No NPSH Required NPSH Curves: No NPSH Required Enable NPSH Curves: No NPSH Required NPSH Required NPSH Required NPSH Required Enable NPSH Curves: No NPSH Required NOZZIE Paramaters Base Elevation Relative to Ground Leve! Nozzie Paramaters Base Elevation (Ground) Curves 0.0000 0.0000 Inertia Results Design Flow Typical Operating Capacity Curves 10.00 m3 Diff action Curves						
Speed: Speed: Flow Head Efficiency (%) ' NPSH NPSH Required - NPSH Available - Enable NPSH Curves: No NPSH Required - NPSH Available - Enable NPSH Curves: No NPSH Required - NPSH Required - Enable NPSH Curves: No Diameter NOZZIE Paramaters 0.0000 0.0000 0.0000 Diameter (m) 5.000e-002 5.000e-002 - - Elevation Relative to Ground Leve! (m) 0.0000 0.0000 - - Diameter (m) 0.0000 0.0000 0.0000 - - Elevation (Ground) (m) 0.0000 Mass (tg) 50.00 * Friction loss factor (rpm) 6.00 Start Up - Start Up - 10.00 m3 - 15.48e-017 Pessure Read 0.6997 m Deta P excluding Static Head Results - 15.48e-017 Pressure Head <						
Flow Head Efficiency (%) ' NPSH Efficiency (%) NPSH Required - NPSH Available - Enable NPSH Curves: No NPSH Required - NPSH Available - Enable NPSH Curves: No NPSH Required - NPSH Curves: No No No Base Elevation Relative to Ground Level - NaOH NaOH NaOH - Diameter (m) 5 0000-002 5 0000-002 Elevation (Ground) - NaOH -	Hart	Characteris	stic Curves			Ŷ.
NPSH NPSH Available			and the second s			
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Elevation (Base) (m) 0.0000 0.0000 0.0000 Elevation (Ground) (m) 0.00000 0.0000 0.0000		And the second second second second		And the second state of th		
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Jossign Flow Typical Operating Capacity 10.00 m3 PERFORMANCE PERFORMANCE Total Head - Velocity Head -1.548e-017 Pressure Head 0.6897 m Detia P excluding Static Head Results DYNAMICS Dynamic Specifications Duty (m) - Not Active Power (k.J/h) 2.507e-004 Not Active Adiabatic Efficiency (rpm) - Not Active Capacity (m3/h) 1.560e-005 Image: colspan="2">Not Active Polytropk Efficiency (%) 75.00 Active Use Characteristic Curves Not Active		Ine	rtia			
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Total Head - Velocity Head -1.548e-017 Pressure Head 0.6897 m Delta P excluding Static Head Results 0 DYNAMICS Dynamic Specifications Duty (m) - Not Active Power (kJ/h) 2.507e-004 Not Active Adiabatic Efficiency (m) - Not Active Capacity (m3/h) 1.560e-005 1000 Polytropic Efficiency (%) 75.00 Active Use Characteristic Curves Not Active Not Active Pressure Increase (kPa) 10.00 Active Pump is Acting as a Turbine Not Active		PERFOR	MANCE			
Pressure Head 0.6897 m Delta P excluding Static Head Results DYNAMICS Dynamic Specifications Duty (m) - Not Active Power (kJ/h) 2.507e-004 Not Active Adiabatic Efficiency (m) - Not Active Capacity (m3/h) 1.560e-005 Potytropic Efficiency (%) 75.00 Active Use Characteristic Curves Not Active Pressure Increase (kPa) 10.00 Active Pump is Acting as a Turbine Not Active		Res	ults			
DYNAMICS Dynamic Specifications Duty (m) - Not Active Power (kJ/h) 2.507e-004 Not Active Duty (m) - Not Active Power (kJ/h) 2.507e-004 Not Active Adiabatic Efficiency (rpm) - Not Active Capacity (m3/h) 1.560e-005 Not Active Polytropic Efficiency (%) 75.00 Active Use Characteristic Curves Not Active Not Active Pressure Increase (kPa) 10.00 Active Pump is Acting as a Turbine Not Active	Total Head		Velocity Head			-1.548e-017 n
Dynamic Specifications Duty (m) - Not Active Power (kJ/h) 2.507e-004 Not Active Adiabatic Efficiency (rpm) - Not Active Capacity (m3/h) 1.560e-005 Polytropic Efficiency (%) 75.00 Active Use Characteristic Curves Not Active Not Active Pressure Increase (kPa) 10.00 Active Pump is Acting as a Turbine Not Active Not Active	Pressure Head	0.6897 m	Delta P excluding St	alic Head Results	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	5 -
Duty (m) - Not Active Power (kJ/h) 2.507e-004 Not Active Adiabatic Efficiency (rpm) - Not Active Capacity (m3/h) 1.560e-005 Polytropic Efficiency (%) 75.00 Active Use Characteristic Curves Not Active Pressure Increase (kPa) 10.00 Active Pump is Acting as a Turbine Not Active		DYNA	MICS			
Adiabatic Efficiency (rpm) - Not Active Capacity (m3/h) 1.560e-005 Polytropic Efficiency (%) 75.00 Active Use Characteristic Curves Not Active Pressure Increase (kPa) 10.00 Active Pump is Acting as a Turbine Not Active	그는 김 승규는 것은 것을 가지 않는 것이 같아요.	Dynamic Sp	ecifications			
Adlabatic Efficiency (rpm) - Not Active Capacity (m3/h) 1.560e-005 Polytropic Efficiency (%) 75.00 Active Use Characteristic Curves Not Active Not Active Pressure Increase (kPa) 10.00 Active Pump is Acting as a Turbine Not Active Not Active	Duty (m) -	Not Active	Power	(kJ/ħ)	2.507e-004	Not Active
Pressure Increase (kPa) 10.00 · Active Pump is Acting as a Turbine Not Active			the second se	and the second	1.560e-005	
		1 Anti-	Use Characteristic (Curves		Not Active
	Polytropic Efficiency (%) 75.00		and the second se	Tuching		41-4 4 -44

MYPROTECH

TEAM LND Calgary, Alberta CANADA

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Unit Set:

Case Name:

Dale/Time: Thu Dec 21 16:52:36 2006

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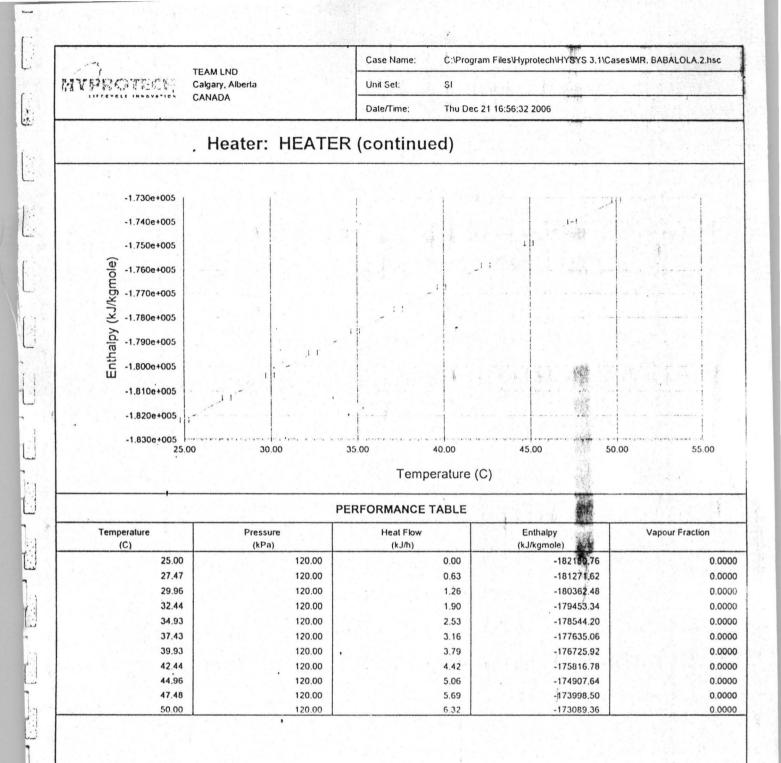
C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc

Pump: PUMP.1 (continued)

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	Holdup Details										
Phase	Accumulation (kgmole/h)	Moles (kgmole)		Volume (m3)							
Vapour	0.0000	0.0000	· · ·	0.0000							
Liquid	0 0000	0.0000	1	0.0000							
Aqueous	0 0000	0 0000	•	0.0000							
Total	0.0000	0.0000	2 3 4 11 11	0.0000							

CANA H STREAM NAM NaOH. STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1	eater: HEAT	TER CONNECTIONS ' Inlet Stream Pump Outlet Stream		2 2006	
CANA H STREAM NAM NaOH. STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1		Date/Time: Thu TER CONNECTIONS Inlet Stream Pump Outlet Stream Tank	FROM UNI	F	
STREAM NAM NaOH. STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1	E	TER CONNECTIONS ' Inlet Stream Pump Outlet Stream	FROM UNI	F	
STREAM NAM NaOH. STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1	E	CONNECTIONS Inlet Stream Pump Outlet Stream		COPERATION	
NaOH. STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1	E	Inlet Stream Pump Outlet Stream Tank		OPERATION	
NaOH. STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1	E	Pump Outlet Stream Tank		OPERATION	
NaOH. STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1	E	Outlet Stream		OPERATION	
STREAM NAM SODIUM HYDROXIDE STREAM NAM Q.HEATER1		Outlet Stream	TO UNIT		
SODIUM HYDROXIDE STREAM NAM Q.HEATER1			TO UNIT		
STREAM NAM Q.HEATER1	E			OPERATION	<u>}.</u>
Q.HEATER1	E				DEGREAS
Q.HEATER1	E	Energy Stream			
•			FROM UNI	OPERATION	
		' PARAMETERS			
Pressure Drop:	0.0000 kPa Duty:			Volume:	
Function:	Not Selected Zones		1	شوديا يود ويتر ويتر وي	
		' User Variables			<u></u>
		RATING			
<u></u>		NOZZLE PARAMETERS	5	de la composition de	
Base Elevation Relative to Ground Lev	el	NaOH.	SODIUME		<u> </u>
Diameter	(m)	5.000e-002	and the second	0e-002	
Elevation (Base)	(m)	0.0000	and the second state of the second second	000	ter interiore
Elevation (Ground)	(m) [620	
	DET	AILED HEAT LOSS PARA	METERS		
Overall Heat Loss (kJ/h)		- Area (m2) Temperature Profile		an a	
5111/0					
Fluid (C) — Inne	er Wall (C) 25.00		Outer Wall	(C) 25.00 E	External (C)
		Conduction			
Thickness	(m)	Metal .	1.000e-002	Ins	sulation
Ср	(kJ/kg-C)		0.4730		
Density - Conductivity	(kg/m3) (W/m-K)		7801		
	<u></u>	Convection			
Outside U (kJ/h-m2-C)		54.00 Inside U (kJ/	₼-m2-C\	<u>.</u>	
Colore o (nomine o)		PERFORMANCE PROFIL			
Zone	Pressure	Temperature		our Fraction	Enthalpy
ı inlet	(kPa)	(C)	S	and the second	/k l/kamak
I Intel 1	120.00	25.00		0.0000	(kJ/kgmol



			Case Na	Case Name: C:\Program Files\Hyprolech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc						
HYPROTECH	TEAM LND Calgary, Albert	а	Unit Set:	SI	and the second s					
	CANADA	£	, Date/Tim	, Date/Time: Wed Feb 07 12:25:04 2007						
	Dum	D 40	l							
	Pump	o: P-10	0							
			CONNE	CTIONS						
			Inlet S	tream						
CNS	n Name		Cooler		From U	nit Operation		COOLER 1		
			Outlet	Stream						
	n Name				To Un	it Operation				
P.CNS			Recycle			·		RCY-1		
Stroom	n Name	in the second	Energy	Stream	From I	Init Operation		General Section		
Q.P	i Name				FIOID	int Operation				
			PARAM	ETERS						
Adiabatic Efficiency (%):		95.00 • Delta	P:	1	0.00 kPa •	Duty:		1.480e-002 k		
			CUR	VES	111					
Della P: Coefficient A:	0	.0000 • Coeff	10.00 kPa • icient B:	Duly:	0.0000 •	Coefficient C:	<u>, and the loss</u>	1.480e-002 1 0.00		
Parameter Preferer	the second s	s for Delta P:	m	Flow Basis	19. 1		Units for Flow:	F7 .		
			User Va	riables		1. 1.				
			RAT	ING		Despire.				
			Characteris	stic Curves						
				Speed:						
Flow	<u>in an an</u>		He		1.000	1	Efficiency (%)			
NPSH Required		NPSH	NP 1 Available	SH		Enable NPSH	Curves:	No		
			NPSH	Curves		- Chable Hir Off				
		<u> </u>								
Para Elevation Palative In Cr	ound Loual		• Nozzle Pa	aramaters	1. X			0.0000 m		
Base Elevation Relative to Gr	ound Level	· .	• Nozzle Pa	aramaters	· F	P.CNS		0.0000 m		
Diameter	ound Level	(m)	CNS	5.000e-002	F	5.000e-0	terreter and the second state of the second st	0.0000 m		
	ound Level		CNS		F		00	0.0000 m		
Diameter Elevation (Base)	ound Level	(m) , (m)	CNS	5.000e-002 0.0000 0.0000		5.000e-0	00	0.0000 m		
Diameter Elevation (Base)		(m) , (m)	CNS	5.000e-002 0.0000 0.0000	F	5.000e-0 0.00 0.00	00			
Diameler Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2)	0.5000 Rad	(m) , (m) , (m)	CNS	5.000e-002 0.0000 0.0000 rtią Mass (kg)	F	5.000e-0 0.00 0.00	00			
Diameler Elevation (Base) Elevation (Ground)	0.5000 Rad	(m) , (m) , (m)	CNS Ine m) 0.1000 • Star	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up		5.000e-0 0.00 0.00	00	pm) 6.000		
Diameler Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2)	0.5000 Rad	(m) , (m) , (m)	CNS Ine m) 0.1000 •	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up		5.000e-0 0.00 0.00	00	pm) 6.000		
Diameler Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2)	0.5000 Rad	(m) , (m) , (m)	CNS Ine m) 0.1000 • Star	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up	р 	5.000e-0 0.00 0.00	00	pm) 6.000		
Diameter Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2) Design Flow Typical Operation Total Head	0.5000 Rad	(m) , (m) , (m)	CNS Ine m) 0.1000 • Star PERFOR Res 1.016 m •	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up RMANCE ults Velocity Head		5.000e-00 0.000 50.00 *	00	pm) 6.000 10.00 m3/h		
Diameter Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2) Design Flow Typical Operation	0.5000 Rad	(m) , (m) , (m)	CNS Ine m) 0.1000 • Star PERFOR Res	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up RMANCE ults Velocity Head Delta P excludi		5.000e-00 0.000 50.00 *	00	pm) 6.000 10.00 m3/h		
Diameter Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2) Design Flow Typical Operation Total Head	0.5000 Rad	(m) , (m) , (m)	CNS Ine m) 0.1000 • Star PERFOR Res 1.016 m • 1.016 m	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up RMANCE ults Velocity Head Delta P excludi MICS		5.000e-00 0.000 50.00 *	00	0.0000 m pm) 6.000 10.00 m3/h -1.457e-007 m		
Diameter Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2) Design Flow Typical Operation Total Head Pressure Head	0.5000 Rad	(m) , (m) , (m)	CNS Ine m) 0.1000 • Star PERFOR Res 1.016 m • 1.016 m DYNA	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up RMANCE ults Velocity Head Delta P excludi MICS		5.000e-00 0.000 50.00 *	00	pm) 6.000 10.00 m3/h -1.457e-007 m 		
Diameter Elevation (Base) Elevation (Ground) Rotational inertia (kg-m2) Design Flow Typical Operation Total Head Pressure Head	0.5000 Rad	(m) (m) ius of gyration (CNS Ine m) 0.1000 • Star PERFOR Res 1.016 m • 1.016 m DYNA , Dynamic Sp	5.000e-002 0.0000 0.0000 rtia Mass (kg) t Up RMANCE ults Velocity Head Delta P excludi MICS ecifications	ing Static He	5.000e-0 0.00 0.00 50.00 •	D0 Friction loss factor (r	pm) 6.000 10.00 m3/h		

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TEAM LND Calgary, Alberta CANADA

 Case Name:
 C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR, BABALOLA.2.hsc

 Unit Set:
 SI

 Date/Time:
 Wed Feb 07 12:25:04 2007

Pump: P-100 (continued)

Pressure Increase	(kPa)	10.00 •	Active	Pump is Acting as a Turbine		and the second second	Not Active
			Holdup	Details			
Phase		Accumulation (kgmole/h)		Moles (kgmole)		Volume (m3)	
Vapour		0.0000		0.0000		0.0000	
Liquid		0.0000		0.0000	•	0.0000	
Aqueous -		0.0000		0.0000	•	0.0000	
Total	A CARLES OF	0.0000		0.0000		0.0000	

<u> </u>		Case Na	ame: C:\Program Files\Hyprotech\H	YSYS 3.1\Cases\M	MR. BABALOLA.hsc				
HYPROTECH Calgary.	Alberta	Unit Set	Unit Set: SI						
CANAD/	A	Dale/Tir	ne: Fri Feb 09 09:10:03 2007						
Vessel Siz	zing: [EGREASING	UNIT,		1				
21 - 22 - 23 - 24 - 24 - 24 - 24 - 24 - 24	Vertical Se	perator Properties:	CONCENTRATOR						
UD Ratio		5.000 *	Demister to Top (m		0.3048				
Liq. Res. Time (seconds)		, 300.0 •			a na na manaha na na kita na mangana kana na mangana kana na				
		Construction	Information						
Chem Eng Fab Index		252.5	Allowable Stress	(kPa)	9.446e+004				
Material Type		Carbon Steel	Shell Thickness	(mm)	6.350				
Mass Density	(kg/m3)	7861	Corrosion Thickness	(mm)	3.175				
FMC		1.000	Joint Efficiency		. 1.000				
		Costing C	oefficients	1. 2.					
Shell Thick		Shell Mass	Base Cost	Ac	cessories				
A1: 0.4000 •	A4:	0.8116 *	A5: 8.600	A8:	1017				
A2: 2.000 *			A6: -0.216	• A9:	0.7396				
A3: 0.2000 *			A7: 4.580e-002	A10:	0.7068				
		Costing	Results		der s				
Base Cost (\$US)	7476	Associated Cost (\$US)	1658 Total Co	st (FOB \$US)	9134				
	20	Sizing	Results						
Diameter	(m)	, 0.6096	Liquid Residence Time (seconds)	300.0				
Total Length	(m)	3.353	Liquid Surge Height	(m)	1.567				
L/D Ratio		5.000	LLSD	(m)	0.4572				
Max, Allowable Vapour Velocity	(m/s)	1.000	Liquid Res. Time at LLSD (seconds)	80.44				
	(mm) '	0.0000							
Demister Thickness		Vanouu	r Space						
Demister Thickness		vapou	• • • • • • • • • • • • • • • • • • • •						
Demister Thickness	(m)	0.3048	Demister To Head	(m)	0.3048				
	(m) (m)			(m) (m)	0.3048				

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0		· c	Case Name:	: C:\Program Files\+	hyprotech\HYSYS 3.1	1\Cases\MR. BABALOLA.2.hsc
HYPROTECH (TEAM LND Calgary, Alberta	· (Jnit Set:	SI		No. 12-12 Addition
	CANADA	C	Dale/Time:	Wed Feb 07 12:26	:38 2007	
Se	parator:	CONCENT	RATO	R		
an a		cc	ONNECT	IONS		an a
		1	nlet Stre	am		
Stream N	ame	Heater		From U	nil Operation	PRE-HEATER
			utlet Str	ream	an a	
Stream N	ame		de i	To Ur	it Operation	
WATER VAPOUR CONCENTRATED NICKEL	SOLUTION	Cooler:	nin dana minana Maria			COOLER 1
		Er	nergy St	ream		
Stream N	ame		1	From L	Init Operation	
		IP,	ARAMET	TERS		
Vessel Volume:	0.1223 m3	Level SP:		50.00 %	Liquid Volume:	6.116e-002 m3
Vessel Pressure: 90.00	0 kPa Pressure I	Drop: 0.0000	0 kPa · C	Duty:	0.0000 kJ/h Heal	t Transfer Mode: Heating
		U	ser Varia	ables		
		•	RATIN	G		
			Sizing	g		
Cylinder			Vertical		Separalor has a	
Volume	0.1223 m3	Diameter		0.3048 m *	Height	1.676
1			Nozzle	25		
Base Elevation Relative to Groun	nd Level	0.00	00 m • C	Diameter	0.3048 m • Heig R VAPOUR	hI 1.676 DNCENTRATED NICKEL SOLUT
Diameter		(m) 8.3	382e-002			8.382e-002
Elevation (Base)		(m)	0.8382	1.676		0.0000
Elevation (Ground)			0.8382			0.0000
Elevation (% of Height)		- <u>} - </u>	50.00		00.00	0.00
		in the second		p Specification		
Level Tap	PV High		PV Low	in the second	OP High	OP Low
	,	Level Taps: Ca		Level Tap Values		
Level Tap			Liquid Lev			Aqueous Level
DV/Mark Tarro Carto's dia			Option	15		
PV Work Term Contribution		(70)		ICS		
				ialize from Produc	t	
Vessel Volume	(m3)			evel Calculator		Vertical cylinder
Vessel Diameter	(m)			raction Calculator		Use levels and nozzles
Vessel Height Liquid Level Percent	(m) (%)	The second second second second second second second		Feed Della P Vessel Pressure	(kPa) (kPa)	0.0000 90.00
		n an		el Levels		
Phase		Level		Percent (%)		Volume (m3)
Vapour		(m) 		(%)		(m3) 0.0000
Liquid	· · · · · · · · · · · · · · · · · · ·			17 - 18 - 19 - 19 - 19 - 19 - 19 - 19 - 19		0.0000
Aqueous		•			,	0.0000
		, Но	oldup: D	Details		

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TEAM LND Calgary, Alberta CANADA

 Case Name:
 C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc

 Unit Set:
 SI

 Date/Time:
 Wed Feb 07 12:26:38 2007

Separator: CONCENTRATOR (continued)

Phase	Accumulation (kgmole/h)	Moles (kgmole)	Volume (m3)
Vapour .	0.0000	0.0000 •	0.0000
Liquid	0.0000	0.0000 •	0.0000
Aqueous	0 0000	0 0000 ·	0.0000
Total	0.0000	0.0000	0.0000

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-		Case Na	ame: C:\Program Files\	Hyprotech\HYS	SYS 3.1\Cases\MR.	BABALOLA.hsc		
HYPROTECH Calgary.		Unit Set	Unit Set: SI					
CANADA	•	Date/Tir	ne: Fri Feb 09 09:22:0	05 2007				
Vessel Siz	zing: \	Vessel Sizing-	11					
	Vertical S	eperator Properties:	DRAGOUT TANK.6					
L/D Ratio		5.000 *	Demister to Top	(m)		0.3048		
Liq. Res. Time (seconds)		3537 •						
	1	Construction	Information	12.04.5	and the target	the second states		
Chem Eng Fab Index		252.5	Allowable Stress		(kPa)	9.446e+004		
Material Type		Carbon Steel	Shell Thickness		(mm)	6,350		
Mass Density	(kg/m3)	7861	Corrosion Thickness		(mm)	3.175		
FMC	(kg/mo)	1.000	Joint Efficiency		1.000			
1			oefficients					
Shell Thick		Shell Mass	Base Cost					
A1: 0.4000 *	A4:	0.8116 *	A5:	8.600 *	ACCE	essories 1017		
A2: 2.000 •	A4.	0.8116	A5: A6:	-0.2165 *	A9:	0.7396		
A3: 0.2000 *			A7:	4.580e-002 *	A10:	0.7068		
		Casting	R	4.5000-002	<u>A10.</u>	0.7008		
			Results					
Base Cost (\$US)	5205	Associated Cost (\$US)	608.5	Total Cost (I	FOB \$US)	5814		
		Sizing	Results					
Diameter	(m)	0.3048	Liquid Residence Time	(sec	conds)	3537		
Total Length	(m)	1.676	Liquid Surge Height		(m)	0.4572		
L/D Ratio		5.000	LLSD		(m)	0.4572		
Max. Allowable Vapour Velocity	(m/s)	1.000	Liquid Res. Time at LLSD	(sec	conds)	3537		
Demister Thickness	(mm)	0.0000	la standard	Sugar Version		Station and the		
		Vapou	r Space 🕝	. Jr				
Sump To Inlet Nozzle	(m)	0.3048	Demister To Head		(m)	0.3048		
Inlet Nozzle to Demister	(m)	0.5334	Ellipsoidal Head		(m)	7.620e 007		
				a second s				

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TEAM LND Calgary, Alberta CANADA Case Name: C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc Unit Set: SI

Date/Time: Wed Feb 07 12:24:03 2007

	IIII DIO	GOUT TAI	III U		
		· CONNE	CTIONS		
		Inlet S	tream		
Stream Name				From Unit Operation	
WCM.2		Tank			DRAGOUT TANK
WATER.10		Tee			TEE-10
		+ Outlet S	Stream		
Stream Name	ana ana amin'ny fanina amin'ny fanina amin'ny fanina amin'ny fanina amin'ny fanina amin'ny fanina amin'ny fanin	Lange Street		To Unit Operation	
WCM,3					
L.SOLN.4		Mixer:			CHROME SOLUTION MIXE
	·	. Energy	Stream	· · · ·	
Stream Name				From Unit Operation	
		Lauran			
		PARAM	ETERS		
Vessel Volume:	Lev	el SP:	50.0	0 % Liquid Volume:	
Vessel Pressure: 90.00 kPa P	ressure Drop:	0.0000 kPa •	Duty:	0.0000 kJ/h He	at Transfer Mode
		User Va	ariables		
		RAT	ING	3 2 3	
	-11. L.L.L.L.L.L.L.L.L.L.L.L.L.L.L.L.L.L.	Siz	ing		
· Cylinder		Ver	tical	Separator has a	Bool: No
Volume ·	Dia	meter		Height	
		Noz	zles		
Base Elevation Relative to Ground Level		0.0000 m *	Diameter	He	ight
		WCM.2		WATER.10	WCM,3
Diameter	(m)	5.000e-00	2	5.000e-002	5.000e-002
Elevation (Base)	. (m)	0.0000		0.0000	0.0000
Elevation (Ground)	(m)	0.0000		0.0000	0.0000
Elevation (% of Height)	(%)	L.SOLN.4			
Diameter	(m)	5.000e-00	the second s		
Elevation (Base)	(m)	0.0000			
Elevation (Ground)	(m)	0.0000	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1		
Elevation (% of Height)	(%)				
	Le	evel Taps: Level	Tap Specificatio	on	
Level Tap	PV High		Low	OP High	OP Low
				and the second state of th	<u></u>
	Leve	el Taps: Calculat	ed Level Tap Va	lues	
Level Tap	'	Liquid	Level		Aqueous Level
		Opti	ons		
PV Work Term Contribution	(%)	100.00 •			
		DYNA	MICS		
	Vess	el Parameters: 1		oduct	
Vessel Volume (m			Level Calculator		Vertical cylind
the second s	n)		Fraction Calculator		Use levels and nozzi
the star was a starting on the start of the starting starting of the start of the s	m)		Feed Della P	(kPa	and the second
	%)	50.00	Vessel Pressure	(kPa	Contraction of the second s
Liquid Level Percent (*		state of the second s			
Liquid Level Percent (*		Holdup: Ve	essel Levels	· · · · ·	

0	115	Case Name:	C:\Program Files\Hyprolech\HY	SYS 3.1\Cases\MR. BABALOLA.2.hsc			
	, Alberta	Unit Set: SI					
CANAD	A	Dale/Time:	Date/Time: Wed Feb 07 12:24:03 2007				
	fank: DRAGO	UT TANK					
Phase	Level (m)		Percent (%)	Volume (m3)			
Vapour				0.0000			
Liquid		1.1.5.4.5.5.4.1.5.5.	-	0.0000			
				0.0000			
Aqueous		A REAL PROPERTY OF THE PARTY OF					
Aqueous		Holdup: Deta	ails				
Phase	Accumulation	Holdup: Deta	Ails Moles	Volume			
	Accumulation (kgmole/h)	Holdup: Deta	en el construction de la construct	Volume (m3)			
		Holdup: Deta	Moles				

0.0000

0.0000

0.0000

0.0000

0.0000

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Aqueous

Total

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•		Case Na	me: C:\Program Files\	Hyprotech\HYS	YS 3.1\Cas	es\MR. B	ABALOLA.hsc
	ry, Alberta	Unit Set	SI				
CANA	DA	Date/Tin	ne: Fri Feb 09 09:21:	23 2007			$\Delta u_{i} = \left\{ \left\{ \left\{ i,j \right\} \} \right\} \}$
Vessel S	<u></u>	/essel Sizing-					
	Vertical Se	eperator Properties:	DRAGOUT TANK.5			e	
L/D Ratio		5.000 •	Demister to Top	(m)			0.304
Liq. Res. Time (seconds)	Liq. Res. Time (seconds) 1.047e+0						
		Construction	Information				
Chem Eng Fab Index		, 252.5	Allowable Stress	(kPa)	1.5	9.446e+00	
Material Type		Carbon Steel	Shell Thickness	(mm)	1.19/19	6.35	
Mass Densily	(kg/m3)	7861	Corrosion Thickness		(mm)	Sec. 15	3.17
FMC		1.000	Joint Efficiency				1.00
		Costing Co	pefficients				
Shell Thick	T	Shell Mass	Base Cost	R		Acces	sories
A1: • 0.4000	· A4:	0.8116 *	A5:	8.600 •	A8:		101
A2: 2.000	•		A6:	-0.2165 •	and the second se		0.739
A3: 0.2000	•		A7: 4.580e-002 *		A10: 0.706		
		Costing	Results			ł	
Base Cost (\$US)	5205	Associated Cost (\$US)	608.5	Total Cost (OB \$US)	1	581
	Î	Sizing	Results			1.0	
Diameter	(m)	0.3048	Liquid Residence Time	(sec	onds)	3	1.047e+00
Total Length	(m)	· 1.676	Liquid Surge Height		(m)	1.1.1	0.457
U/D Ratio		5.000	LLSD		(m)		0.457
Man Allemakle Manager Malagilu	(m/s)	1,000	Liquid Res. Time at LLSD	(sec	onds)	11	1.047e+00
Max. Allowable Vapour Velocity							

Sump To Inlet Nozzle	(m)	0.3048	Demister To Head	(m)	0.3048
Inlet Nozzle to Demister	(m) ·	. 0.5334	Ellipsoidal Head	(m)	7.620e-002
Demister Thickness	(mm)	0.0000	Total Vapour Height	(m)	1.21

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~			Case Na	me: C:\Program File	s\Hyprotech\HYS	SYS 3.1\Cases\M	AR. BABALOLA hsc
HYPROTECH Calgary. CANADA	, Alberta		Unit Set:	SI	d. 1. (1997) 1997 - Starley		
CANADA	`````		Date/Tim	ne: Fri Feb 09 09:20	0:30 2007		
Vessel Siz	zing: ˌ\	/essel Si	zing-	9			
	Vertical Se	eperator Prope	rties:	DRAGOUT TANK.4			
U/D Ratio			5.000 .	Demisler to Top	(m)	- 1	0.3048
Liq. Res. Time (seconds)	1.04		12e+004 ·	ar anna an ann an ann a' an a' a		- 1.4	e monte e la subcontrant de la subcey contract subcontra de soutro
		Con	struction	Information			
Chem Eng Fab Index				Allowable Stress		(kPa)	9.446e+004
Material Type		Carb	on Steel	Shell Thickness (mm)			6.350
Mass Density	(kg/m3)		7861	Corrosion Thickness	(mm)	3.175	
FMC			1.000	Joint Efficiency			1.000
		C	osting Co	oefficients		1	
Shell Thick		Shell Mass		Base Cos	it .	A	ccessories
A1: 0.4000 •	A4:		0.8116 *	A5:	8.600 *	A8:	1017
A2: 2.000 •			-	A6:	-0.2165 *	A9:	0.7396
A3: 0.2000 •			6	A7:	4.580e-002 *	A10:	0.7068
			Costing	Results			
Base Cost (\$US)	5205	Associated Cos	st (SUS)	608.5	Total Cost (FOB SUS)	5814
		10 stal.	Sizing	Results		IV	
Diameter	(m)	in the second	0.3048	Liquid Residence Time	(se	conds)	1.042e+004
Total Length	(m)		1,676	Liquid Surge Height	(50)	(m)	0.4572
L/D Ratio			5.000	LLSD		(m)	0.4572
Max. Allowable Vapour Velocity	(m/s)		1.000	Liquid Res. Time at LLS	D (see	conds)	1.042e+004
Demister Thickness	(mm)		0.0000				
			Vapou	Space			
Sump To Inlet Nozzle	(m)		0.3048	Demister To Head		(m)	0.3048
		and the set of the set		and the state of t	the second s	(and a second	and the second
Inlet Nozzle to Demister	(m)		0.5334	Ellipsoidal Head		(m)	7,620e-002

Page 1 of 1 * Specified by user.

		Case Na	me: C:\Program	Files\Hyprotech\HYSYS 3.1\C	ases\MR. BABALOLA.3.hsc			
TEAM LND Calgary, Alberta		Unit Set:	SI		「「ション」ないなめ			
CANADA		Date/Tin						
T-ulu F		,						
Tank: [RAGU		NK.4					
		CONNE	CTIONS					
		Inlet S			an and a second sec			
Stream Name CHROMED METAL	Co	nversion Reacto		From Unit Operation	CHROME PLATING TANK			
WATER 8	Tee				TEE-100			
		Outlet :	Stream					
Stream Name				To Unit Operation				
WCM.1	Tai	nk:			DRAGOUT TANK.5			
SOLN.2	Mix	er:			CHROME SOLUTION MIXER			
		Energy	Stream					
Stream Name			and the second	From Unit Operation				
		PARAM	ETERS					
Vessel Volume: 1.216 m3	Level SP:		50.0	00 % Liquid Volume:	0.6081 m3			
Vessel Pressure: 90.00 kPa Pressure D		0.0000 kPa *	Duty:	0.0000 kJ/h Heat T	ransfer Mode: Heating			
		User Va	riables					
		RAT	ING		a na an ang ang an ang ang ang ang ang a			
		, Siz	ing		1			
Cylinder		• Ver	licəl	Separator has a Bo	ot: No			
Volume 1.216 m3	Diameter		0.76	20 m • Height	2.667			
		Noz	zles					
Base Elevation Relative to Ground Level		0.0000 m *	Diameter	0.7620 m * Height	2.667			
		CHROMED METAL		WATER.8	WCM.1			
Diameter Elevation (Base)	(m)	0.1334		0.1334	0.1334 2.667			
Elevation (Ground)	(m) (m)	1.333		1.333	2.667			
Elevation (% of Height)	(%)	\$0.00		50.00	100.00			
AMALIN		L.SOLN.2						
Diameter (Dece)	(m)	0.1334						
Elevation (Base) Elevation (Ground)	(m) (m)	0.0000						
Elevation (% of Height)	(%)	0.00		· · · · · ·				
	Level	Taps: Level	Tap Specificati	on				
Level Tap PV High		· PV		OP High	OP Low			
				· · · · ·	01 2017			
	Levellap		ed Level Tap Va					
Level Tap	L.	Liquid		Aq	ueous Level			
		Opti	ons					
PV Work Term Contribution	(%)	100.00 •	1					
경제에서 집중에서 있었다.		DYNA	MICS					
\ \	essel Pa	rameters: I	nitialize from Pr	oduct				
Vessel Volume (m3)		1.216	Level Calculator		Vertical cylinder			
Vessel Diameter (m)		0.7620 •	Fraction Calculator		Use levels and nozzles			
Vessel Height (m) Liquid Level Percent (%)		2.667 • 50.00	Feed Delta P Vessel Pressure	(kPa) (kPa)	0.0000 90.00			
(70)	۳ *		essel Levels		50.00			
				an a				

Case Name: C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.3.hsc Unit Set: SI

Date/Time: Wed Feb 07 12:21:49 2007

Tank: DRAGOUT TANK.4 (continued)

TEAM LND

CANADA

Calgary, Alberta

HYPRO

Phase	Level (m)	Percent (%)	Volume (m3)
Vapour			0.0000
Liquid			0.0000
Aqueous			0.0000
	Holdup:		
Phase	Holdup: Accumulation	Details	Volume
Phase	and the second se		Volume (m3)
Phase Vapour	Accumulation	Moles	
	Accumulation (kgmole/h)	Moles (kgmole)	(m3)
Vapour	Accumulation (kgmole/h) 0.0000	Moles (kgmole) 0.0000 •	(m3) 0.0000

		Case Na	me: C:\Program Files\Hyprol	lech\HYSYS 3.1	Cases\MR. BAB	ALOLA.hsc			
HYPROTECH Calgary.	Alberta	· Unit Set:	Unit Set: SI						
CANADA		Date/Tim	ne: Fri Feb 09 09:13:17 200)7					
Vessel Siz	zing: \	essel Sizing-	3						
	Vertical Se	perator Properties:	DRAGOUT TANK.3						
U/D Ralio		5.000 *	Demister to Top	(m)		0.3048			
Liq. Res. Time (seconds)	Anno 1997 - Anno 1997 - Anno 1997 - A	3537 •				Contract Lands (with December 4)			
		Construction	Information						
Chem Eng Fab Index		252.5	Allowable Stress	(kF	Pa)	9.446e+004			
Material Type	1	Carbon Steel	Shell Thickness	. (m	m)	6.350			
Mass Density	(kg/m3)	7861	Corrosion Thickness		m)	3.175			
FMC		1.000	Joint Efficiency			1.000			
	16.2	Costing Co	oefficients						
Shell Thick	<u></u>	Shell Mass	Base Cost		Accesso	ries			
A1: 0.4000 *	A4:	0.8116 *	A5:	8.600 · A8:		1017			
A2: 2.000 •			A6: -0	.2165 • A9:		0.7396			
A3: 0.2000 •			A7: 4.580	e-002 • A10:		0 706			
아이지 않는 것은 것이 같다.		Costing	Results						
Base Cost (\$US)	5205	Associated Cost (\$US)	608.5 Tot	al Cost (FOB \$U	IS)	58			
		Sizing I	Results						
Diameter	(m)	0.3048	Liquid Residence Time	(seconds)	1	3:			
Total Length	(m)	1.676	Liquid Surge Height	(m)		0.457.			
L/D Ratio		5.000	LLSD (r			0.457			
Max. Allowable Vapour Velocity	(m/s)	1.000	Liquid Res. Time at LLSD	(seconds)		3537			
Demister Thickness	(mm)	0.0000							
김 의원 같은 혼란을 다.		Vapour	Space						
Sump To Inlet Nozzle	(m)	0.3048	Demister To Head	(m)	1	0.3048			
Inlet Nozzle to Demister	(m)	0.5334	Ellipsoidal Head	(m)		7.620e-00			
Demister Thickness		0.0000	Total Vapour Height			1.21			

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0		distant an		Case Na	me: C:\Pro	gram FilesV	Hyprotech\HY	SYS 3.11	Cases\MR. BABAL	OLA,3.hsc
HYPROTECH	TEAM LN Calgary, A			Unit Set:	SI					
	CANADA			Dale/Tim	ne: Wed F	eb 07 12:1	9:29 2007			(Mappin)
	Та	ank: D	RAG	OUT TAN	NK.3					
				CONNEC						
	ii aali olaafaan oo qaa			Inlet St			•			
Stream	Name			iniero		From I	Jnit Operation			in the second
P.IRON.	I Wallie			Tank			Sint Operation		DRAG	OUT TANK
WATER.7		•		Tee					WATE	ER SPLITTER
				Outlet S	Stream					
Stream	Name	· · · ·				To U	nit Operation			
PLATED METAL		the second s		Conversion Reacto	or:				CHROME PL	ATING TANK
WASH WATER.3				Mixer:						MIXER.
				Energy	Stream '					
Stream	Name	*****				From I	Jnit Operation	1		
·····				PARAM	ETERS					id N
Vessel Volume:		0.9800 m3 •	Level S	p.		50.00 %	Liquid Volu	me:		0.4900 m
	0.00 kPa	Pressure Dr		0.0000 kPa •	Duty:		0.0000 kJ/h	1	Fransfer Mode:	Healin
				User Va		2414		1		
				RAT						
				RAI	ING					
				Sizi						
Cylinde		0.9800 m3 *	Diamet	' Verl	lical	0.9405 m	Separato Height	has a B	oot: No	1.41
and the second strategy and the se		0.9800 m3 *	Diamet	' Verl	tical	0.9405 m		r has a Be	oot: No	1.41
		0.9800 m3 *	Diamet	' Vert er	tical	0.9405 m		r has a Bo		
Volume Base Elevation Relative to Gr				* Vert er *0.0000 m * P.IRON.	lical Zles Diameter	w	Height 0.9405 m ATER.7		1 PLATED	1.41 METAL
Volume Base Elevation Relative to Gr Diameter			(m)	* Vert er *0.0000 m * P.IRON. 7.054e-002	lical Zles Diameter	W 7.(Height 0.9405 m /ATER.7 054e-002		I PLATED 7.054e	1.41 METAL -002
Volume Base Elevation Relative to Gr Diameter Elevation (Base)			(m) (m)	* Vert er *0.0000 m * P.IRON. 7.054e-003 0.7054	lical Zles Diameter	W 7.(Height 0.9405 m /ATER.7 054e-002 0.7054		1 PLATED 7.054e 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) ' Elevation (Ground)			(m) (m) (m)	* Vert er *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054	lical Zles Diameter	W 7.(Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054		1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base)			(m) (m)	* Vert er *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054 50.00	zles Diameter	W 7.(Height 0.9405 m /ATER.7 054e-002 0.7054		1 PLATED 7.054e 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height)			(m) (m) (m) (%)	* Vert er *0.0000 m * P.IRON. 7.054e-002 0.7054 0.7054 50.00 WASH WATE	zles Diameter 2 ER.3	W 7.(Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter	ound Level		(m) (m) (m) (%)	* Vert er *0.0000 m * P.IRON. 7.054e-00 0.7054 0.7054 50.00 WASH WATE 7.054e-00	zles Diameter 2 ER.3	W 7.(Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054	Heigh	1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base)	ound Level		(m) (m) (m) (%) (m) (m)	* Vert er *0.0000 m * P.IRON. 7.054e-003 0.7054 0.7054 50.00 WASH WATE 7.054e-003 0.0000	zles Diameter 2 ER.3	W 7.(Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) ' Elevation (Ground) Elevation (% of Height) Diameter	ound Level		(m) (m) (m) (%)	* Vert er *0.0000 m * P.IRON. 7.054e-00 0.7054 0.7054 50.00 WASH WATE 7.054e-00	zles Diameter 2 ER.3	W 7.(Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) ' Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground)	ound Level		(m) (m) (%) (%) (m) (m) (m) (%)	* Vert er *0.0000 m * P.IRON. 7.054e-003 0.7054 0.7054 50.00 WASH WATE 7.054e-003 0.0000 0.0000	zles Diameter 2 ER.3 2	W 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground)	ound Level		(m) (m) (%) (%) (m) (m) (m) (%)	Vert er Noz: *0.0000 m * P.IRON. 7.054e-002 0.7054 50.00 WASH WATE 7.054e-002 0.0000 0.0000 0.0000 0.000	zles Diameter 2 ER.3 2	W 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (Mof Height) Diameter Elevation (Base) Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h)	ound Level		(m) (m) (%) (m) (m) (m) (m) (%) Do	Vert P.IRON. 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATE 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Temperate	zles Diameler 2 ER.3 2 oss Parame Area (m2) ure Profile	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41 100.	1.41 METAL -002 11 11 00 4.16
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height)	ound Level		(m) (m) (%) (%) (m) (m) (m) (%)	Vert er Noz: *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054 50.00 WASH WATE 7.054e-00; 0.0000 0.0000 0.0000 0.000 0.0000 0.0000	zles Diameter 2 ER.3 2 oss Parame Area (m2) ure Profile C) 25.00	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41	1.41 METAL -002 11 11 00 4.16
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (Mof Height) Diameter Elevation (Base) Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h)	ound Level		(m) (m) (%) (m) (m) (m) (m) (%) Do	Vert P.IRON. 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATE 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Temperatu Outer Vessel (free tools of the second se	zles Diameter 2 R.3 2 SR.3 2 Area (m2) ure Profile C) 25.00 uction	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	Heigh	1 PLATED 7.054e 1.41 1.41 100.	1.41 METAL -002 11 11 00 4.16
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) D.0000 Thickness	ound Level	Vall (C) (m)	(m) (m) (%) (m) (m) (m) (m) (%) Do	Vert er Noz: *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054 0.7054 0.7054 0.0000 WASH WATE 7.054e-00; 0.00000 0.00000 0.0000 0.0000 0.0000 0.0	zles Diameter 2 2 R.3 2 2 oss Parame Area (m2) ure Profile C) 25.00 uction etal e-002	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	8	t PLATED 7.054e 1.41 1.41 100.	1.41 METAL -002 11 11 00
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) D.0000 Thickness Cp	ound Level	Vall (C) (m) (kJ/kg-C)	(m) (m) (%) (m) (m) (m) (m) (%) Do	Vert er Noz: *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054 0.7054 0.7054 0.0000 WASH WATE 7.054e-00; 0.00000 0.00000 0.0000 0.0000 0.0000 0.0	zles Diameter 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	8	1 PLATED 1 7.054e 1.41 1.41 100. 4 Ambient (C) Insulation 3.000e-002 0.8200	1.41 METAL -002 11 11 00 4.16
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) O.0000 Thickness Cp Density	ound Level	Vall (C) (m) (kJ/kg-C) (kg/m3)	(m) (m) (%) (m) (m) (m) (m) (%) Do	Vert er Noz: *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054 0.7054 0.7054 0.00000 0.00000 0.0000 0.00000 0.00000 0.0000000 0.00000 0.00	zles Diameter 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	8	1 PLATED 1 7.054e 1.41 1.41 100. 4 Model of the second sec	1.41 METAL -002 11 11 00 4.16
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) D.0000 Thickness Cp	ound Level	Vall (C) (m) (kJ/kg-C)	(m) (m) (%) (m) (m) (m) (m) (%) Do	Vert er Noz: *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054 0.7054 0.7054 0.00000 0.00000000	zles Diameter 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	8	1 PLATED 1 7.054e 1.41 1.41 100. 4 Ambient (C) Insulation 3.000e-002 0.8200	1.41 METAL -002 11 11 00 4.16
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) O.0000 Thickness Cp Density	ound Level	Vall (C) (m) (kJ/kg-C) (kg/m3) (W/m-K)	(m) (m) (%) (%) (m) (m) (m) (%) 25.00	Vert er Noz: *0.0000 m * P.IRON. 7.054e-00; 0.7054 0.7054 0.7054 0.7054 0.00000 0.00000 0.0000 0.00000 0.00000 0.0000000 0.00000 0.00	zles Diameter 2 2 ER.3 2 Coss Parame Area (m2) ure Profile C) 25.00 uction etal ie-002 730 730 730 730	w 7.0	Height 0.9405 m /ATER.7 054e-002 0.7054 0.7054 50.00	25.00	1 PLATED 1 7.054e 1.41 1.41 100. 4 Model of the second sec	1.41 METAL -002 11 11 00 4.16
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0.0000 Thickness Cp Density Conductivity	ound Level	Vall (C) (m) (kJ/kg-C) (kg/m3) (W/m-K)	(m) (m) (%) (%) (m) (m) (%) (%) 25.00	Vert er Noz: *0.0000 m * P.IRON. 7.054e-003 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.0000 7054 0.0000 7054 0.0000 7054 0.0000 7054 7054 7054 7054 7054 7054 7054	zles Diameter 2 2 3 3 3 4 5 8.3 2 3 5 8.3 2 3 5 8 7 3 9 7 8 7 1 9 7 7 1 9 7 7 1 9 7 7 7 1 9 7 7 7 7	W 7.0 ters	Height 0.9405 m (ATER.7) 54e-002 0.7054 50.00 sulation (C)	25.00	1 PLATED 7.054e 1.41 1.41 1.00. Ambient (C) Insulation 3.000e-002 0.8200 520.0 0.1500	1.41 METAL -002 11 11 00 4.16 25.0
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0.0000 Thickness Cp Density Conductivity	ound Level	Vall (C) (m) (kJ/kg-C) (kg/m3) (W/m-K)	(m) (m) (%) (%) (m) (m) (%) (%) 25.00	Vert P.IRON. 7.054e-003 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATE 7.054e-003 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0	zles Diameter 2 Diameter 2 CR.3 CR.3 C	W 7.0 ters	Height 0.9405 m (ATER.7) 54e-002 0.7054 50.00 sulation (C)	25.00	1 PLATED 7.054e 1.41 1.41 1.00. Ambient (C) Insulation 3.000e-002 0.8200 520.0 0.1500	1.41 METAL -002 11 11 00 4.16 25.0 54.0
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (% of Height) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) O.0000 Thickness Cp Density Conductivity Inside Vap Phase U (kJ/h-m2)	ound Level	Vall (C) (m) (kJ/kg-C) (kg/m3) (W/m-K) PV High	(m) (m) (m) (%) (m) (m) (m) (%) (%) 25.00 25.00	Vert er Noz: *0.0000 m * P.IRON. 7.054e-003 0.7054 0.7054 0.7054 0.7054 0.0000 WASH WATE 7.054e-003 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.0000000 0.00000000	zles Diameter 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	w 7.0 ters	Height 0.9405 m (ATER.7)54e-002 0.7054 0.7054 50.00 sulation (C)	25.00	1 PLATED 7.054e 1.41 1.41 100. 4 Mbient (C) Insulation 3.000e-002 0.8200 520.0 0.1500 de U (kJ/h-m2-C)	1.41 METAL -002 11 11 00 4.16 25.0 54.0
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (% of Height) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) O.0000 Thickness Cp Density Conductivity Inside Vap Phase U (kJ/h-m2)	ound Level	Vall (C) (m) (kJ/kg-C) (kg/m3) (W/m-K) PV High	(m) (m) (m) (%) (m) (m) (m) (%) (%) 25.00 25.00	Vert P.IRON. 7.054e-003 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATE 7.054e-003 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.000 0.0000 0.0000 0.0000 0.000	zles Diameter 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	w 7.0 ters	Height 0.9405 m (ATER.7)54e-002 0.7054 0.7054 50.00 sulation (C)	Heigh	1 PLATED 7.054e 1.41 1.41 100. 4 Mbient (C) Insulation 3.000e-002 0.8200 520.0 0.1500 de U (kJ/h-m2-C)	1.41 METAL 002 11 11 00 4.16 25.0 54.0
Volume Base Elevation Relative to Gr Diameter Elevation (Base) Elevation (Ground) Elevation (Ground) Elevation (M of Height) Dlameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) Overall Heat Loss (kJ/h) Fluid (C) Thickness Cp Density Conductivity Inside Vap Phase U (kJ/h-m2 Level Tap	ound Level	Vall (C) (m) (kJ/kg-C) (kg/m3) (W/m-K) PV High	(m) (m) (m) (%) (m) (m) (m) (%) (%) 25.00 25.00	Vert P.IRON. 7.054e-003 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATE 7.054e-003 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.000 0.0000 0.0000 0.0000 0.000	zles Diameter 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	w 7.0 ters	Height 0.9405 m (ATER.7)54e-002 0.7054 0.7054 50.00 sulation (C)	Heigh	Ambient (C) Insulation 3.000e-002 0.8200 520.0 0.1500 de U (kJ/h-m2-C) OP I	1.41 METAL 002 11 11 00 4.16 25.0 54.0

0	TEAULIND	Case Na	me: C:\Program Files\Hyprol	ech\HYSYS 3.1\Ca	ses\MR. BABALOLA.3.hsc				
HYPROTECH	TEAM LND Calgary, Alberta	Unit Set	Unit Set: SI						
	CANADA	Date/Tin	ne: Wed Feb 07 12:19:29 2	007					
	Tank: D	RAGOUT TAI	NK.3 (continued)						
		., Opti	ons						
PV Work Term Contribution		(%) 100.00 *							
		DYNA	MICS						
		5117							
	Vo	essel Parameters: I	nitialize from Product						
Vessel Volume	(m3)	0.9800 *	Level Calculator		Vertical cylinde				
Vessel Diameter	(m)	0.9405	Fraction Calculator		Use levels and nozzle				
Vessel Height	(m)	1,411	Feed Delta P	(kPa)	0.000				
Liquid Level Percent	(%)	50.00	Vessel Pressure	(kPa)	90.0				
		Holdup: Ve	ssel Levels						
Phase		Level	Percent		Volume				
	것 : 동일 이것 같은 것 같	(m)	(%)		(m3)				
Vapour					0.0000				
Liquid	White is the second second second second second	• 0.0 (0.0 (0.0) 0.000(0.0) 0.0 (0.0) • 1 (0.0)	and a contract the second s		0.0000				
Aqueous					0.0000				
		Holdup:	Details						
Phase	A	ccumulation	Moles		Volume				
	Sec. A construction	(kgmole/h)	(kgmole)	and the second	(m3)				
Vapour		0.0000	0.0000	•	0.0000				
Liquid	elisanen eta erretaria eta erretaria.	0.0000	0.0000		0.0000				
Aqueous		0.0000	0.0000	•	0 0000				
Total	COLUMN AND AVAILABLE	0.0000	0.0000	State of the state of the	0.0000				

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~	L		Case Na	me: C:\Program Files\Hyprol	ech\HYSYS	3.1\Cases\MR	BABALOLA.hsc		
MYPROTECH	TEAM LI Calgary,	Alberta	Unit Set:	Unit Set: SI					
CIPENTOLE INCOVATION	CANADA		Date/Tim	ne: Fri Feb 09 09:12:35 200	7				
Vess	el Siz	zing:	Vessel Sizing-	2					
	•	Vertical S	eperator Properties:	DRAGOUT TANK.2					
UD Ratio	·* 1		5.000 •	Demister to Top	(m)		0.3048		
Liq. Res. Time (s	econds)		1.047e+004 *	The second se			•		
		1.1.1	Construction	Information					
Chem Eng Fab Index	4		· · · · · · · · · · · · · · · · · · ·	me i construir qu'anne d'anne anne anne a		(1.0-)	0.445-4004		
Material Type	ę		252.5 Carbon Steel	Allowable Stress Shell Thickness		(kPa)	9.446e+004 6.350		
Mass Density		(kg/m3)	7861	Corrosion Thickness	-	(mm) (mm)	3.175		
FMC		(kg/iii3)	1,000	Joint Efficiency	((()))	1.000			
			• Costing Co				N		
Shell Thick	•		Shell Mass	Base Cost		Acce	ssories		
A1:	0.4000 •	A4:	0.8116 *	A5:	8.600 · A	8:	1017		
A2:	2.000 •			A6: -0	.2165 · A	49:	0.7396		
A3:	0.2000 •		·	A7: 4.580	e-002 · A	A10:	0 7068		
			Costing	Results					
Base Cosl (\$US)	<u>72</u> 5	5205	Associated Cost (\$US)	608.5 Tota	al Cost (FO	B SUS)	5814		
			Sizing I	Results					
Diameter	71	(m)	0.3048	Liquid Residence Time	(secon	ds)	1.047e+00		
Total Length		(m)	1.676	Liquid Surge Height		(m)	0.4572		
UD Ralio			5.000	LLSD	((m)	0.4572		
Max. Allowable Vapour Veloci	ty	(m/s)	1.000	Liquid Res. Time at LLSD	(secon	ds)	1.047e+004		
Demister Thickness	£.	(mm)	0.0000				A		
			Vapour	Space		14 14 E			
Sump To Inlet Nozzle		(m)	0.3048	Demister To Head	((m)	0.3048		
Inlet Nozzle to Demister		(m)	0.5334	Ellipsoidal Head	((m)	7.620e-002		
and the second sec			0.0000	Total Vapour Height			1,219		

1	EAM LND	Case Na	me: C:\Program Files	Hyprotech HYSYS 3.1 Case	sWR. BABALOLA.3.hsc				
HYPROTECH G	algary, Alberta	Unit Set	SI						
	ANADA	Date/Tin	ne: Wed Feb 07 12:1	18:54 2007					
	Tank: D	RAGOUT TAI	NK.2						
		CONNE	CTIONS		<u>n de la compositiva de</u>				
		Inlet S	tream						
Stream N	ame	Tank	From	Unit Operation	DRAGOUT TANK.				
P.IRON WATER.6		Tee							
		Outlet	Stream						
Stream N	ame			Jnit Operation					
P.IRON.		Tank:			DRAGOUT TANK.				
WASH WATER.2		Mixer:	State of the second state of the	and the second	MIXER.				
		Energy	Stream						
·Stream N	ame	1	From	Unit Operation					
		PARAN	IETERS						
Vessel Volume:	0.9800 m3 •	Level SP:	50.00 %	Liquid Volume:	0.4900 n				
Vessel Pressure: 90.00	kPa Pressure Dro	op: 0.0000 kPa *	Duty:	0.0000 kJ/h Heat Tran	sfer Mode: Heater				
		User Va	ariables						
		RAT	TING	<u></u>	1				
		Siz	ing						
Cylinder			tical	Separator has a Boot:	No				
Volume	0.9800 m3 •	Diameter	0.9405 m	Height	1.41				
Base Elevation Relative to Groun	d Loug	0.0000 m *	Diameter	0.9405 m Height	1.41				
base Lievalion Relative to Group		P.IRON	have and many many many many many	VATER.6	P.IRON.				
Diameter	(m) • 7.054e-00	2 7	.054e-002	7.054e-002				
Elevation (Base)	and the second	m) 0.7054		0.7054	1.411				
Elevation (Ground)	and a second	m) 0.7054		0.7054	1.411				
Elevation (% of Height)		%) 50.00 WASH WAT	ER 2	50.00	100.00				
Diameter	, (m) 7.054e-00	and state out the first state and the state of the state						
Elevation (Base)	(m) 0.0000							
Elevation (Ground)	the best of the second s	m) 0.0000							
Elevation (% of Height)		%) 0.00	Tap Specification						
Level Tap	PV High		Low	OP High	OP Low				
			led Level Tap Values						
Level Tap		Liquid	Level	Aque	ous Level				
		Opt	ions						
PV Work Term Contribution		(%) 100.00 *							
			MICS						
	V	essel Parameters: I	nitialize from Produ	ct					
Vessel Volume	(m3)	. 0.9800 •	Level Calculator	<u> </u>	Vertical cylind				
Vessel Diameter	(m)	0.9405	Fraction Calculator		Use levels and nozzle				
Vessel Height	(m)	1.411	Feed Delta P	(kPs)	0.000				
Liquid Level Percent	(%)	Holdup: Ve	Vessel Pressure	(kPa)	90,0				
		noiuup, ve			the second second second				
and the second									

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0	TEAMINE	Case Name: C:\Program Files\Hyprotech\HYSY	S 3.1\Cases\MR. BABALOLA.3.hsc
HYPROTECH	TEAM LND Calgary, Alberta	Unit Set: SI	· 《 》、他被招表了
	CANADA	Date/Time: Wed Feb 07 12:18:54 2007	a the second
Phase	Level	OUT TANK.2 (continued)	Volume
Veren	(m)	(%)	(m3)
			0,0000
Vapour Liquid Aqueous	алтан аланын алан алан алан алан алан алан	anna a sua a bandina a suma a sua su surrana in anaganing inanand dana m	0.0000 0.0000 0.0000
Liquid	장애 가슴에 가슴을 물건을 다 가슴다.	Holdup: Details	0,0000

(kgmole)

0.0000

0.0000

0.0000

0.0000

(m3)

0.0000

0.0000

0.0000

0.0000

(kgmole/h)

0.0000

0.0000

0.0000

0.0000

7.		

Vapour

Liquid

Aqueous

Total

-			Case Na	me: C:\Program Files\	Hyprotech\HY	SYS 3.1\Cases\MF	R. BABALOLA.hsc
HYPROTECH Calgary	Alberta		Unit Set:	SI	1000	1.1.	
CANAD.	A		Date/Tim	e: Fri Feb 09 09:11:	46 2007		
Vessel Si	zing: \	/essel`S	izing-	1			
	Vertical Se	eperator Prope	erties: I	DRAGOUT TANK.1			
L/D Ratio	· · · ·		5.000 •	Demister to Top	(m)		0.3048
Liq. Res. Time (seconds)		1.0	42e+004 ·	Construction of the second secon			
		Con	struction	Information			
Chein Eng Fab Index			252.5	Allowable Stress		(kPa)	9.446e+004
Material Type		Carl	oon Steel	Shell Thickness		(mm)	6.350
Mass Density	(kg/m3)	7861		Corrosion Thickness (m			3.175
FMC			1.000	Joint Efficiency			1.000
		c	osting Co	pefficients			
Shell Thick	·	Shell Mass		Base Cost		Acc	essories
A1: 0.4000 *	A4:		0.8116 •	A5:	8.600 *	A8:	1017
A2: 2.000 *			·	A6:	-0.2165 *	A9:	0.7396
A3: 0.2000 *				A7:	4.580e-002 *	A10:	0.7068
			Costing	Results			
Base Cost (\$US)	5205	Associated Co	st (SUS)	608.5	Total Cost (FOB SUS)	5814
			Sizing F	Results			i.di
Diameter	(m)		0.3048	Liquid Residence Time	(sec	conds)	1.042e+004
Total Length	(m)		1.676	Liquid Surge Height	(000	(m)	0.4572
UD Ratio			5.000	LLSD		(m)	0.457
Max. Allowable Vapour Velocity	(m/s)		1.000	Liquid Res. Time at LLSD	(sec	conds)	1.042e+004
Demister Thickness	(mm)		0.0000				
•		•	Vapour	Space		4	3
Sump To Inlet Nozzle	(m)		0.3048	Demister To Head		(m)	0.3048
Inlet Nozzle to Demister	(m)		0.5334	Ellipsoidal Head		(m)	7.620e-002
	and the second se			and the second se			and the second se

~			Case Name: C	:\Program Files\	Hyprotech\HYSYS	3.1\Cases\MR. BABALOL	A.3.hsc
	M LND ary, Alberta		Unit Set: S	i		E pr	
CAN	ADA		Dale/Time: M	Ved Feb 07 12:1	8:07 2007		
	· · · · · · · · · · · · · · · · · · ·						
	Tank: DF	RAGC	UT TANK.1				
			CONNECTIONS		10-1 		
Stream Nam		<u> </u>	Inlet Stream	From I	Unit Operation		
LATED IRON	<u>u</u>	Cor	version Reactor	110111		ELECTROPLAT	ING TANK
VATER.5		Teo				WATER	SPLITTER
\$			Outlet Stream				
Stream Nam	e			To U	nit Operation	· · · · · · · · · · · · · · · · · · ·	
P.IRON		Tar Mix				DRAGOU	JT TANK.
VASH WATER.1			a de la companya de La companya de la comp				MIACK.
			Energy Stream				
Stream Nam	e		4	From	Unit Operation		
			PARAMETERS				1. 3
essel Volume:	0.9800 m3 •	evel SP:		50.00 %	Liquid Volume:		0.4900 m
essel Pressure: 90.00 kP			0.0000 kPa * Duly:		the second s	leat Transfer Mode:	Heating
			User Variables		•		
ning tanan di kanang kanan			RATING				
	-		Sizing				
			and the second stand standard groups and standard standards at		T		
Cylinder		2	Vertical	0.0105	Separator has	a Boot: No	
Cylinder *	0.9800 m3 *	Diameter		0.9405 m	Separator has Height	a Boot: No	1.41
olume		Diameter	Nozzles	0.9405 m	Height		
selected and the second se		Diameter		<u>.</u>	Height	a Boot: No	
olume ase Elevation Relative to Ground Lo			Nozzles	; w	Height 0.9405 m H	leight	1.41
olume ase Elevation Relative to Ground Le iameter levation (Base)	evel (m (m)	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054	W 7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054	leight P.IRON 7.054e-00 1.411	1.41
olume ase Elevation Relative to Ground Le liameter levation (Base) levation (Ground)	evel (m (m (m)	Nozzles 0.0000 m • Diameter PLATED IRON 7.054e-002 0.7054 0.7054	W 7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411	1.41
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground)	evel (m (m)	Nozzles 0.0000 m • Diameter PLATED IRON 7.054e-002 0.7054 0.7054 50.00	W 7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054	leight P.IRON 7.054e-00 1.411	1.41
olume ase Elevation Relative to Ground Lo iameter levation (Base) levation (Ground) levation (% of Height)	evel (m (m (m)	Nozzles 0.0000 m • Diameter PLATED IRON 7.054e-002 0.7054 0.7054	W 7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411	1.41
olume ase Elevation Relative to Ground Lo iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base)	evel (m (m (m (%)))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000	W 7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411	1.41
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base) levation (Ground)	evel (m (m (m (% (% (m) (m) (m) (m) (m) (m) (m) (m))))))))	Nozzles 0.0000 m* Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000	W 7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411	1.41
olume ase Elevation Relative to Ground Le biameter levation (Base)	evel (m (m (m (%))))))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.000	-	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411	1.41
olume lase Elevation Relative to Ground Le liameter levation (Base) levation (Ground) levation (% of Height) levation (Base) levation (Ground) levation (% of Height)	evel (m (m (m (% (% (m) (m) (m) (m) (m) (m) (m)))))))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000	-	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411	1.41
olume ase Elevation Relative to Ground Le hameter devation (Base) devation (Ground) levation (% of Height) hameter levation (Base) levation (Ground)	evel (m (m (m (% (% (m) (m) (m) (m) (m) (m) (m)))))))))	Nozzles 0.0000 m* Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.000 0.0000 Area (m2	W 7.(Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411	1.411
olume lase Elevation Relative to Ground Le liameter levation (Base) levation (Ground) levation (% of Height) liameter levation (Base) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h)	evel (m (m (m (% (% (m) (m) (m) (m) (m) (m) (m)))))))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil Profil	www.7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00	leight P.IRON 7.054e-00 1.411 1.411 100.00	4.16
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h)	evel (m (m (m (% (% (m (m (m) (%)))))))))) Deta	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2 0.0000 Area (m2 Temperature Profil	www.7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054	leight P.IRON 7.054e-00 1.411 1.411 100.00	4.16
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base) levation (Ground) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h) uid (C) 0.0000 Inr	evel (m (m (m (% (% (m (m (m) (%)))))))))) Deta	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2 Temperature Profil <output (c)<="" outer="" td="" vessel=""> 25.</output>	www.7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00	leight P.IRON 7.054e-00 1.411 1.411 100.00 0 0 Ambient (C) Insulation	4.16
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h)	evel (m (m (m (% (m) (m))))))))))) Deta	Nozzles 0.0000 m* Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.000 0.0000 Area (m2 Temperature Profill 25. Conduction Metal 1.000e-002 0.002	www.7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00	leight P.IRON 7.054e-00 1.411 1.411 100.00 0 Ambient (C) Insulation 3.000e:002	4.16
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Ground) levation (% of Height) verall Heat Loss (kJ/h) uid (C) 0.0000 Inr ickness p	evel (m (m (m (% (% (m) (kJ/kg-C))))))))))) Deta	Nozzles 0.0000 m* Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.000 0.0000 Area (m2 Temperature Profill 25. Conduction Metal 1.000e-002 0.4730	www.7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00	leight P.IRON 7.054e-00 1.411 1.411 100.00 00 Ambient (C) Insulation 3.000e-002 0.8200	1.411 1.411 2 4.168 25.00
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base) levation (Ground) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h) uid (C) 0.0000 Inr	evel (m (m (m (% (m) (m))))))))))) Deta	Nozzles 0.0000 m* Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.000 0.0000 Area (m2 Temperature Profill 25. Conduction Metal 1.000e-002 0.002	www.7.0	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00	leight P.IRON 7.054e-00 1.411 1.411 100.00 0 Ambient (C) Insulation 3.000e:002	4.16
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h) uid (C) 0.0000 Inr ickness p ensity I onductivity	evel (m (m (m (% (% (m) (kJ/kg-C) (kg/m3) (W/m-K))))))))))))))))))))	Nozzles 0.0000 m* Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2 Temperature Profill 25. Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection 0.000	W 7.0 7.0 9 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00	leight P.IRON 7.054e-00 1.411 1.411 100.00 00 Ambient (C) Insulation 3.000e-002 0.8200 520,0	1.41 2 4.16
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Ground) levation (Ground) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h) uid (C) 0.0000 Inr ickness p ensity I	evel (m (m (m (% (% (m) (kJ/kg-C) (kg/m3))))))))))))))))))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 0.000 0.0000 0.000 0.0000 0.000 0.0000 Area (m2 Temperature Profil 0.000 Outer Vessel (C) 25. Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection de Liq Phase U (k.J/h-m2-C	Ww 7.0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Height 0.9405 m H /ATER.5 D54e-002 0.7054 D50.00 sulation (C) 25.	leight P.IRON 7.054e-00 1.411 1.411 100.00 00 Ambient (C) Insulation 3.000e-002 0.8200 520,0	1.41 2 4.160 25.00
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (% of Height) le	evel (m (m (% (% (m) (% (% (% (% (% (% (% (% (% (% (% (% (%)))))))))))))))))))	Nozzles 0.0000 m* Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2 Temperature Profill 25. Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection 0.000	Ww 7.0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Height 0.9405 m H /ATER.5 D54e-002 0.7054 D50.00 sulation (C) 25.	Ieight P.IRON 7.054e-00 1.411 1.411 1.411 1.00.00 100.00 1 100.00 1 100.00 1 1.411 1.411 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.00.00 1 0.00.00 1 0.00.00 1 0.002 0.8200 520.0 0.1500 0.1500	1.41 2 4.16 25.0
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (Ground) levation (% of Height) iameter levation (Base) levation (Ground) levation (Ground) levation (% of Height) verall Heat Loss (kJ/h) uid (C) 0.0000 Inr ickness p ensity I onductivity	evel (m (m (m (% (% (m) (%) (%) (%) (%) (%) (%) (%) (%) (%) (%)))))))))))))))))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2 Temperature Profil 25. Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection 50.00 Jet Liq Phase U (kJ/h-m2-C 36.00 PV Low PV Low	www. 7.0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00 0	Ieight P.IRON 7.054e-00 1.411 1.411 1.411 1.00.00 100.00 1 100.00 1 100.00 1 1.411 1.411 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.411 1 1.00.00 1 0.00.00 1 0.00.00 1 0.002 0.8200 520.0 0.1500 0.1500	1.41 2 4.160 25.00 54.00
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (% of Height) le	evel (m (m (m (% (% (m) (%) (%) (%) (%) (%) (%) (%) (%) (%) (%)))))))))))))))))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.7054 0.000 WASH WATER.1 7.054e-002 0.0000 0.000 0.0000 0.000 0.0000 Area (m2 Temperature Profill 25. Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection 361 45.00 Convection 3de Liq Phase U (kJ/h-m2-C aps: Level Tap Spe	www. 7.0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00 0	Ieight P.IRON 7.054e-00 1.411 1.411 1.411 1.00.00 100.00 0 Ambient (C) Insulation 3.000e-002 0.8200 520.0 520.0 0.1500	1.41 2 4.160 25.00 54.00
olume ase Elevation Relative to Ground Le iameter levation (Base) levation (% of Height) le	evel (m (m (m (% (% (m) (%) (%) (%) (%) (%) (%) (%) (%) (%) (%)))))))))))))))))))	Nozzles 0.0000 m * Diameter PLATED IRON 7.054e-002 0.7054 0.7054 0.7054 50.00 WASH WATER.1 7.054e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2 Temperature Profil 25. Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection 50.00 Jet Liq Phase U (kJ/h-m2-C 36.00 PV Low PV Low	www. 7.0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Height 0.9405 m H /ATER.5 054e-002 0.7054 0.7054 50.00 0	Ieight P.IRON 7.054e-00 1.411 1.411 1.411 1.00.00 100.00 0 Ambient (C) Insulation 3.000e-002 0.8200 520.0 520.0 0.1500	1.41 2 4.16 25.0 54.0

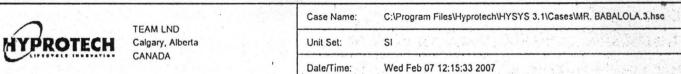
Case Name: C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.3.hsc TEAM LND Unit Set: SI Calgary, Alberta HY CANADA Date/Time: Wed Feb 07 12:18:07 2007 Tank: DRAGOUT TANK.1 (continued) Options PV Work Term Contribution 100.00 . (%) DYNAMICS Vessel Parameters: Initialize from Product Vessel Volume (m3) 0.9800 . Level Calculator Vertical cylinder Vessel Diameter 0.9405 Fraction Calculator Use levels and nozzles (m) Vessel Height 1.411 Feed Delta P (kPa) 0.0000 (m) Liquid Level Percent Vessel Pressure (kPa) (%) 50.00 90.00 Holdup: Vessel Levels Phase Level Percent Volume (m) (%) (m3) Vapour 0.0000 ----0.0000 Liquid ------'n. Aqueous 0.0000 ------. Holdup: Details Phase Accumulation Moles Volume (kgmole/h) (kgmole) (m3) 0.0000 Vapour 0.0000 0.0000 0.0000 Liquid 0.0000 0.0000 Aqueous 0.0000 0.0000 0.0000 Total 0.0000 0.0000 0.0000

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HYPROTECH Calgary.		Unit Set:	SI		and the second second	
CANADA		Dale/Tim	e: Fri Feb 09 09:14:00 20	07		
Vessel Siz	ing: \	/essel Sizing-4	4			
in the second	Vertical Se	eperator Properties:	ELECTROPLATING TANK			
UD Ratio		5.000 •	Demister to Top	(m)		0.3048
Liq. Res. Time (seconds)		300.0 •	an an an a' an		1 114	1
		Ċonstruction	Information			
Chem Eng Fab Index	Y	252.5	Allowable Stress		(kPa)	9.446e+004
Material Type		Carbon Steel	Shell Thickness		(mm)	6.350
Mass Density	(kg/m3)	7861	Corrosion Thickness	3	(mm)	3.175
FMC		1.000	Joint Efficiency		8	1.000
		Costing Co	pefficients			The second second
Shell Thick		Shell Mass	' Base Cost	1	Acc	cessories
A1: 0.4000 *	A4:	0.8116 *	A5:	8.600 *	A8:	1017
A2: 2.000 •			A6: -	0.2165 •	A9:	0.7396
A3: 0.2000 •		X*	A7: 4.58	0e-002 •	A10:	0.7068
		Costing	Results			
Base Cosl (\$US)	7476	Associated Cost (\$US)	1658 To	tal Cost (F	OB SUS)	9134
		Sizing F	Results			
Diameter	(m)	0 6096	Liquid Residence Time	(sec	onds)	300.0
Total Length	(m)	3.353	Liquid Surge Height		(m)	1.521
L/D Ratio		5.000	LLSD		(m)	0.4572
Max. Allowable Vapour Velocity	(m/s)	0.6644	Liquid Res. Time at LLSD	(sec	onds)	82.94
Demister Thickness	(mm)	0.0000	and the second	Sec. 1		
		Vapour	Space			
Sump To Inlet Nozzle	(m)	0.3048	Demister To Head		(m)	0.3048
Inlet Nozzle to Demister	(m)	1.070	Ellipsoidal Head		(m)	0.1524
			Total Vapour Height		and the second sec	and the second state of th

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0	TEALLING		Case Nar	me: C:\Pr	ogram Files	Hyprotech\HY	SYS 3.110	Cases\MR. BABA	LOLA.3.hsc
HYPROTECH	TEAM LND Calgary, Alberta		Unit Set:	SI					
	CANADA		Date/Tim	e: Wed	Feb 07 12:1	5:33 2007			
Conve	ersion Reac	tor: EL	ECTRO	OPLATI	NG TA	NK			
1			CONNEC	CTIONS					
		Inle	et Stream C	Connection	S				
Stream	Name				From U	nit Operati	on		
RCY DRIED BASE METAL		Air co				· · · · · ·			AIR DRIER
		Outl	et Stream	Connection	ns				
Stream	Name				To Un	it Operatio	n		
PLATED IRON		Tank:			1			DRA	GOUT TANK.1
NICKEL SOLUTION		Mixer							MIXER.2
		Ener	gy Stream	Connectio			í.		
Stream	Name				From U	nit Operati	on		
			PARAM	ETERS					
	Physical Parameters					Optional He	eat Transl		Heating
Delta P 0.0000 kPa	. Ve	2.583 m3	1e .		Duty 0.0000 kJ/h			Energy Str	eam
0.0000 кга			User Va		0.0000 kj/ll		I		
		•		a survey and a second second					
			RATI	ING					
			Sizi	ng					
Cylinder			Sizi Verti				has a Bo	pol: No	
Cylinder Volume	2.583 m3 *	Diameler		ical	1.299 m	Reactor Height	has a Bo	pol: No	1 949
	2.583 m3 *	Diameter	Verli	zles	1.299 m		has a Bo		1 949
Volume Base Elevation Relative to Gro	2.583 m3 •		Verti Nozz 0.0000 m • RCY	zles Diameter	DRIED	Height 1.299 m BASE METAL	Height	PLATEC	1.949) IRON
Volume Base Elevation Relative to Gro Diameter	2.583 m3 •	(m)	Verti Nozz 0.0000 m • RCY 9.743e-002	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 243e-002	Height	PLATEC 9.743e	1.949) IRON 2-002
Volume Base Elevation Relative to Gro	2.583 m3 •		Verti Nozz 0.0000 m • RCY	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL	Height	PLATEC	1 949) IRON 9-002 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base)	2.583 m3 *	(m) (m)	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 43e-002 0.9743	Height	PLATEC 9.743e 1.9	1 94: 0 IRON 9-002 49 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground)	2.583 m3 *	(m) (m) (m) (%)	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 438-002 0.9743 0.9743	Height	PLATEC 9.743e 1.9 1.9	1 949 0 IRON 9-002 49 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height)	2.583 m3 *	(m) (m) (m) (%) N (m)	Verti Nozz 0.0000 m • RCY 9.743e-002 0.9743 50.00 IICKEL SOLU1 9.743e-002	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 438-002 0.9743 0.9743	Height	PLATEC 9.743e 1.9 1.9	1 94: 0 IRON 9-002 49 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base)	2.583 m3 *	(m) (m) (m) (%) (m) (m)	Verti Nozz 0.0000 m • RCY 9.743e-002 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 438-002 0.9743 0.9743	Height	PLATEC 9.743e 1.9 1.9	1 949 0 IRON 9-002 49 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height)	2.583 m3 *	(m) (m) (m) (%) N (m)	Verti Nozz 0.0000 m • RCY 9.743e-002 0.9743 50.00 IICKEL SOLU1 9.743e-002	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 43e-002 0.9743 0.9743	Height	PLATEC 9.743e 1.9 1.9	1 949 0 IRON 9-002 49 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground)	2.583 m3 *	(m) (m) (%) (%) (m) (m) (m) (%)	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.000	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 43e-002 0.9743 0.9743	Height	PLATEC 9.743e 1.9 1.9	1 949 0 IRON 9-002 49 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground)	2.583 m3 *	(m) (m) (%) (%) (m) (m) (m) (%)	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.000	zles Diameter	DRIED 9.7	Height 1.299 m BASE METAL 43e-002 0.9743 0.9743	Height	PLATEC 9.743e 1.9 1.9	1 949 0 IRON 9-002 49 49
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h)	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.0000 0.0000 0.000 ed Heat Lo 0.0000 Temperatu	zles Diameter 2 TION 2 Doss Parame Area (m2) Ure Profile	DRIED 9.7	Heighl 1.299 m BASE METAL 43e-002 0.9743 0.9743 50.00		PLATEC 9.743e 1.9 1.9 100	1 949 0 IRON 3-002 49 49 00 7.953
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height)	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m • RCY 9.743e-002 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.000 0.000 ed Heat Lo 0.0000	zles Diameter 2 TION 2 Diss Parame Area (m2) DICE Profile C) 25.00	DRIED 9.7	Height 1.299 m BASE METAL 43e-002 0.9743 0.9743	Height	PLATEC 9.743e 1.9 1.9	1 949 5-002 49 49 00
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0 0000	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.0000 0.0000 ed Heat Loc 0.0000 Temperatu Duter Vessel (C - Condu Met	zles Diameter 2 TION 2 DSS Parame Area (m2) Ure Profile C) 25.00 Uction tal	DRIED 9.7	Heighl 1.299 m BASE METAL 43e-002 0.9743 0.9743 50.00	25.00	PLATEC 9.743e 1.9 1.9 100 4mbient (C) Insulation	1 949 0 IRON 3-002 49 49 00 7.953
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0 0000 Thickness	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.0000 0.0000 0.0000 ed Heat Loc 0.0000 Temperatu Duter Vessel (C - Condu Met 1.000e	zles Diameter 2 TION 2 Diameter 2 TION 2 Diameter 2 Dio	DRIED 9.7	Heighl 1.299 m BASE METAL 43e-002 0.9743 0.9743 50.00	25.00	PLATEC 9.743e 1.9 1.9 100 400 500 500 500 500 500 500 500 500 5	1 949 0 IRON 3-002 49 49 00 7.953
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0 0000 Thickness Cp	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m • RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.000 0.000 0.000 ed Heat Lo 0.0000 Temperatu Suter Vessel (C . Condu Met 1.000e 0.47	zles Diameter 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	DRIED 9.7	Heighl 1.299 m BASE METAL 43e-002 0.9743 0.9743 50.00	25.00	PLATEC 9.743e 1.9 1.9 100 400 400 400 400 400 400 400 400 400	1 949 0 IRON 3-002 49 49 00 7.953
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0 0000 Thickness	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.0000 0.0000 0.0000 ed Heat Loc 0.0000 Temperatu Duter Vessel (C - Condu Met 1.000e	zles Diameter 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	DRIED 9.7	Heighl 1.299 m BASE METAL 43e-002 0.9743 0.9743 50.00	25.00	PLATEC 9.743e 1.9 1.9 100 400 500 500 500 500 500 500 500 500 5	1 949 0 IRON 3-002 49 49 00 7.953
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0.0000 Thickness Cp Cp Contexts	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m • RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.000 ed Heat Lo 0.0000 Temperatu Duter Vessel (C • Condu Met 1.000e 0.43 Conve	zles Diameter 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	DRIED 9.7	Height 1.299 m BASE METAL (43e-002 0.9743 50.00 sulation (C)	25.00	PLATEC 9.743e 1.9 1.9 100 400 100 100 100 100 100 100 100 100	1 945 0 IRON 9-002 49 49 00 7.953 25.00
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (% of Height) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0 0000 Thickness Cp Cp Comments	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000000 0.00000000	zles Diameter 2 TION 2 Diameter 2 TION 2 Diameter 2 Dia	DRIED 9.7	Heighl 1.299 m BASE METAL 43e-002 0.9743 0.9743 50.00	25.00	PLATEC 9.743e 1.9 1.9 100 400 100 100 100 100 100 100 100 100	1 949 0 IRON 3-002 49 49 00 7.953
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0.0000 Thickness Cp Cp Contexts	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.0000 0.0000 0.0000 ed Heat LC 0.0000 ITemperatu Duter Vessel (C . Condu Met 1.000e 0.47 780 433 Conve 54.00 DYNA	zles Diameter Diameter 2 TION 2 TION 2 DSS Parame Area (m2) DICTON 1 1 1 2 2 DSS Parame Area (m2) DICTON 1 1 2 DICTON 1 2 DICTON 2 DICTON 1 2 DICTON 2 DICT	DRIED 9.7 9.7 Pters Outer In: h-m2-C)	Height 1.299 m BASE METAL 43e-002 0.9743 50.00 sulation (C)	25.00	PLATEC 9.743e 1.9 1.9 100 400 100 100 100 100 100 100 100 100	1 945 0 IRON 9-002 49 49 00 7.953 25.00
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0 0000 Thickness Cp (Saturdy, Saturdy) Outside U (kJ/h-m2-C)	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m • RCY 9.743e-002 0.9743 0.9743 0.9743 0.9743 0.9743 0.9743 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000000 0.00000000	zles Diameter Diameter 2 2 100N 2 2 100N 2 2 100N 2 2 100N 2 2 100N 2 100 100 100 100 100 100 100 100 100 1	DRIED 9.7 9.7 9.7 9.7 9.7 9.7 9.7 9.7 9.7 9.7	Height 1.299 m BASE METAL 43e-002 0.9743 50.00 sulation (C)	25.00	PLATEC 9.743e 1.9 1.9 1.9 100 400 520.0 0.1500	1 949 D IRON 3-002 49 49 00 7.953 25.00 7200
Volume Base Elevation Relative to Gro Diameter Elevation (Base) Elevation (Ground) Elevation (% of Height) Diameter Elevation (Ground) Elevation (Ground) Elevation (% of Height) Overall Heat Loss (kJ/h) Fluid (C) 0.0000 Thickness Cp Cp Contexts	2.583 m3 *	(m) (m) (%) (%) (m) (m) (%) Detaile	Verti Nozz 0.0000 m * RCY 9.743e-002 0.9743 0.9743 50.00 IICKEL SOLUT 9.743e-002 0.0000 0.0000 0.0000 0.0000 0.0000 ed Heat LC 0.0000 ITemperatu Duter Vessel (C . Condu Met 1.000e 0.47 780 433 Conve 54.00 DYNA	zles Diameter Diameter 2 TION 2 TION 2 DSS Parame Area (m2) DICTON 1 1 1 2 2 DSS Parame Area (m2) DICTON 1 1 2 DICTON 1 2 DICTON 2 DICTON 1 2 DICTON 2 DICT	DRIED 9.7 9.7 9.7 9.7 9.7 9.7 9.7 9.7 9.7 9.7	Height 1.299 m BASE METAL 43e-002 0.9743 50.00 sulation (C)	25.00	PLATEC 9.743e 1.9 1.9 1.9 100 400 520.0 0.1500	1 945 0 IRON 9-002 49 49 00 7.953 25.00



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Conversion Reactor: ELECTROPLATING TANK (continued)

Vessel Height	(m) 1.	949 Feed Delta P	(kPa)	0.0
Liquid Level Percent	(%) 50	0.00 Vessel Pressure	(kPa)	. 90
di se	Holdup	: Vessel Levels		
Phase	Level (m)	Percent (%)		Volume (m3)
Vapour Liquid	· · · · · · · · · · · · · · · · · · ·			0.0000 0.0000
Aqueous	•••	-		0.0000
*	Hole	dup: Details		
Phase	Accumulation (kgmole/h)	Moles (kgmole)		Volume (m3)
Vapour	0.0000	0.0000	•	0.0000
Liquid *	0.0000	0.0000	•	0.0000
Aqueous	0.0000	0.0000		0.0000
Total	0.0000	0.0000		0.0000

-		Case Na	me: C:\Program Files	Hyprotech\HYS	SYS 3.1\Cases\	MR. BABALOLA.hsc
HYPROTECH Calgary,	Alberta	Unit Set:	SI			
CANADA	`	Date/Tim	ie: Fri Feb 09 09:10:	43 2007		
Vessel Siz	zing: [DEGREASING	UNIT			
	Vertical Se	eperator Properties: I	DEGREASING UNIT	4		
UD Ratio	1.00 J . 1. 1. 1. 1. 1.	5.000 *	Demister to Top	(m)		0.3048
Liq. Res. Time (seconds)	•	1.360e+006 *				
		Construction	Information	1		
Chem Eng Fab Index		252.5	Allowable Stress	ang san sa	(kPa)	9.446e+004
Material Type		Carbon Steel	Shell Thickness	2	(mm)	6.350
Mass Density	(kg/m3)	7861	Corrosion Thickness		(mm)	3.175
FMC		1.000	Joint Efficiency			1.000
	1000	Costing Co	pefficients			
Shell Thick		Shell Mass	Base Cost		A	ccessories
A1: 0.4000 •	A4:	0.8116 *	A5:	8.600 *	A8:	1017
A2: 2.000 •			A6:	-0.2165 *	A9:	0,7396
A3: 0.2000 *			A7:	4.580e-002 *	A10:	0.7068
		Costing	Results			
Base Cost (\$US)	5205	Associated Cost (\$US)	608.5	Total Cost (FOB \$US)	\$ 5811
		Sizing F	Results			
Diameter	(m)	0.3048	Liquid Residence Time	(sec	conds)	1.360e+006
Total Length	(m)	1.676	Liquid Surge Height		(m)	0.4572
L/D Ratio		5.000	LLSD		(m)	0.4572
Max. Allowable Vapour Velocity	(m/s)	0.8129	Liquid Res. Time at LLSC) (sec	conds)	1.360e+006
Demister Thickness	(mm)	0.0000				
		Vapour	Space	1		
Sump To Inlet Nozzle	(m)	0.3048	Demister To Head		(m)	0.3048
Inlet Nozzle to Demister	(m)	0.5334	Ellipsoidal Head		(m)	7.620e-002
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TEAM LND		' Case Nar	ne: .C:\Pro	ogram FilesV-	typrotech/HYSY	5 5. Incases MR		
Calgary, Alberta	•	Unit Set:	SI					Sec. 1
CANADA		Date/Tim	e: Thu D	Dec 21 16:58	:45 2006			
' Tanl	: DEG	REASING	UNIT					
		CONNEC	CTIONS					
		Inlet S	tream	1.4 46				1
Stream Name	La di sa			From	Unit Operation	<u></u>	WASH	ING UNIT
WASHED.B.M. SODIUM HYDROXIDE		Tank Heater			· · ·		<u>, 117,07</u>	HEATER
		Outlet S	Stream	1.189.64				
Stream Name		, , , , , , , , , , , , , , , , , , , ,		To U	Init Operation			
DEGREASED B.M	,	Tank:					WASI	HING UNIT
SOAP + WATER		Mixer:			in the second			MIXEF
		Energy	Stream					1.1
Stream Name				From	Unit Operation	<u></u>		
	an a	PARAM	ETERS					
Vessel Volume:	- Level	SP:		50.00 %	Liquid Volume	e:	1	
Vessel Pressure: 100.0 kPa Pres	sure Drop:	0.0000 kPa *	Duty:		0.0000 kJ/h	Heat Transfer	Mode:	Healer
		User Va	riables		والمستحد المستحد			
		RAT	ING					
		Siz	ing					
Cylinder	Dia	Ver	lical		Separator h	nas a Boot: No		·····
Volume	Diam				Height			
		Noz						
Base Elevation Relative to Ground Level		0.0000 m * WASHED.B	Diameter	SODIU		Height	EGREASE	DRM
Diameter	(m)	5.000e-00			000e-002		5.000e-0	
Elevation (Base)	(m)	0.0000			0.0000		0.0000)
Elevation (Ground)	(m)	0.0000			0.0000		0.0000)
Elevation (% of Height)	(%)	SOAP + WA			-			
Diameter	(m)	5.000e-00						
Elevation (Base)	(m)	0.0000						
Elevation (Ground)	(m)	0.0000					1	
Elevation (% of Height)	(%)							
	Le	vel Taps: Level	Tap Specifi	ication		an Adam		14 - 14 - 14 14 - 14 - 14 - 14 - 14 - 14
Level Tap P\	/ High	1	Low		OP High		OP Lo	w
	Leve	I Taps: Calculat	ed Level Ta	p Values			- Weight	
Level Tap		Liquid	Level		1	Aqueous	Level	
		Opt	ions					
PV Work Term Contribution	(%)	100.00 *						
FV WOR TEIM COmmonition		DYNA	MICS		- 1 - A	1		
PV Work Term Commonition			nitialize from	m Produc	t			
- vvork renn comnounon	Vesse	I Parameters: I	incluined in or			and the second se		
Vessel Volume (m3)	Vesse	I Parameters: 1	Level Calcula	ator	1		Ve	rtical cylinde
	Vesse	I Parameters: 1					191	
Vessel Volume (m3) Vessel Diameter (m) Vessel Height (m)	Vesse		Level Calcuta Fraction Calc Feed Delta P	culator		(kPa)	191	and nozzle 0.000
Vessel Volume (m3) Vessel Diameter (m)	Vesse		Level Calcuta Fraction Calc Feed Delta P Vessel Press	sulator		(kPa) (kPa)	191	and nozzle 0.000
Vessel Volume (m3) Vessel Diameter (m) Vessel Height (m)	Vesse		Level Calcuta Fraction Calc Feed Delta P Vessel Press	sulator			191	and nozzle 0.000
Vessel Volume (m3) Vessel Diameter (m) Vessel Height (m)	Vesse		Level Calcuta Fraction Calc Feed Delta P Vessel Press	sulator			191	rtical cylinde and nozzle 0.000 100.

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TEAM LND Calgary, Alberta CANADA Case Name: C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.2.hsc

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Unit Set:

Date/Time: Thu Dec 21 16:58:45 2006

SI

Tank: DEGREASING UNIT (continued)

Phase	Level (m)	Percent (%)	Volume (m3)
Vapour	-	-	0.0000
Liquid	-		0.0000
Aqueous	-		0.0000
Phase	Accumulation (kgmole/h)	Moles (kgmole)	Volume (m3)
Vapour	(kgmole/h) 0.0000	the second s	and the second
	0.0000	0.0000 •	0.0000
	0.0000		
Liquid	0.0000	0.0000 •	0.0000
	0.0000 0.0000 0.0000	0.0000 ·	0.0000

5.8

		Case Nar	me: C:\Program Files\Hyp	protech\HYS	YS 3.1\Cases\MR.	BABALOLA.hsc		
		Unit Set:	Unit Set: SI					
CANADA	•	Date/Tim	Date/Time: Fri Feb 09 09:15:38 2007					
Vessel Siz	ing: \	/essel Sizing-	7					
	Vertical S	eperator Properties:	WASHING UNIT.3	1. 1. 1				
UD Ratio		5.000 *	Demister to Top	(m)		0.3048		
Lig Res. Time (seconds)	and determined to sender the second	300.0 •	and an and a second			and the second		
	1. N. 1. 1.	Construction	Information	in a se				
Chem Eng Fab Index		252.5	Allowable Stress		(kPa)	9.446e+004		
Material Type		Carbon Steel	Shell Thickness		(mm)	6.350		
Mass Densily	(kg/m3)	7861	Corrosion Thickness		(mm)	3.175		
FMC	(1.000	Joint Efficiency			1.000		
Shell Thick		Costing Co Shell Mass	Base Cost		Acc	essories		
A1: 0.4000 •	A4:	0.8116 *	A5:	8.600 *	A8:	1017		
A2: 2.000 •			A6:	-0.2165 *	A9:	0.7396		
A3: 0.2000 •			A7: 4.	580e-002 *	A10:	0.706		
	1	Costing	Results					
Base Cost (\$US)	6297	Associated Cost (\$US)	1094	Total Cost (F	OB SUS)	730		
		Sizing	Results					
Diameter	(m)	0.4572	Liquid Residence Time	(sec	onds)	300.0		
Total Length	(m)	2.515	Liquid Surge Height		(m)	0.8147		
UD Ratio		5.000	LLSD		(m)	0.4572		
Max. Allowable Vapour Velocity	(m/s)	0.5607	Liquid Res. Time at LLSD	(sec	onds)	161.9		
Demister Thickness	(mm)	0.0000						
		Vapour	Space					
	(m)	0.3048	Demister To Head		(m)	0.304		
Sump To Inlet Nozzle			the second se			and the second se		
Sump To Inlet Nozzle Inlet Nozzle to Demister	(m)	0.9760	Ellipsoidal Head	111	(m)	0.1143		

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0	Case Name: C.V	Program Files\Hyprotech\HYSY	S 3.1\Cases\MR. BABALOLA.3.hsc
TEAM LND Calgary, Alberta	Unit Set: SI		
CANADA	Date/Time: The	u Dec 21 17:04:59 2006	
Tank: WA	SHING UNIT.3		
	CONNECTIONS		
	Inlet Stream		
Stream Name		From Unit Operation	
WASHED.BM	Tank		WASHING UNIT2 PUMP.4
P.WATER.4	Pump		PUMP.4
	Outlet Stream		
Stream Name		To Unit Operation	
N.B.M	Air cooler:		AIR DRIER MIXER
WATER+LIGTH SOAP	Miker:		MIACK
	Energy Stream		
Stream Name		From Unit Operation	
• • • • • • • • • • • • • • • • • • •	PARAMETERS		
Vessel Volume: 2.034 m3 * Le	vel SP:	50.00 % Liquid Volume	1.017 m ⁻³
Vessel Pressure: 100.0 kPa Pressure Drop:	0.0000 kPa * Duty: *	0.0000 kJ/h	Heat Transfer Mode: Heat
	User Variables		
	RATING		
	Sizing		
Cylinder	Vertical	Separator h	as a Boot: No
Volume 2.034 m3 * Dia	ameler	1 200 m Height	1.799
	Nozzles		
	HULLICS		
Base Elevation Relative to Ground Level	0.0000 m * Diameter	1.200 m	Height 1.799
Base Elevation Relative to Ground Level	0.0000 m * Diameter WASHED BM	1.200 m P.WATER.4	Height 1.799 W.B.M
Diameter (m)	0.0000 m • Diameter WASHED BM 8.997e-002	P.WATER.4 8.997e-002	W.B.M 8.997e-002
Diameter (m) Elevation (Base) (m)	0.0000 m * Diameter WASHED BM 8.997e-002 0.8997	P.WATER.4 8.997e-002 0.8997	W.B.M 8.997e-002 1.799
Diameler (m) Elevation (Base) (m) Elevation (Ground) (m)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997	P.WATER.4 8.997e-002	W.B.M 8.997e-002
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m)	0.0000 m * Diameter WASHED BM 8.997e-002 0.8997	P.WATER.4 8.997e-002 0.8997 0.8997	W.B.M 8.997e-002 1.799 1.799
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002	P.WATER.4 8.997e-002 0.8997 0.8997	W.B.M 8.997e-002 1.799 1.799
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m)	0.0000 m * Diameter WASHED BM 8.997e-002 `0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000	P.WATER.4 8.997e-002 0.8997 0.8997	W.B.M 8.997e-002 1.799 1.799
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002	P.WATER.4 8.997e-002 0.8997 0.8997	W.B.M 8.997e-002 1.799 1.799
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000	P.WATER.4 8.997e-002 0.8997 0.8997 50.00	W.B.M 8.997e-002 1.799 1.799
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%)	0 0000 m * Diameter WASHED BM 8.997e-002 * 0 8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000 0 0000 0 0000	P WATER.4 8.997e-002 0.8997 0.8997 50.00	W.B.M 8.997e-002 1.799 1.799
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 4 4 4 4 4 50.00 4 50.00 4 50.00	W.B.M 8.997e-002 1.799 1.799 100.00 6.782
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 25.00 Outer Vessel (C) 25.0	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 4 4 4 4 4 50.00 4 50.00 4 50.00	W.B.M 8.997e-002 1.799 1.799 100.00
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 500 Outer Vessel (C) 25 (Conduction	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 1 1 1 1 1 1 1 1 1 1 1 1 1	W.B.M 8.997e-002 1.799 100.00 6.782 25.00 Ambient (C) 25.00
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) Fluid (C) 0.0000 Inner Wall (C) 2	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 25.00 Outer Vessel (C) 25.0	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 1 1 1 1 1 1 1 1 1 1 1 1 1	W.B.M 8.997e-002 1.799 1.799 100.00 6.782
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) Fluid (C) 0.0000 Inner Wall (C) 2 Thickness (m)	0.0000 m * Diameter WASHED BM 8.997e-002 * 0.8997 0.8997 50.00 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 500 Outer Vessel (C) 25 (0 Conduction Metal	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 1 1 1 1 1 1 1 1 1 1 1 1 1	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0.0000 Inner Wall (C) 2 Thickness (m) Cp (kJ/kgrC) Density (kg/m3) (kg/m3)	0 0000 m * Diameter WASHED BM 8.997e-002 0 8997 0 8997 0 8997 0 8997 0 8997 0 8997 0 8997 0 000 WATER+LIGTH SOAP * 8.997e-002 0 0000 0 000 0 0000 0 000 0 000 0 000 0 0000 0 0	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 4 4 4 4 50.00 0 6 6 6 6 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00 Insulation 3.000e-002 0.8200 520.0
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0.0000 Inner Wall (C) 2 Thickness (m) Cp (kJ/kgrC) Density (kg/m3) (kg/m3)	0 0000 m * Diameter WASHED BM 8.997e-002 0 8997 0 8997 0 8997 0 8997 0 8997 0 8997 0 8997 0 000 WATER+LIGTH SOAP * 8.997e-002 0 0000 0 000 0 0000 0 000 0 000 0 000 0 0000 0 0	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 4 4 4 4 50.00 0 6 6 6 6 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00 Insulation 3.000e-002 0.8200
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0.0000 * Inner Wall (C) 2 Thickness (m) Cp ³ (kJ/kg-C) Density (kg/m3) Conductivity (W/m-K)	0 0000 m * Diameter WASHED BM 8.997e-002 0 8997 0.8997 0.8997 0.8997 0.8997 0.800 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 0.0000 0.000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 25.00 Outer Vessel (C) 25.0 Conduction Metal 1.000#602 0.4730 7801 45.00 Convection	P WATER.4 8.997e-002 0.8997 0.8997 50.00 4 4 4 4 4 4 50.00 0 6 6 6 6 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00 Insulation 3.000e-002 0.8200 520.0
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0.0000 ° Inner Wall (C) 2 Thickness (m) C 2 Thickness (m) C 2 Inside Vap Phase U (kJ/h-m2-C) 7200	0 0000 m * Diameter WASHED BM 8.997e-002 0 8997 0.8997 0.8997 0.8997 0.8997 0.8000 WATER+LIGTH SOAP * 8.997e-002 0.00000 0.0000 0.0000 0.0000 0.0000 0	P WATER.4 8.997e-002 0.8997 0.8997 50.00 	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00 Insulation 3.000e-002 0.8200 520.0 0.1500
Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0.0000 * Inner Wall (C) 2 Thickness (m) C 2 Thickness (m) C 2 Inside Vap Phase U (kJ/h-m2-C) 7200	0.0000 m * Diameter WASHED BM 8.997e-002 `0.8997 0.8997 0.8997 0.8997 0.8997 0.8000 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 0.0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 25.00 Outer Vessel (C) 25.0 Conduction Metal 1.000€ 602 0.4730 7801 45.00 Convection D Inskde Liq Phase U (kJ/h-m2-C)	P WATER.4 8.997e-002 0.8997 0.8997 50.00 	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00 Insulation 3.000e-002 0.8200 520.0 0.1500
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0.00000 ° Inner Wall (C) 2 Thickness (m) Cp 2 Thickness (m) Cp 2 Inside Vap Phase U (kJ/h-m2-C) 7200 7200 Level Tap PV High 1	0 0000 m * Diameter WASHED BM 8.997e-002 0 8997 0.8997 0.8997 0.8997 0.8997 0.8000 WATER+LIGTH SOAP * 8.997e-002 0.0000 0 0000 0 0000 0 0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 25 00 Outer Vessel (C) 25 0 Conduction Metal 1.000e*802 0.4730 7801 45.00 Convection 0 Inside Liq Phase U (kJ/h-m2-C) Level Taps: Level Tap Spec	P WATER.4 8.997e-002 0.8997 0.8997 50.00 	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00 Insulation 3.000e-002 0.8200 520.0 0.1500 Outside U (kJ/h-m2-C)
Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0.00000 ° Inner Wall (C) 2 Thickness (m) C Cp [°] (kJ/kg-C) 0 0 Density (kg/m3) Conductivity W/m-K) Inside Vap Phase U (kJ/h-m2-C) 7200 1 Level Tap PV High 1	0.0000 m * Diameter WASHED BM 8.997e-002 0.8997 0.8997 0.8997 0.8997 0.000 WATER+LIGTH SOAP * 8.997e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Detailed Heat Loss Parar 0.0000 Area (m2) Temperature Profile 25.00 Outer Vessel (C) 25.0 Conduction Metal 1.000# 602 0.4730 7801 45.00 Convection 0 Inside Liq Phase U (kJ/h-m2-C) Level Taps: Level Tap Spec	P WATER.4 8.997e-002 0.8997 0.8997 50.00 	W.B.M 8.997e-002 1.799 1.799 100.00 6.782 25.00 Ambient (C) 25.00 Insulation 3.000e-002 0.8200 520.0 0.1500 Outside U (kJ/h-m2-C)

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MUPROTS C	TEAM LND Calgary, Alberta	Unit Set	Unit Set: SI					
	CANADA	Date/Tin	ne: Thu Dec 21 17:04:59 20	06				
· · · ·	Tank: \	WASHING UN	IT.3 (continued)					
PV Work Term Contribution		(%) 100.00 *	L					
		. DYNA	AMICS					
		Vessel Parameters:	Initialize from Product					
Vessel Volume	(m3)	2 034 *	Level Calculator		Vertical cylinder			
Vessel Diameter	(m)	1.200	Fraction Calculator		Use levels and nozzle			
Vessel Height	(m)	1.799	Feed Delta P	(kPa)	0.000			
Liquid Level Percent	(%)	50.00	Vessel Pressure	(kPa)	100.0			
		Holdup: Ve	essel Levels					
Phase		Level	Percent	States and the states	Volume			
		(m)	(%)		(m3)			
Vapour		-			0.0000			
Liquid					0.0000			
Aqueous		-	-		0.0000			
		Holdup	: Details					
Phase		Accumulation (kgmole/h)		14 . ·	Volume (m3)			
Vapour		0.0000	0.0000	· · ·	0.0000			
Liquid		0.0000	.00000	0.0000 .0000				
Aqueous		0.0000	0.0000	•	0 0000			
Total	and the second second	0.0000	0.0000	0.0000				

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TEAM LND Calgary, Alberta CANADA

C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.hsc Case Name: SI Unit Set: Fri Feb 09 09:14:39 2007

Vessel Sizing: Vessel Sizing-5

WASHING UNIT2 Vertical Seperator Properties:

Date/Time:

the strength of the strength o			and the second se	and the second			
UD Ralio	4	10.00	5.000 *	Demisler lo Top	(m)		0.3048 *
Liq. Res. Time	(seconds)		564.7 •			1000	
			Construction	Information			
Chem Eng Fab Index	•		252.5	Allowable Stress	1. 12	(kPa)	9.446e+004
Material Type			Carbon Steel	Shell Thickness		(mm)	6.350
Mass Densily		(kg/m3)	7861	Corrosion Thickness	1000	(mm)	3.175
FMC	1		1.000	Joint Efficiency	5		. 1.000

Costing Coefficients

	Shell Thick	Shell	Mass	Sec. Com	Base Cost		Accessories	in the second
A1:	0.4000 *	A4:	0.8116 · A	5:	8.600 *	A8:		1017 •
A2:	2.000 •		A	6:	-0.2165 *	A9:		0.7396 *
A3:	0.2000 *		A	7:	4.580e-002 *	A10:		0.7068 *

Base Cost (\$US)	5205	Associated Cost (\$US)	608.5	Total Cost (FOB \$US)	5814
		Sizing	Results		
Diameter	(m)	0.3048	Liquid Residence Time	(seconds)	564.7
Total Length	(m)	1.676	Liquid Surge Height	(m)	0.4572
L/D Ratio		5.000	LLSD	(m)	0.4572
Max. Allowable Vapour Velocity	(m/s)	1.000	Liquid Res. Time at LLSD	(seconds)	564.7
Demister Thickness	(mm)	0.0000			
		Vapou	r Space		
Sump To Inlet Nozzle	(m)	0.3048	Demister To Head	(m)	0.3048
Inlet Nozzle to Demister	(m)	0.5334	Ellipsoidal Head	(m)	7.620e-002
Demister Thickness	(mm)	0.0000	Total Vapour Height	(m)	1.219

Sump To Inlet Nozzle	(m) 0.3048		Demister To Head	(m)	0.3048	
Inlet Nozzle to Demister	(m)	0.5334	Ellipsoidal Head	(m)	7.620e-002	
Demister Thickness	(mm)	0.0000	Total Vapour Height	(m)	1.219	

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TEAM LND		VProgram FilesVH	sprotective rs	10 0.110855 W		
Calgary, Alberta CANADA	Unit Sel: SI				1	<u>i di se se s</u>
CANADA	Date/Time; Th	Date/Time: Thu Dec 21 17:01:19 2006				
Tank: WA	SHING UNIT2					
	CONNECTIONS					
	Inlet Stream			<u>n an tha san tha sheer</u>		
Stream Name		From	Unit Operation	1		1
DEGREASED B.M	Tank	,		a the second second	DEGREAS	
P.WATER.3	Pump					PUMP.3
	Outlet Stream		and the second			
Stream Name		To U	nit Operation			
WASHED.BM	Tank: Mixer:	and a strength			WASHI	MIXER
WATER+SOAP						
	Energy Stream		i	and the second		1
Stream Name		From	Unit Operation		1997 - 1997 -	and I
	PARAMETERS					1
Vessel Volume: 2.050 m3 * Lev	vel SP:	85.00 % *	Liquid Volur	ne:	and the second	1.742 m3
Vessel Pressure: 100.0 kPa Pressure Drop:	0.0000 kPa Duty:	and the second second second second second	0.0000 kJ/h	Heat Transfe	r Mode:	Healin
	User Variables			Still.		
	RATING	J. I.		14		e d Marine
	Sizing	<u></u>		4 1		<u></u>
and the second						
Cylinder	Horizontal		Separator	has a Boot: N	10	Cont in the
Cylinder 2.050 m3 * Dia	Horizontal	1 203 m	Separator Length	has a Boot: N	10	1 804
		1 203 m		has a Boot: N	10	1 804
	meler			has a Boot: N	4 <u>0</u>	
Volume 2.050 m3 Dia	Nozzles		Length		WASHED,	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m)	0.0000 m * Diameter DEGREASED B.M 6.014e-002	P \ 6.0	Length 1.203 m WATER.3 014e-002	Length	WASHED.	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m) Elevation (Base) (m)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014	P \ 6.	Length 1.203 m WATER.3 014e-002 0.6014		WASHED. 6.014e-00 1.203	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m) Elevation (Base) (m) Elevation (Ground) (m)	0.0000 m * Diameter DEGREASED B.M 6.014e-002	P \ 6.	Length 1.203 m WATER.3 014e-002	Length	WASHED.	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m) Elevation (Base) (m)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014	P \ 6.	1.203 m NATER.3 014e-002 0.6014 0.6014	Length	WASHED.0 6.014'e-00 1.203 1.203	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 50.00 WATER+SOAP 6.014e-002	P \ 6.	1.203 m NATER.3 014e-002 0.6014 0.6014	Length	WASHED.0 6.014'e-00 1.203 1.203	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 50.00 WATER+SOAP 6.014e-002 0.014e-002 0.0000	P \ 6.	1.203 m NATER.3 014e-002 0.6014 0.6014	Length	WASHED.0 6.014'e-00 1.203 1.203	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Helght) (%) Diameter (m)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 50.00 WATER+SOAP 6.014e-002	P \ 6.	1.203 m NATER.3 014e-002 0.6014 0.6014	Length	WASHED.0 6.014'e-00 1.203 1.203	1.804 3M
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level . Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 50.00 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014	Length	WASHED.0 6.014'e-00 1.203 1.203	1.804 3M
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Base) (m)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 50.00 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000	P V 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014	Length	WASHED.0 6.014'e-00 1.203 1.203	1.804 3M 2
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (W of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%)	Nozzles 0.0000 m* Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 50.00 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000 0.000 Area (m2) Temperature Profil	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00		WASHED. 6.014e-00 1.203 1.203 100.00	1,804 3M 2 6,817
Volume 2.050 m3 Dia Base Elevation Relative to Ground Level Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.0000 0.0000 0.0000 0.0000 0.000 Area (m2) Temperature Profil 500 Outer Vessel (C) 25	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00		WASHED.0 6.014'e-00 1.203 1.203	1,804 3M 2 6,817
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (W of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (W of Height) (%) Overall Heat Loss (kJ/h) (%)	Nozzles 0.0000 m* Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 50.00 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000 0.000 Area (m2) Temperature Profil	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00		WASHED. 6.014/e-00 1.203 1.203 100.00	1,804 3M 2 6,817
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (W of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (W of Height) (%) Overall Heat Loss (kJ/h) (%)	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.0000 0.6014 0.00014 0.6014 0.00014 0.6014 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) 0.0000 Area (m2) Temperature Profil 0.00 0.00 Outer Vessel (C) 25 Conduction 0.00	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00	25.00 Aml	WASHED. 6.014/e-00 1.203 1.203 1.00.00 100.00 bient (C)	1,804 3M 2 6,817
Volume 2.050 m3 Diameter Base Elevation Relative to Ground Level Image: Constraint of the second sec	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.0000 0.0014 0.0014 0.6014 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 5.00 0.0000 Area (m2) Temperature Profil 5.00 0.000 Area (m2) Temperature Profil 5.00 0.000 Area (m2) Temperature Profil 5.00 0.000 Area (m2) 5.00 Outer Vessel (C) 25 Conduction Metal 1.000e-002 0.4730	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00	25.00 Aml 1.150/2	WASHED. 6.014'e-00 1.203 1.203 1.203 100.00 100.	1.804 3M 2 6.817
Volume 2.050 m3 Diameter Base Elevation Relative to Ground Level Image: Constraint of the second sec	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.0000 0.0014 0.0014 0.6014 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 5.00 0.000 Area (m2) Temperature Profil 5.00 0.000 Area (m2) 5.00 Outer Vessel (C) 25 Conduction Metal 1.000e-002 0.4730 7801 7801	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00	25.00 Amt 15.00 Amt 15.00 0.82 520	WASHED.8 6.014/e-00 1.203 1.203 1.203 1.00.00 100.00	1.804 3M 2 6.817
Volume 2.050 m3 Diameter Base Elevation Relative to Ground Level Image: Constraint of the system of	Nozzles 0.0000 m ' Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.000 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 5.00 Outer Vessel (C) 25 Conduction Metal 1.000e-002 0.4730 7801 45.00	P \ 6.0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00	25.00 Aml 1.150/2	WASHED.8 6.014/e-00 1.203 1.203 1.203 1.00.00 100.00	1.804 3M 2 6.817
Volume 2.050 m3 Diameter Base Elevation Relative to Ground Level Image: Constraint of the second sec	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.0000 0.0014 0.0014 0.6014 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 5.00 0.000 Area (m2) Temperature Profil 5.00 0.000 Area (m2) 5.00 Outer Vessel (C) 25 Conduction Metal 1.000e-002 0.4730 7801 7801	P \ 6,0 2 3 3 4 4 5 5 6 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00	25.00 Amt 15.00 Amt 15.00 0.82 520	WASHED.(6.014/e-00 1.203 1.203 1.203 100.00 100.00	1.804 3M 2 6.817 25.00
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (W of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Fluid (C) 0.0000* Inner Wall (C) 2! Thickness (m) Cp (kJ/kg-C) Density (kg/m3) Conductivity (W/m-K) Inside Vap Phase U (kJ/h-m2-C) 7200	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.0000 0.6014 0.0014 0.6014 0.0014 0.6014 0.0014 0.6014 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 0.000 5.00 Outer Vessel (C) 25 Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection 45.00	P \ 6.0 2 3 3 3 4 5 5 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00	25.00 Amt 15.00 Amt 15.00 25.00 Amt 15.00 0.82 520 0.15	WASHED.(6.014/e-00 1.203 1.203 1.203 100.00 100.00	1.804 3M 2 6.817 25.00
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (W of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Fluid (C) 0.0000* Inner Wall (C) 2! Thickness (m) Cp (kJ/kg-C) Density (kg/m3) Conductivity (W/m-K) Inside Vap Phase U (kJ/h-m2-C) 7200	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 0.6014 0.000 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000 0.0000 Detailed Heat Loss Parate 0.0000 Dottailed Heat Loss Parate 0.0000 Dotailed Heat Loss Parate 0.0000 0.000 Area (m2) Temperature Profil 5.00 Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection Inside Liq Phase U (kJ/h-m2-C)	P \ 6.0 2 3 3 3 4 5 5 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.203 m NATER.3 014e-002 0.6014 0.6014 50.00	25.00 Amt 15.00 Amt 15.00 25.00 Amt 15.00 0.82 520 0.15	WASHED.(6.014/e-00 1.203 1.203 1.203 100.00 100.00	1.804 3M 2 6.817 25.00 54.00
Volume 2.050 m3 Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Base) (m) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Filuid (C) 0.0000 Inner Wall (C) Zep (kJ/kg-C) Density (kg/m3) Conductivity (W/m-K) Inskde Vap Phase U (kJ/h-m2-C) 7200 1 Inductivity	Nozzles 0 0000 m * Diameter DEGREASED B.M 6 014e-002 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.000 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 0.000 5.00 Outer Vessel (C) 25 Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection Inside Liq Phase U (kJ/h-m2-C) Level Taps: Level Tap Spe 1	P \ 6.0 2 	Length	25.00 Amt 15.00 Amt 15.00 25.00 Amt 15.00 0.82 520 0.15	WASHED.(6.014/e-00 1.203 1.203 1.203 100.00 100.00 100.00 200 200 200 200 200 200 200 200 20	1.804 3M 2 6.817 25.00 54.00
Volume 2.050 m3 Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Base) (m) Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Filuid (C) 0.0000 Inner Wall (C) Zep (kJ/kg-C) Density (kg/m3) Conductivity (W/m-K) Inskde Vap Phase U (kJ/h-m2-C) 7200 1 Inductivity	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.6014 0.000 0.000 0.0000 0.0000 0.000 Area (m2) Temperature Profil 0.000 0.000 Area (m2) Temperature Profil 0.000 0.000 Area (m2) Temperature Profil 0.000 0.000 Area (m2) Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection Inside Liq Phase U (kJ/h-m2-C) Level Taps: Level Tap Spe PV Low	P \ 6.0 2 	Length	25.00 Amt 15.00 Amt 15.00 25.00 Amt 15.00 0.82 520 0.15	WASHED.8 6.014e-00 1.203 1.203 100.00 100.00 (C) 200 200 200 200 200 200 200 200 200 20	1.804 3M 2 6.817 25.00 54.00
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0 0000 * Inner Wall (C) 2! Thickness (m) Cp (kJ/kg-C) Density (kg/m3) Conductivity (W/m-K) Inskde Vap Phase U (kJ/h-m2-C) 7200 1 1 Level Tap PV High	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.0000 0.6014 0.0014 0.6014 0.000 0.6014 0.0000 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 0.000 0.0000 Area (m2) Temperature Profil 0.000 0.000 Area (m2) Temperature Profil 0.000 0.000 Area (m2) 5.00 Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection Inside Liq Phase U (kJ/h-m2-C) Level Taps: Level Tap Spe PV Low vel Taps: Calculated Level Liquid Level	P \ 6.0 2 	Length	Length 25.00 Aml Insula 3.000e 0.82 520 0.15 Outside U (k	WASHED.8 6.014e-00 1.203 1.203 100.00 100.00 (C) 200 200 200 200 200 200 200 200 200 20	1.804 3M 2 6.817 25.00 54.00
Volume 2.050 m3 * Diameter Base Elevation Relative to Ground Level * Diameter (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Diameter (m) Elevation (Base) (m) Elevation (Base) (m) Elevation (Ground) (m) Elevation (Ground) (m) Elevation (% of Height) (%) Overall Heat Loss (kJ/h) (%) Fluid (C) 0 0000 * Inner Wall (C) 2! Thickness (m) Cp (kJ/kg-C) Density (kg/m3) Conductivity (W/m-K) Inskde Vap Phase U (kJ/h-m2-C) 7200 1 1 Level Tap PV High	Nozzles 0.0000 m * Diameter DEGREASED B.M 6.014e-002 0.6014 0.6014 0.0000 0.6014 0.0014 0.6014 0.0014 0.6014 0.0014 0.6014 0.0014 0.6014 0.000 WATER+SOAP 6.014e-002 0.0000 0.0000 0.0000 0.0000 Area (m2) Temperature Profil 0.0000 0.0000 Area (m2) Temperature Profil 0.0000 0.0000 Area (m2) Temperature Profil 0.000 0.0000 Area (m2) Conduction Metal 1.000e-002 0.4730 7801 45.00 Convection Inside Lkj Phase U (kJ/h-m2-C) Level Taps: Level Tap Spe PV Low vel Taps: Calculated Level PV Low	P \ 6.0 6.0 7 6.0 7 6.0 7 7 7 7 7 7 7 8 7 7 7 8 7 7 7 8 7 7 8 7 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 8 7 8 7 8	Length	Length	WASHED.8 6.014e-00 1.203 1.203 1.203 100.00 500 00 00 00 00 00 00 00 00 00 00 00	1.804 3M 2 6.817 25.00 54.00

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		Case Na	me: C:\Program Files\Hyprote	chVHYSYS 3.1\Ca	ses\MR. BABALOLA.2.hsc
TEAM LND Calgary, Alberta	Unit Set:	SI			
UNIEVELT INNOVATION	CANADA	Date/Tim	ne: Thu Dec 21 17:01:19 200	06	
	Tank:	WASHING UNI	T2 (continued)		
PV Work Term Contribution		(%) 100.00 *			
		DYNA	MICS		
		Vessel Parameters: 1	nitialize from Product		
Vessel Volume	(m3)	2.050 *	Level Calculator	<u> k </u>	Horizontal cylind
Vessel Diameter	(m)	1.203	Fraction Calculator	An Array	Use levels and nozzle
Vessel Length	(m)	1.804	Feed Delta P	(kPa)	0.000
Liquid Level Percent	(%)	85.00 *	Vessel Pressure	(kPa)	100.
		Holdup: Ve	ssel Levels		
Phase		Level	Percent		Volume
Vapour		(m)	(%)		(m3)
. Liquid	[10] Y (10] 44	- , · · · ·			0.0000
Aqueous	승규가 물건을 다.	사람이 친구들을 통하는 것이 같다.	지수는 전투 문화가.	1. 1. 1. 1. 1.	0.0000
					0 0000
		Holdup:	Details		
Phase	· Accumulation		Moles		Volume
1		(kgmole/h)	(kgmole)		(m3)
Vapour	5.00	0.0000	0.0000	•	0.0000
Liquid		0.0000	0.0000	•	0.0000
Aqueous	1	0.0000	0.0000	•	0.0000
Total		0.0000	0.0000	1 mil 1 mil 100	0.0000

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0		Case Na	Case Name: C:\Program Files\Hyprotech\HYSYS 3.1\Cases\MR. BABALOLA.hsc Unit Set: SI				
HYPROTECH Calgary.	Alberta	Unit Set:					
CANAD/	`	Date/Tim	ne: Fri Feb 09 09:15:08 2007				
Vessel Siz	zing: V	essel Sizing-	6		*		
	Vertical Se	perator Properties:	WASHING UNIT.1	n series and a			
L/D Ratio Liq. Res. Time (seconds)	· · · · ·	5.000 • 300.0 •	Demister to Top (m)	and a second	0.3048		
		Construction	Information				
Chem Eng Fab Index	T	252.5	Allowable Stress	(kPa)	9.446e+004		
Material Type		Carbon Steel	Shell Thickness	(mm)	6.350		
Mass Density	(kg/m3)	7861	Corrosion Thickness (mm)		3.175		
FMC		1.000	Joint Efficiency		1.000		
	39	Costing Co	pefficients				
Shell Thick		Shell Mass	Base Cost	Ac	cessories		
A1: 0.4000 *	A4:	0.8116 *	A5: 8.600 *	A8:	1017		
A2: 2.000 *	2.1		A6: -0.2165 *	A9:	0.7396		
A3: 0.2000 •			A7: 4.580e-002 *	A10.	0.705		
		Costing	Results				
Base Cost (\$US)	7476	Associated Cost (\$US)	1658 Total Cost (FOB SUS)	<u>9</u> 13/		
		Sizing	Results				
			Liquid Residence Time (sec	conds)	300.		
Diameter	(m)	0.6096					
Diameter Total Length	(m) (m)	0.6096	and a state of the				
Total Length	(m) (m)	3,353	Liquid Surge Height	(m)	1.71		
Total Length L/D Ratio	(m)	3.353 5.000	Liquid Surge Height LLSD		1.71 0.457		
Total Length		3,353	Liquid Surge Height LLSD	(m) (m)	1.71 0.457		
Total Length L/D Ratio Max, Allowable Vapour Velocity	(m) (m/s)	3.353 5.000 0.8989	Liquid Surge Height LLSD Liquid Res. Time at LLSD (sec	(m) (m)	1.71 0.457		
Total Length L/D Ratio Max. Allowable Vapour Velocity	(m) (m/s)	3.353 5.000 0.8989 0.0000	Liquid Surge Height LLSD Liquid Res. Time at LLSD (sec	(m) (m)	0.4572 73.10 0.3041		
Total Length L/D Ratio Max. Allowable Vapour Velocity Demister Thickness	(m) (m/s) (mm)	3.353 5.000 0.8989 0.0000 Vapour	Liquid Surge Height LLSD Liquid Res. Time at LLSD (sec	(m) (m) conds)	1,719 0.4572 73.10		

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TEAM LND	Case Name: C:\P	Program Files\Hyprolech\HYSYS 3	.1\Cases\MR. BABALOLA.2.hsc
Calgary, Alberta	Unit Set: SI		
CANADA	' Date/Time: Thu	Dec 21 16:50:06 2006	
Tank: WAS	HING UNIT.1		
	CONNECTIONS	<u> </u>	
	Inlet Stream	<u> </u>	
Stream Name		From Unit Operation	
BASE.METAL	Tank		ACID PICKLING UNIT
P.WATER.2	Pump	a	PUMP.2
	Outlet Stream		
Stream Name		To Unit Operation	and a second
WASHED.B.M.	Tank:		DEGREASING UNIT
FeCI3 +WATER	Energy Stream		
Stream Name	Lifergy Stream	From Unit Operation	
QEEE			an a
	PARAMETERS		
Vessel Volume: 2.024 m3 * Level		50.00 % Liquid Volume:	1.012
Vessel Pressure: 100.0 kPa Pressure Drop:	0.0000 kPa * Duty:	4.962e+005 kJ/h He	al Transfer Mode: Heating
	User Variables		
Selfadent at	RATING		
	Sizing		le la
Cylinder	Vertical	Separator has	a Bool: No
Volume 2.024 m3 * Diam	eler	1 198 m Height	1.797
	Nozzles	1. 小学生教学主	
Base Elevation Relative to Ground Level	0.0000 m * Diameter	1.198 m He	ight 1.797
	BASE METAL	P.WATER.2	WASHED B.M.
Diameter (m) Elevation (Base) (m)	8.983e-002 0.8983	8.983e-002 0.8983	8.983e-002 1.797
Elevation (Base) (m) Elevation (Ground) (m)	0.8983	0.8983	1.797
Elevation (% of Height) (%)	50 00	50.00	100.00
	FeCI3 +WATER		
Diameter (m)	8.983e-002		
Elevation (Base) (m) Elevation (Ground) (m)	0.0000		
Elevation (% of Height) (%)	0.00		
	Detailed Heat Loss Param	eters	
Overall Heat Loss (kJ/h)	0.0000 Area (m2)	and a second	6.759
	Temperature Profile		
Fluid (C) 0.0000 Inner Wall (C) 25.0	and the second	Outer Insulation (C) 25.0	00 Ambient (C) 25.00
· · · ·	Conduction Metat		Insulation
Thickness (m)	1.000e-002		3.000e-002
Cp (kJ/kg-C)	0.4730		0.8200
Density (kg/m3)	7801		520.0
Conductivity (W/m-K)	45.00		0.1500
Inside Vap Phase U (kJ/h-m2-C) 7200	Convection Inside Lig Phase U (kJ/h-m2-C)	- 0	utside U (kJ/h-m2-C) 54.00
	evel Taps: Level Tap Speci		
Level Tap PV High	PV Low	OP High	OP Low
Leve	I Taps: Calculated Level T	ap Values	Januar Bressier and
	Liquid Level		Aqueous Level
LevelTap			
Level Tap	Options		

the second s		and an and a second	and the second	and the second state of th	and a state of the	
			Name: C:\Program Files\Hypro	blech\HYSYS 3.1\Cas	es\MR. BABALOLA.2.hsc	
TEAM LND Calgary, Alberta		' Unit	Unit Set: SI .			
[1776-611 1858444101	CANADA		/Time: Thu Dec 21 16:50:06 2	2006		
	Tank:	WASHING U	NIT.1 (continued)			
PV Work Term Contribution		(%) 100.0	0 •	1		
		DY	NAMICS			
		Vessel Parameters	: Initialize from Product			
Vessel Volume	. (m3)	2.02	4 * Level Calculator		Vertical cylinder	
Vessel Diameter	(m)	1.19	8 Fraction Calculator		Use levels and nozzles	
Vessel Height	(m)	1.79	7 Feed Delta P	(kPa)	0.0000	
Liquid Level Percent	(%)	50.0	0 Vessel Pressure	(kPa)	100.0	
		Holdup:	Vessel Levels			
Phase		Level (m)	Percent		Volume (m3)	
Vapour Liquid			-		0.0000 0.0000	
Aqueous		-	-		0.0000	

Holdup: Details

Phase	Accumulation	Moles	Volume
	(kgmole/h)	(kgmole)	(m3)
Vapour	0.0000	0.0000	• 0.0000
Liquid	0.0000	0.0000	• 0.0000
Aqueous	0.0000	0.0000	• 0.0000
Total	0.0000 0.0000		0.0000
	Duty Valve Source :	Direct_Q	
SP .	Min, Av	vailable	Max. Available
(kJ/h)	(k.		(kJ/h)
4.962e+005			

Liquid Heater Height as % of Vessel Volume

1.111.12

Top of Heater : 5.00 %

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Bottom

Bottom of Heater: 0.00 %

Heat Flow into the PFR: Heating

		' Case Na	me: C:\Program Files\Hyp	orotechVHYS	YS 3.1\Cases\MR.	BABALOLA.hsc	
TEAM LND Calgary, Alberta CANADA			Unit Set: SI				
			ne: Fri Feb 09 09:09:22 2	2007		hard Although a star margin (Charles	
Vessel Siz	zing: [DEGREASING	UNIT	54 - X			
	Vertical Se	eperator Properties:	ACID PICKLING UNIT				
Max. Vap. Velocity (m/s)		0.5343 *	Liq. Res. Time (:	seconds)		300.0	
UD Ratio	Bar Barris	3.000 •	Demister to Top	(m)		0.3048	
		Construction					
Chem Eng Fab Index		252.5	Allowable Stress		(kPa)	9.446e+004	
Material Type		Carbon Steel	Shell Thickness	fining the	(mm)	6.350	
Mass Densily FMC	(kg/m3)	. 7861	Corrosion Thickness Joint Efficiency		(mm)	3.175	
angen en e		Costing Co					
Shell Thick		Shell Mass	Base Cost		Acce	ssories	
A1: 0.4000 •	A4:	0.8116 *	A5:	8.600 *	A8:	1017	
A2: 2.000 •			A6:	-0.2165 *	A9:	0.7396	
A3: 0.2000 *	144 A. A. A.		A7: 4.5	80e-002 ·	A10:	0.7068	
		Costing	Results	1 1	14	111	
Base Cost (\$US)	1.200e+004	Associated Cost (\$US)	3894	Total Cost (F	OB SUS)	1.5896	
		Sizing	Results	1			
Diameter	(m)	1.372	Liquid Residence Time	(sec	onds)	300.0	
Total Length	(m)	4.801	Liquid Surge Height		(m)	0.4300	
L/D Ralio	1.11	3.000	LLSD		(m)	0.7620	
Max. Allowable Vapour Velocity	(m/s)	0.5343	Liquid Res. Time at LLSD	(sec	onds)	615.5	
Demister Thickness	(mm)	0.0000					
	Sec. 1	Vapour	Space	1			
					1.56		
Sump To Inlet Nozzle	(m)	0.3048	Demister To Head	12. 2. 2.	(m)	0.303	
Sump To Inlet Nozzle Inlet Nozzle to Demister	(m) (m)	0.3048 3.418	Demister To Head Ellipsoidal Head		(m) (m)	0 303 0 5-	

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1.00.0

APPENDIX II

Cathodic balance

Nickel deposited is 40.679kg.

Chrome deposited is 351.62kg.

Anodic Balance

Since it is assumed that what is removed from Anode is deposited on the cathode. It implies that 351.62kg and 187.89kg of nickel and chrome were what is removed from Anode and consequently deposited at the cathode.

Electrolyte balance

Volume of Electroplating tank is 2.583m³

=

Volume of Bath

0.6 x 2.583

= 1.550m³

It implies total quantity of water required to make the Electrolyte is 1.550m³ and quantity of salt to dissolve can be calculated thus.

0.6 x volume of the Electroplating Tank.

NiSO₄6H₂0 291g	1000L	1kg	
L	lm3	1000g	
			1 +
영양 우리 김 김 영영	= 291kg/m ³		
NiCl ₂ 6H ₂ O 52.5g	1000L	1kg	
L	lm3	1000g	
	= 52.5kg/m ³		

H₃BO₃ (Boric Acid) 42.5g	1000L	1kg
L	lm ³	1000g

Cr ₂ (SO ₄) ₃ 6H ₂ O 300g	1000L	1Kg
L	lm ³	1000g

= 300kg/m³

Sulphuric Acid tetraoxosulphate (vi) Acid

10ml is required it implies

0.01L is required

1000L ------ 1M³

1

1L =

1000m³

$$0.01L = \frac{1 \times 0.01m^3}{1000}$$

 $0.01L = 1.0 \times 10^{-5} \text{ m}^3$

Density of H₂SO₄ is 1184kg/m³

Mass	=	Density x Volume	

= 1184kg x 1.0 x 10⁻⁵m³

m³

= 0.01184kg

Volume Equivalent of constitu	ent of the electrolyte
NiSO ₄ .6H ₂ O 291 x 1.550	= 1.168m ³
386.01	
NiCl2.6H2O 52.5 x	1.550m ³ ⁼ 0.211m ³
386.01	
Cr ₂ (SO ₄) ₃ 6H ₂ O 300	x 1.550 = 1.205
386.01	and the product of the second
Boric Acid H3B2 42.5 x	$1.550 = 0.171 \text{m}^3$
386.01	
Sulphuric Acid H_3SO_4 =	$0.01184 \times 1.550 = 4.754 \times 10^{-5} \text{m}^3$
	386.01

Quantity of each constituent that will be require to make 1.502 titles are NiSO_{4.6H₂O 291kg x 1.168³m³ = 339.89kg m³ NiCl_{2.6H₂O = 52.5KG x 0.211m³ = 11.08kg M³ H₃B₂ = 42.5kg x 0.171m³ = 7.27kg M³ H₂SO₄ = 0.01184kg Direct evaluation of cost of material NiSO_{4.6H₂O 1kg \longrightarrow N400 00}}}

NISO4.0H2O TKg	-	114400.00
339.89kg	-	₩400 x 339.89 = ₩ 135,956
NiCl2.6H2O 1kg		N340.00
11.08Kg		N 340 x 11.08
		= N 3,767

Boric Acid 1 kg	>	₩630.00
7.27kg		N 620 x 7.27
		= N4.580

10ml H₂SO₄ l is needed

10ml = 0.01L

1L = N500

19

Cr₂(SO₄)₃6H₂O 1Kg → N380

189.89Kg + N380 x 189.89 = N72,158

 $0.01L = 0.01 \times 1500 = 15$

Anode 1kg ----- N720

351.62kg → N720 x 351.62 = N253.159

Water required in dissolution of salts.

25 litres ----- N5.00

1.550m³ 1550 litres

Cost of water required in dissolution $5 \times 1550 = N310.00$

25

Total water required for washing

Post acid pickling washing 2901kg

Post decreasing unit washing 576.073kg

Post electroplating washing (Dragout) 1823kg

Total water required is (2901 + 576.07 + 1823) kg = 5,300.07kg

Density = Mass

Volume

Volume = Mass

Density

Volume 5300 .07 Kg = $5.3m^3$ 1000 Kg/m³

5.3m³ ------ 5,300Litres

Total water required for the entire process =

Water required for dissolution + water required for post (Acid pickling, Decreasing and Electroplating) + water required in Acid pickling tank + water required in dragout tank =

(1550 + 5300 + 1220 + 1215) litres.

= 9,285 litres

cost of this Water = N5 x $9,285 \times 10^3$

20

= N46,425

Actual mass of HCL required = 0.6935kg/m³ x 1.2204m³ = 0.846kg

Actual mass of NaOH require = 0.028kg/m³ x 1.215m³ = 0.034kg

Volume of Acid = $0.6 \times 1.550 \text{m}^3$

Pickling unit = $0.6 \times 1.550 \times 1000L = 930L$

Volume of Degreasing = 0.6×2.583

Unit = $0.6 \times 2.583 \times 100L$

= 154.98L

Costing of NaOH and HCI required

NaOH

1kg ----- N5,00

0.034

HCI

2.795kg ------ N300

0.039 = N17.00

1kg	<u></u>	•	N 300		=-N107.3	3
			2.795			
0.8464kg	=	30	00 x 0.8464			
			2.795			
	=	N90.8	35			
Cost of wri	ist wate	ch1kg	of raw wrist	twatch	chain ——	<u> </u>
Each wrist	watch	weigh	t of 0.25kg			
0.25kg		•	0.25 x 10	= N2.50)	
1999.0kg -			1999.0 x 1	0 = 19,9	990	

N10

=**№**1.2 x 10⁴

APPENDIX III

COST ESTIMATION OF EQUIPMENT AND ECONOMIC ANALYSIS USING COST INDEX ESTIMATION (Marshall and Smith Cost Index) Cost equipment

The cost are based on cost data of 2006 which are available in dollars. Exchange rate ER as at 2006: 130 naira = 1 dollar Therefore ER: 130 naira

Purchased Cost Data

The purchased cost data for process equipment is given below as: Purchase Cost Data for Reactors, Degreasing Tank, Acid Pickling, tank electroplating tank and washing tanks.

PC	=M . S		(101 . D 1.066 H0.802) ER
	280		
Where	D	=	Diameter of the column (ft)
	н	=	Height of the column (ft)
	M.S	=	Marshall and Smith index
	Fc	=	1.00 + Fm + Fp

Fm		Fp				
CS	1.00	<50Psia	1.00			
SS	3.67	200	1.15			
Monel Steal	6.34	400	1.35			
Titanium	7.89	600	1.60			

Note: CS = Carbon Steel

SS = Stainless Steel

Monel Steal

Purchase cost of the acid pickling unit

Purchase cost PC is given by the relation below: Marshall and Smith index is Ms: = 110 The material of construction selected is

Carbon Steel:

Fm	=	1.00	Fp	= 1.00
Fc	=	1 + fm + fp		
Fc	=	1+1+1		
Fc	=	3		Note: 1m [□] 3.281
Diam	eter o	f the tank		D:1.200m or 3.937 ft
Height				H: 1.799m or 5.903ft

 $PC_{Acidpickling tank} = \frac{M/s}{280} \left[101.9(D)_{Acid pickling tank}^{1.066} (H_{Acidpickling tank}) 0.802 \text{ Fc ER} \right]$

 $= 11.0 \left(101 \times 9(3.907) 1.066 \times (5.903) 0.802 \times 3 \right) 130$ 280

= N277,191

Purchased cost of the Washing Tank 1

Purchase cost Pc is given by the relation below:

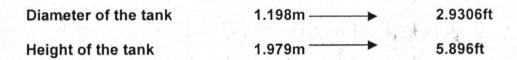
Marshall and Smith index is Ms: = 110

The material of construction is carbon steel

For carbon steel

Fm = 1.00 fp = 1.00

Fc	=	1+fm+fp		
Fc	=	1+1+1		
Fc	=	3		



Pc_{washing tank} Ms
$$101.9(D_{washing tank})^{1.066} (H_{washing tank})^{0.802} Fc ER$$

280
= 110 101 9(3 9306)1 066 x (5 896)0 802 x3 x 130

$$= \underbrace{110}_{280} 101.9(3.9306)1.066 \times (5.896)0.802 \times 3 \times 130$$

= N278,711

Degreasing Unit

Purchasing cost of the degreasing tank

Purchase cost Pc is given by the relation below:

Marshall and Smith index is Ms: 110

The material of consturciton selected is carbon steel

Fm	=	1.00	Fp	=	1.00	
Fc	=	1 + fm + fp				
Fc	=	1+1+1				
Fc	=	3		14	1.	* 1
Diameter	r of the f	tank	D	=	1.198n	n or 3.931

Н

=

ft

1.797m or 5.896 ft

PC_{Degreasing tank} = Ms 101.9 (D_{Degreasing tank})^{1.066} (H_{Degreasing tank})^{0.802} Fc ER 280 110 101.9 $(3.931)^{1.066} \times (5.896)^{0.802} \times 3$ 130 280 N278,741 **Purchasing Cost of Washing Tank 2** Purchasing cost Pc is given by the relation below Marshall and Smith index is Ms 110 The material of construction selected is carbon steel 1.00 Fp Fm 1.00 = = + Fm + Fp Fc 1 = Fc = 1+1+1 Fc 3 = Diameter of the tank 1.203m or 3.947 ft D н = 1.804m or 5.919 ft $Pc_{washing tank 2} = Ms \left[101.9 \left(D_{washing tank 2} \right)^{1.066} \left(H_{washing tank 2} \right)^{0.802} Fc ER \right]$ 280 N297,500 = 110 [101.9 (3.947)1.066 x (3.919)0.802 x 3] 130 = 280 N201,753 = Purchasing cost of the washing tank 3

Purchase cost Pc is given by the relation below

Marshal and Smith index is Ms = 110

The material of construction selected is carbon steel.

Fm 1.00 1.00 Fp = = 1 + Fm + Fp Fc = Fc 1+1+1 -Fc 3 =: Diameter of the tank D 1.299 or 4.262 = H 1.949 or 6.395 =

 $\frac{\mathsf{Pc}_{\mathsf{washing tank 3}} \mathsf{Ms}}{280} \begin{bmatrix} 101.9 \ (\mathsf{D}_{\mathsf{washing tank 3}})^{1.066} \ (\mathsf{H}_{\mathsf{washing tank 3}})^{0.802} \ \mathsf{Fc} \end{bmatrix} \mathsf{ER}$

$$= 110 \left[101.9 \ (4.262)^{1.066} \ x \ (6.395)^{0.802} \ x \ 3 \right] 130$$

= N324,284

Purchasing Cost of the Electroplating Tank Purchase Cost Pc is given by the relation below: Marshal and Smith Index is Ms = 110

The material of construction selected is carbon steel

Fm	=	1.00 Fp =	1.00
Fc	=	1 + Fm + Fp	
Fc	= (1 +1 + 1	
Fc	=	3	

Diameter of the tank

D = 1.299m or 4.262 H = 1.949m or 6.395

$$Pc_{Electroplating tank} = Ms \left[101.9 \left(D_{electroplating tank} \right)^{1.066} \left(H_{electroplating tank} \right)^{0.802} Fc \right] ER$$

$$= \frac{110}{280} \left[101.9 \left(4.262 \right)^{1.066} x \left(6.395 \right)^{0.802} x \right] 130$$

= N324,284

Purchasing cost of the Dragout tank 1

Purchase cost Pc is given by the relation below Marshal and Smith index is : Ms = 110 the material of construction selected is carbon steel

1.00 Fp 1.00 Fm = = Fc 1 + Fm + Fp = Fc 1 + 1 + 1= Fc = 3 Diameter of the tank D 0.9405m or 3.08616ft = H 1.411 or 4.629ft =

PC_{Dragout tank 1} Ms [101.9 (D_{dragout tank 1})^{1.066} (H_{dragout tank 1})^{0.802} Fc]ER

280

 $= \frac{110 [101.9(3.086)^{1.066} \times (4.629)^{0.802} \times 3] 130}{280}$

= **№**177,374

Purchasing cost of the Dragout Tank 2

Purchase Cost Pc is given by the relation below: Marshall and Smith index is : Ms 110 The material of construction selected is carbon steel

1.00 Fp = Fm = 1.00 Fc = 1+Fm+Fp Fc 1 + 1 + 1= Fc = 3 Diameter of the tank 0.9405m or 3.086ft D . = 1.411m or 4.629ft н = Pc_{Dragout tank 2} = Ms [101.9 (D_{dragout tank 2})^{1.066} (H _{Dragout tank 2}^{0.802})Fc]ER 280 110 [101.9 (3.086)^{1.066} x (4.629)^{0.802} x 3] 130 -280 N177,374

Purchasing cost of the Dragout Tank 3

Purchase Cost is given by the relation below:

Marshall and Smith index is Ms = 110

The material of construction selected is carbon steel

Fm	=	1.00 Fp 1.00
Fc	=	1 + Fm + Fp
Fc	=	1+1+1
Fc	=	3
Diamete	r of the t	ank D =

Diameter of the tank

0.9405m or 3.086ft 1.411m or 4.629ft

186

н

PC_{Dragout tank 3} Ms [101.9 (D_{Dragout tank 3})^{1.066} (H _{Dragout tank 3})^{0.802} Fc] ER

280

- $= 110 [101.9 (3.086)^{1.066} \times (4.629)^{0.802} \times 3] 130$
 - 280
- = N177,374

Purchasing cost of the Dragout Tank 4

Purchase Cost is given by the relation below:

Marshall and Smith index is Ms = 110

The material of construction selected is carbon steel

Fm	=	1.00	Fp	1.00			
Fc	=	1 + Fm	+ Fp	o			
Fc	=	1 + 1 +	1				f
Fc	=	3					
Dian	neter of the ta	nk			D	=	0.762m or 2.500ft
					н	=	2.667m or 8.750ft
Pc _{Dra}	agout tank 3 MS [101.9 ([Drago	out tank 3	1.066 (H	H _{Dragou}	t tank 3) ^{0.802} Fc] ER
	280						
=	<u>110 [</u> 101.9	(2.500) ^{1.0}	⁰⁶⁶ x	(8.750)	^{0.802} X	3] 130	
	280						
=	N236,139						V. 3

Purchasing cost of the Dragout Tank 5

Purchase Cost is given by the relation below:

Marshall and Smith index is Ms = 110

The material of construction selected is carbon steel

1.00 Fp 1.00 Fm = Fc 1 + Fm + Fp = Fc = 1+1+1

Fc 3

Diameter of the tank	D	=	0.762m or 2.500ft	
	н	=	2.667m or 8.750ft	
Pc _{Dragout tank 3} Ms [101.9 (D _{Dragout t}	ank 3) ^{1.066} (H Drago	out tank 3) 0.802 Fc] ER	

110 [101.9 (2.500)^{1.066} x (8.750)^{0.802} x 3] 130 = 280

N236,139 =

Purchasing cost of the Dragout Tank 6

Purchase Cost is given by the relation below:

Marshall and Smith index is Ms = 110

The material of construction selected is carbon steel

Fm	. =	1.00 Fp 1.0	0		
Fc	=	1 + Fm + Fp			
Fc	=	1 + 1 + 1			
Fc	=	3			
Diameter	of the t	ank	D	=	0.762m or 2.500ft
			Ĥ		2.667m or 8.750ft
Pc _{Dragout ta}	nk 3 Ms	[101.9 (D _{Dragout tan}	k 3) ^{1.066} ((H _{Drago}	ut tank 3) ^{0.802} Fc] ER
=110	[101.9	(2.500)1.066 x (8.	750)0.8	02 x 3]	130
280	D	장 같은 것이 없는 것이 없다.			

N236,139

Purchasing cost of the Concentrator

Purchase Cost Pc is given by the relation below: Marshal and Smith index is : Ms = 110The material of construction selected is carbon steel 1.00 Fp 1.00 Fm = Fc = 1 + Fm + Fp Fc = 1 + 1 + 1Fc 3 0.3048m or 1.000ft Diameter of the tank D 1.676m or 5.499ft н = Pcconcentrator Ms [101.9 (Dconcentrator)^{1.066} (H Dragout tank 3) ^{0.802} Fc] ER 280 110 [101.9 (1.000)^{1.066} x (5.499)^{0.802} x 3] 130 = 280 N61,260 = Purchasing cost of Pump $\left(\begin{bmatrix} Q2 \\ C1 \\ 01 \end{bmatrix}^n \right) \left(\frac{M-s \ 2006}{M-s \ 1979} \right)$ ER Naira Cost Pump =C2 Q = Volumetric Flow rate gal/min Where C = Cost of pump and M-s = Marshal and Smith index n = Exponent Note that all flow rates are converted into gallon/minutes From Timmerhaus, Cost of pump of 10gpm is 1 x 10³ Q1 = 10 gal/minC1 = 1000

Flow rate of the pump 1 designed is:

Q ₂	=	1.560m3	1000L	4 gallon	1h
		h	1m ³	4L	60 min

 $Q_2 = 6.5 \text{ gal/min}$

Marshal and Smith index

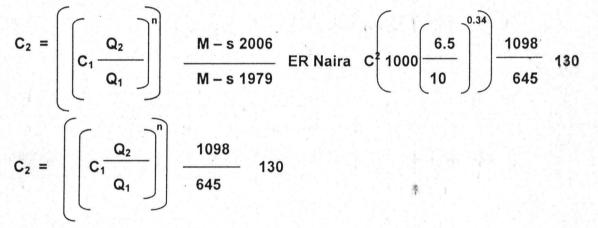
n = 0.34

Accordingly Chebrony, Marshall and Smith index obtained by extrapolating equation for year 2006 is:

M .s_2006 is :

M.s - 2006 = 1098

Cost of pump 1 in year 2006 is:



= N2,002

Cost of pump 2 in year 2006 is

 $Q_1 = 10 \text{ gal/min.}$ $C_1 = 1000$ M - s - 1979 = 645M - s 2006 = 1098 n = 0.34

Q²	=	0.1002m ³	1000L	1 gallon	1h
		h	1 3	4 litros	60 min
		한다. 아이지 않는 것이 같아.			[전화] 작품

がな

= 0.4175 gallon/min Q₂ Q₂ M-s 2006 C₂ C₁ _____ = ER naira M-s 1979 0.4175 1098 C₂ = 1000 -130 645 10 N787 = Cost of pump 3 in year 2006 is

 $Q^1 = 10 \text{ gal/min.}$ C₁ 1000 = M-s-1979 645 n = 0.34 M - s - 2006 1098 1000L 1 gallon 0.2 044 Q₂ 1h = 1m³ 4 litres Н 60 min

Q₂: = 0.852 gallon/min

$$C_{2} = \left(\begin{pmatrix} Q_{2} \\ C_{1} \\ Q_{1} \end{pmatrix}^{n} \right) \left(\frac{M - s \ 2006}{M - s \ 1979} \right) ER \text{ naira}$$

$$C_{2} = \left(1000 \left(\begin{array}{c} 0.852 \\ 10 \end{array} \right)^{0.34} \right) \begin{array}{c} 1098 \\ 645 \end{array} \right) 130$$

= N1,003

Cost of pump in year 2006 is

 $Q^1 = 10 \text{ gal/min.} C_1 = 1000$

M - s - 1979 645

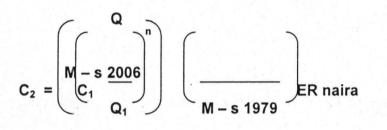
M-s-2006 1098 n = 0.34

Q ₂	= _	1.543m ³	1000L	1 gallon	1h
		н	1m ³	4 litres	60 min

$$Q_2$$
: = 6.43 gallon/min

Cost of pump 4 in year 2006 is

$$Q_2$$
: = 0.835 gallon/min



$$C_{2} = \left(1000 \quad \left(\frac{6.43}{10}\right)^{0.34} \quad \left(\frac{1098}{645}\right) \quad 130\right)$$

= N4,261

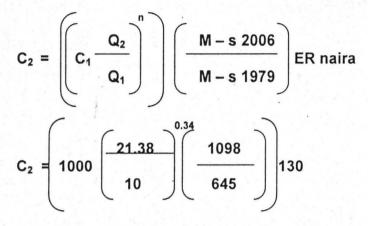
M -

Cost of recycling pump in year 2006 is

 $Q_1 = 10 \text{ gal/min.} \quad C_1 = 1000$

M-s-1979 645

Q ₂	=	5.131m ³	1000L	1 gallon	1h
		H.	1m ³	4 litres	60 min
Q ₂ :	=	21.38 gallon/min	1.1.1.1.1.		



Total cost of pump = cost of pump 1 + cost of pump 2 + cost of pump 3 +

Cost of pump 4 + cost of recycling pump

N(2,002 + 787 + 1003 + 4,261 + 3000)

Tc pumps N11,053

Operating Cost

Total purchased cost of equipment

Pc_Equip = PcAcid pickling + Pcwashing + Pcwashing + Pcwashing + Pcwashing + Pc Electroplating +
TankTanktank1tank 2tank3tankPcDragout + Pcdragout + Tc pumps
tank1tank2tank3tank4tank5

+ PCheater + PCair dryer + PC preheater + PC cooler + PC Mixer

Pc Equip = -N(277,191 + 278,711 + 278,741 + 201,753 + 324,284 + 324,284 + 177,374 + 177,374 + 177,374 + 236,139 + 236,139 + 236,139 + 61,260 + 2002 + 787 + 1003 + 4261

Pc = N2,758,677

ECONOMIC ESTIMATION OF TOTAL CAPITAL INVESTMENT

The total capital investment can be given by

Tin = TFC + Wc + TLC

Where TFC = Total fixed cost

Wc = Working capital

TLC = Total Land cost.

Total Fixed Cost

The factorial method can be used with the relationship below: (Direct Cost)

TFC:	=	10Pc equip
	· =	758,677
	=	N27,586,770

Working Capital

WC	=	0.5 TFC
	=	0.5 N 27,586,770
	=	₩13.793,385
Tota	l land	cost
TLC	=	0.1 TFC

= 0.1 x N27,586,770

= N2,758,677

Tinv = T	Ľ	C +	WC	+	TFC
----------	---	-----	----	---	-----

= **N**(2,758,677 + 13,793,385 + 27,586,770)

= N44,138,832

Operating Cost

This is divided into fixed and variable operating cost.

Let the plant life be 20 years n = 20 years

Fixed Operating Cost

Direct Labour Cost

Lbc	=	0.06 TFC

- = 0.06 x N27,586,770
- = №1,655,206.2

194

3

Plant Maintenance and Repair

Мс	=	0.08 TFC
Мс	=	0.08 x N 27,586,770
Мс	=	₩2,206,941.6

Insurance

Insc	=	0.01 TFC
	=	0.01 X N27,586,770
	=	N 275,867.7

Local Taxes

Lbc	=	0.02 TFC
	=	N 0.02 x 27,586,770
	=	N551,735.4

Royalties and licensed fee

0.01 TFC
0.01 x ₦27,586,770
N 275,867.7

Laboratory Cost

Labc	=	0.21bc
	=	0.2 x N 551,735.4
	=	₩110,347.08

Plant overhead cost

POHc = 0.5 Lbc

GENERAL EXPENSES

i. Administrative

ADMc	=	0.25 Lbc	
=	0.25	x N 551,735.4	
=	N137	,933.85	

ii. Research and Development

RADc	=	0.015 TFC
	=	0.015 x N 27,586,770
40.021	_	N413 801 55

Total Fixed Operating Cost

TFOc: = RADc +ADMc +POHc +Labc + Royc + Labc + Insc + Mc + Lbc + Sc

TFOc =	=	N [413,801.55 + 137,933.85 + 275,867.7 + 110,347.08 +
		275,867.7 + 551,735.4 + 275,867.7 + 2,206,941.6 + 655,206]

TFOc = N5,903,567.98

Annual fixed operating Cost

TFO annum = <u>TFOc</u> N

TFO annum = <u>N5,903,567.98</u> 20 = <u>N295,178.4/Annum</u>

Variable Operating Cost

Cost of raw materials CRMC

Cost of Raw Material Nickel Chloride Cost	= Chron	ne sulphate+Nickel	Sulphate Cost +
	+ Bor	c Acid Cost + Sulph	horic Acid + Aniode
	Cost + syster	Total cost of water f	for the electroplating lloric acid + Cost of
CRMc = 9,000 + 19 N147,540		2,500 + 50 + 18,000 -	+ 14,000 +)

Annual cost of raw material

8 9 9 9 P P	1	같아? 같은 것 같은 것은 것 같아요. 같은 것 같아요. 영화 감
	536	,148 300 days
	Da	ay 1 year
ACRM	=	N 44,262,000/Annum
Misceller	neous	
Msc	=	0.05 Lbc
	=	0.05 x N551,735.4
Utilities	= cost	N 27,586.77
Utc	=	0.02 Lbc
	=	0.02 x N551,735.4
	. =	N11,034.7
Packagi	ing	
PAC	=	0.001 Lbc
	=	0.001 x N 551,735.4
	=	₩551.7
Total Va	ariable	Operating Cost
TVOc	=	Pac + Msc ACRM + U

TVOc	=	Pac + Msc ACRM + Utc
	=	N 551.7 + 27,586.77 + 11,034.7 + 147,540
	=	₩44,301,173

Annual Variable Operating Cost

TVO annum	=	<u>TVOc</u> n
TVO annum	=	<u>44,301,173</u> 20
TVO annum	=	₩2,215,058

TVO annum	=	•	N2,215,05	8

197

Total Annual Operating Cost

AOCc	=	TFO annual +	TVO ann	ual
	=	N295,178 + 2,2	215,058	
	=	₩2,510,236.7		
Profit An	alysis			
Annual	Produc	ction Rate (AP	R)	
	=	7x 3600 x 20 x	300 = 1	814400kg
Productio	on Cost	(PC) per kg	=	AOCc/APR
			=	N2,501,236.

= №2,501,236.7/181,4400kg
 = №2.0

Selling Price

This is a function of total production cost demanded and market forces. Distribution price of N12.00 per kg is assumed

= 12 x 181440000

APS (Annual Product Sales)

= ₩21,772,800

Profit before tax (PBT)

- PBT = APS AOCc
 - = N[21,772,800 2,510,236.7

PBT = N19,262,563.3

Annual Depreciation (Depr)

Let S = Salvage value after n years of the plant

Assume plant life of 20 years

Then S:=

Let Vs after 20 years be taken as 15% of TFC in

$$\frac{15}{100} \times N27,586,770$$

$$S = N4,138,015.5$$

$$Dep = Tin - s = N[44,138.832 - 4,138,015.5]$$

$$= N2,000,040.8$$

Tax Payable (TP)

Assume tax ratio of 65% and depreciation is tax allowable, hence tax ratio = 0.65

1

TP	=	(PBT – Depr) Tax ratio
	=	N[19,262,563.3 - 2,000,040.8
ТР	=	17,262,522.5 x 0.65
ТР	=	N11,220,639.6

Profit after tax (PAT)

ΡΑΤ	=	PBT - TP
	=	N[19,262,563.3 - 11,220,639.6
	=	N8,041,923.7
Net Inco	me (NIN)	그는 방법에 가지 않는 것을 하는 것이다.
NIN	=	N8,041,923.7 + 2,000,040.8/year
	=	N10,041,964.5

Pay back period (PBP)

PBP: =

NIN N44,138.832 N10,041,964.5

Tinv

199

PBP = 4.39 year

300 days
1year

1

PBP = 1317 days

Rate of return on investment

RORI = Nin + Dep = 100

Tinv

<u>N10,041,964.5 + 2,000,040.8</u> = 0.273 = 108.5%

N44,138,832

= 0.273 x 100 = 27.28%