MODIFICATION AND CONSTRUCTION OF A PLASTIC SEALANT

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DEDICATION

This project work is dedicated to God Almighty for His merciful kindness to me throughtout my academic pursuit, to Him be the glory. Also to the memory of my beloved Father, late Rev. Moses Ishola Adeiye, who slept in the Lord on 21st June, 1997; may your soul continue to rest in the peace of God through Christ.

CERTIFICATION

This is to certify that this Project work on Modification and construction of a plastic sealant was presented by ISHOLA OLSHINA of the Agricultural Engineering Department, school of Engineering, Federal University of Technology, Minna, in partial fulfilment of the requirement for the award of the Degree of Bachelor of Engineering in Agricultural Engineering.

3/2/99
DATE

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EXTERNAL EXAMINER

AKNOWLEDGEMENT

Thanking is a function of thinking which is an integral part of appreciation. And so, a deep thought on my academic pursuit with respect to divine and supernatural support of the I AM the I AM, (the Almighty God), who through His Son (Jesus Christ) has made it possible for me to have gone thus far in my academic pursuit revealed that "if not that He is for me I should be saying now". Therefore I am using this great priviledge to say that may His name be exalted for ever.

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CHAPTER ONE

1.0 INTRODUCTION

Packaging is an integrat part of food processing which advertises food (agricultural products) at the point of sale, and protect same to a predetermined degree for the expected shelf life.

There are various ways by which agricultural products, most especially foods, could be packed and this depends on the type of food (for blochemical reasons) and type of material available.

However, the major reasons for packaging are;

1) To enhance easy transportation from where it is processed to the consumer table.
2) To ensure that the food remains whole some for a projected shelf-life.

In addition, the packaging chosen for a particular type of food at a certain state (eg moisture content.) Should not influence the product (eg through migration of toxic compounds, reactions between the pack and the food or by selected harmful micro-organisms in the packaged food).

Other requirements of packaging are smoothe, efficient and economic level of operation on the production line, resistance to breakage (such as fractures, tears, dents coursed by filling and sealing equipment).
Minimum total cost is another requirement of packaging selection.

A good packaged should be aesthetically pleasing, having a functional size and shape, retain the food in a convinient form.

The choice of package should also meet legislative requirement (i.e the law and rules concerning foods) for food and labelling.

1.1 Problem Facing Packaging of Agricultural Products

The shelf-life of a packaged food is controlled by the physical properties and characteristics of the product (packaged food).

These Characteristic properties include:

i) Water Cavity
ii) PH value
iii) Susceptibility to enzymic or microbiological deterioration
iv) Mechanism of spoilage
v) Requirement for sensitivity to Oxygen (O_2), light, carbon dioxide (CO_2) and moisture.

Moisture loss or uptake is one of the most important factors that controls the shelf-life of foods (agricultural products).

There is a micro-climate within a package, which is determined by the food at the temperature of storage. In some foods an infinitesional increase in

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moisture content leads to microbiological or enzymic spoilage, where as in others this causes drying out or loss of cripsiness of the food (eg dried foods) which may be a requirement of such product by the consumer (e.g biscuits, water and juice).

Some agricultural products (eg fatty foods and freeze-dried foods) are susceptible to oxidation and it is therefore necessary to use a package with low Oxygen (O_2) permeability which leads to loss of vitamin C in fruits and vegetables.

In contrast, however, fresh foods (eg fresh tomatoes, mango, pineaple, fish e.t.c) require oxygen (O_2) for respiration, and a permeable or perforated package is used.

All these pose problems of packaging agricultural products. It has therefore become necessary to be very careful while selecting a type of packaging material for a particular product.

1.2 PACKAGING MATERIALS

There are two (2) main group of packaging materials - shipping containers and Retail containers.

1.2.1 Shipping Containers

- These contain and protect their content during transportation and distribution from one location to another. These include - wood, metal, fibreboard cases, crates, barrels, drums and sacks.
They could be used for transportation from one region or nation to another

1.2.1.1 Wood and Textile

Wooden shipping containers have traditionally been used for a wide range of solid and liquid foods including fruits, vegetables, tea and beer. However, they are limited to shipping alone due to the fact that they have a poor moisture or water resistance property (since absoption of moisture often constitute a problem of spoilage in packaged foods (eg fresh foods). Textile containers have poor gas and moisture barrier properties, they are not suitable for high speed filling (ie filling of product into bags, and sacks and bottles by machine at high speed).
They are therefore limited to shipping containers.

1.2.2 Retail containers

These protect and advertise the product in convinient quantities for retail sales and home storage. These include metal cans, glass bottles, jars, rigid and semi-rigid plastic tubes, Collapsible tubes, semi-rigid paper board (cartoons), and flexible plastic bags, sachets and over-wraps.

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1.2.2.1 **Metal cans**

Metal cans have a number of advantages over other type of packaging m
such - provision of total protection of the content
- Convinience for ambient storage
- Temper proof.

1.2.2.3 **Aluminium foil**

This is produced by a cold reduction process in which pure alluminium (purity, greater than 99.4%) is passed through rollers to reduce the anneale to give dead-folding properties[1]. The advantages of that include-a good apperance:

(ii) Dead folding
(iii) The ability to reflect radiant energy
(iv) Excellent barier to moisture and gases, light and micro-organisms.

It is widely used for wraps (0.009mm), bottle caps (0.05mm) and trays for and ready meals. Foil is also used as the barrier material in laminated films and also used to metallise flexible films[1].

However, the high production cost and technology involved makes it nc to be widely used as plastic (nylon) materials.

But however, the high cost of metal and relatively high manufacturing cost technology make cans to be expensive. They are also heavier than other materials such as plastics, aluminium foil etc.

1.2..2.2 **Glass**

This is a product got from heating of sand(73%), sodium Oxide (13%) and calcium-oxide (12%) annealed at 540-570%c.

They are usually:-
- Good for high filling speed
- Impervious to moisture, odour and microorganism
- Inert.

Disadvantages:-
- Higher weight, hence higher transport cost
- Low resistance to fracture
- Possess potential serious lazard when it got splitted.

1.2.2.4 **Plastic**

Plastics are arbitrary group of artificially made or synthesized materials, generally of Synthetic organic matter which at some stage in manufacture are in a plastic condition during which they are shaped, often with the aid of heat and pressure.

This polypylene, polythene or Nylon, polyvinylidene chloride (PVC) and other polymers.

They are good materials that is widely used in packaging due to their-relatively low cost

- Good moisture and gases berrier properties
- Low density.

1.30 Conditions favourable for good packaging

In order to acheive a good packaging that is protective and advertising enough for the food and to the consumers, there is a need to know conditions favourable for good packaging. Factors influencing produce packaging are:

i) Moisture content requirement
ii) Temperature requirement
iii) Gaseons environment requirement
iv) Odour/Savour and other sensory quality retention.
v) Level of contermination (migration) allowable
vi) Humidty
vii) Mechanical strength required.

The moisture content of a packaged food, most especially grainss affects their wholesome-ness over a period of time.
If the moisture content of rice in a package is greater than 13%; the rice will start to deteriorate by moulding. With time some fungi begin to appear on the surface of the grainss whcih might have clogged or clatster to each other. Temperature within the pack and at the surface of the pack should not be too high to cause burning of the product in the package. Some food needs a temperature to keep them fresh while some need freezing temperature to remain wholesome (eg fresh fruits, vegetables e.t.c).

Some fresh food demands a package that will ensure free gaseous exhange to liberate their gaseous products such as carbon (Iv) oxide (CO_2). This is obvious since they respire (because their cells are still living). And so the package is made inaway so as to allow free exchange of these gases.

In contract, some processed foods (eg sknackfoods) is packed with the climate within the pack having low Oxygen value. Also in vacum packaging (such as for bulkfresh meat, cheese etc) air and other gases are eliminated completely.

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Ability of a packaging material to retail food sensory characteristic properties (such as odour, savoury etc) throughout the staroge period can not be under streessed in the choice of any material to pack a type of food. This is because this sensory quality is obviously demanded by the consumer.

The level of migration of packaging material substance to the food and from the food to the packaging material should be kept at bearest minimum. For example, the colour of the printing on the package found on the surface of the food. Infact some matallised polythene do loose their metallic element to the surface of the food and thus contaminate the the food. Also the migration of oil from packaged food to the pack makes the package not to meet its advertising quality demand in every packaging.

The level of water or moisture content in the air contaminate over a packaged food should be at the level that will not cause deterioration of such food. Factually speaking, fresh produce such as tomatoes has high percentage by weight being water (up to 90 percentage). If such fresh produce is enclosed in a container so that water vapour can not escape, the relative humidity (R.H) of the air around the product in the pack will reach about 97%, just 3% below saturation.

If the relative humidity (R.H) around the product within the pack is allowed to fall below 97%, it ill lose water (through transportation). A loss of only a few percentage can rduce cripness and freshness in vegetables and the saleable weight of fruits.

1.4 Plastics as good packaging materials

Plastic is a flexible packaging material. This is wdely used by most manufacturers and packaging industries because of the following properties of plastics.

1. Relatively low cost
2. Good barrier properties against moisture and gasses
3. Suitability for high-speed filling
4. Heat sealable to prevent leakages of the content
5. They have suitable surface for printing
6. They are easy to handle and convenient for manufacturers, retailers and consumers
7. They add little weight to the product
8. They fit closely to the shape of the packaged food, thereby wasting little space during storage and distribution.

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Plastics of varieties of mechanical, optical, thermal and barrier properties are produced for each type of polymer by variation in film thickness and in the type and thickness of coating and inclusions.

Plasticisers are added to soften the film and to make it more flexible for use in cold climate or frozen foods.

All these make plastic an excellent packaging material widely acceptable by the manufacturer and the customer and also in alignment with law pertaining to food packaging and labelling.

1.5 Agricultural products that could be packed in plastic

Plastic materials has been found to be suitable for packaging of almost all agricultural products (with few exceptions such as in the case of egg). However, the level of moisture content in these products should be checked, also their temperature, gaseons environment requirements should be ascertain since agricultural products are all biomaterials. The summary of applicability of plastics in food packaging is given as table 1.

Table 1.0 Selected plastic Materials used for food packaging[1] [1 of 1]

Types pf Plastic Materials	Types of food application
1. Polyvinychloide (PVC)	Crops, snack foods
2. Coated polypropylene	Confectionery, ice cream, biscuits, chocolate, Bakery products, Cheese, dried fruits, frozen vegetables.
3. Cellulose-Polyethylene	Pies, Crusty bread, bacon, coffee, cooked meat, Cheese.
4. Metallised Polyester -polyethylene	Coffee, dried milk, Potato, Flakes, Frozen foods etc.
5. Polyethylene-Nylon	Vacuum packs for bulk fresh meat, Cheese, fish.

1.5.1 Plastic sealing and sealants

Having ascertain the fact that plastic are excellent packaging material[6]. These is a need to look into how they could be sealed to prevent leakages of the content either in the solid or liquid form. The characteristic property of plastic that actually makes it suitable for this purpose is its heat-sealing ability[6].

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This makes it necessary to research into the technology of plastic sealing candidly, a lot has been done in this area, but the need to improve on this work is abvious as high productivity is the anticipation of any entrepreneur. Details of various plastic sealants in existence is discussed in chapter two.

1.6 Important Terminology

1. Shelf-life - This is the period of time during which a food item remains wholesome in storage.

2. Migration - This refer to transfer of the package constituents to the food or reaction of the food to the constituents of the package.

3. Aesthetic - A sense of beauty or how to make the pack to be atractive.

4. Filling speed - This refer to the rate of filling the material (product) into the pack and this varies with materials.

5. Flexible packaging - It describes packaging with flexible (i.e non rigid films such as plastic tilms (a non-fibrous material) which are usually less them 0.25mm thick.

6. Plasticisers - Are substances or materials incorporated in a material increase its flexibility and workability.

7. Wet and dry welght - Weight of the dry matter plus water is wet weight: while the weight of the dry matter constituting a material is its dry weight.

1.7 Importance of the Project

Judging from the fact that plastics has become an indispensable packaging material most especially in the area of food packaging in food processing industries at small, medium and large seale level, there is a need to look into how the problem encountered during packaging (of foods and other agricultural products) with plastics could be alleviated.

1.8 Objectives of the project

It is the objective of this project to modify by redesign and construct a plastic sealant with the aim to;

1. Modify the sealing arm from hand operated to pedal operated with abjustments.

2. Increase the span of the sealing arm to accomodate packaging materials (Nylon) of longer width up to 560-580mm (for 50kg Nylon sack/bag).

3. Improve the comfortability of operate of various heights by providing or an abjustable seat for the Operator which is an integral of part of the machine.

This is to help improve the process of sealing a plastic material by increasing the comfortability of the operater to enhance better performance and high efficiency.

The modified sealant designed in this project is unique among its likes due to the fact that considerations are given to necessary anthropometrical and ergonomic data (such as pedal adjustments and operator's seat horizontal and vertical adjustment).

CHAPTER TWO

2.0 Literature review

Plastics could be defined as an arbiterary group of artificial materials, generally of synthetic origin which at some stage in manufacture are in a plastic condition during which they are shaped, often with the aid of heat and pressure and often in a mould.

2.1 Classfication of plastic Materials

Plastics are divided into two

(2) Broad groups viz:

- Thermosetting materials and
- Thermoplastic materials

2.1.1 Thermosetting plastics

These are those plastics which require heat and pressure to mould them into shape.

When heat is applied, they first become soft and palstic and on further heating they undergo chemical change and set hard.

The process is called Themosetting or Thermohardening[6].

When a material is thermoset, it is parmanently set and does not soften to any appteciable extent when again heated. However, intense heating will bring about the breakdown of the material by burning[6]. The following are some of the thermosetting materials:

1. Alyds and polyesters.
2. Aminos (urea and formaldehyde resins and plastics).
3. Casein
4. Epoxides
5. Phenolics
6. Silicones.

This category of plastic can not be heat-sealed hence does not find wide use in packaging.

2.12 Thermoplastic Materials

These are plastics which softens in the application of heat, with or without pressure, but they require cooling to set them to shape. As hardening in thermoplastic materials is not due to any chemical action, so the shaped articles from thermoplastic materials will resoften on heating. This makes possible the heat-sealing ability of this material and thus its wide application in packaging industries. (i.e it is popular in packagong industries).

Cellulose film, polyvinyldehene chlonde, polypupy lene, polyethylene (poly thene) etc.

Generally, the material that is called plastics in this study shall be majorly - polyethene and polypropylene.

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Table 2.0 below shows physico-mechanical properties of polyethene and polypropylene materials.

Table 2.0 selected properties of packaging[1] [Ref 1]

Material	Films. Thickness (NM)	Desity (Kg/m^3)	Specific gravity	Tensile strength (MN/m^2)	Sealing Temperatur (°C)
Polythene					
Lowdensity	25 - 200	920 - 930	0.93-0.95	16	121 - 170
High density	350 - 1000	980 - 970	0.95-0.97	61	135 - 170
Polypropylene					
Oriented	20 - 30				
Polyumyldene Chloride(PVC)	18 - 34			215	120 - 145
Metalised	20 - 30				

Thermoplastice are further divided into two (2) categories according to their density as

- Low density polyethene and
- High density polyethene

Low density polythene

This was developed by I.C.I limited. In 1933 it was described in a research chemist note book as a waxy solid found in reaction tube. It was later on improved and developed to the plastic films of about 0.25mm thick. This is mostly used in packaging bread and some bakery products.

High density Polyethene

Professor ziegler is credited with discovering method of polymerizing ethylene at low pressure and temperature. The result of his experiments in the 1980s in Germany was a new polythene which had high density, more rigidity, harder, with a higher softening point than the low density polythene.

However, these two products are the most widely used for packages in food processing and other industries.

2.2 Plastic sealants

There has been various types and models of sealants in existence. And their classification could be based on either their functions or their modes of operation [4].

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2.2.1 Functional Classification

This classification is based on the purpose or function such sealant perform.

The following are examples:

- Laminating Machine[4]
- Multipurpose sealing machine[4]

Laminating Machine

This class of plastic sealant is used extensively for lamination of cards, certificates and some other kind of material[4]. This is to prevent the materials from being spoiled by dust, water and other liquids that are not solvent to plastic materials. There are various models of this machine in existence some could be used only for small sized paper or card such as with length or span less than or equal to one hundred millimeters (L 100mm), while some can accomodate cards or paper of size within the range less than or equal to three hundred millimeters (L 300mm).

Sealing is acheived in this type of sealant by placing the card or paper to be laminated in between the palstic films (which is usually of high density type). This is pushed into the sealant which heat sealed the material in less than five seconds (L 5 sees.)

In the smaller model (L 100mm length), there is no mechanism for ejection, the sealed material is removed by hand.

However, in the bigger model (L 300mm length), there is a mechanism of roller it which is being driven by a motor.

This roller automatically ejects the laminated material as soon as the process is over.

Furthermore, in both cases, hand is used to give the pressure required for sealing and this is acheived by processing the top of the machine gently with hand.

Multipurpose sealing machine

These are sealants that can do various types of sealing jobs. It can be used to seal nylon, as well as in lamination of cards and certificates. This class of sealants could also be used to seal plastic (nylon) bags containing food items, hence it found its application in food processing and packaging industries.

It can be used to seal plastic of various density (low, medium, and high) since the sealing temperature is thermostatically controlled or regulated.

This is the most common of all the sealants.

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2.2.2 Operational Classification

This classification is based on the mode of operation of the various sealants apart from laminating machines, has a component that is generally referred to as the sealing arm (or simply arm). The process differs from one machine to another, depending on the design of such machine. Some are hand operated, others are foot or pedal operated. In either model, sealing is acheived by pressing the sealing arm against the material (Nylon) placed in contact with the sealing element and this continues for :: seconds (usually less then 5 secs) depending on the density and thickness of the material.

2.2.3 Other Models and Design

There have been modified model of nylon cutting and sealing machine by Ogundipe; (1995), Ojajumu; (1996), Adesoko; (1997), Babalola; 1998). The these design are foot or pedal except those by Ogundipe and Ojajumu which are hand operated. Novertheless, these designs are similar in the sense that they all use heating element (i.e electrically heated to seal the nylon.

Heat sealing by means of burning coal is being developed.

2.3 Principle of Plastic sealing

The principle behind plastic sealing is based on thermoplastics (e.g Nylon or polythene) being heat-sealable. This means that when heated to its melting point, it soften and plastic (this is done in presence of no chemical reaction i.e no chemical change) and thus set hard.

When setting occurs in this material, it is parmanent and does not soften with any appreciable loss in strength of the bond area. This heating is acheived in sealants by the element or fillament (that is electrical heating) and the setting follows immediately by allowing the heated material to cool in air for few seconds. In most of sealants, the temperature at which sealing is accomplished is regulated by a thermostart or regulator.

2.4 Types and uses of Sealant in agro-allied and packaging industries

In agro-allied and packaging industries all over the globe, plastic (Nylon) bags are being used for packaging foods, chemicals and others products which are sealed at the tips[2]. For instance the invention of plastic (Nylon) satchets as a packaging material, most especially in food processing industries, has really called for the means or the device of heat sealing the same, hence the need for plastic sealants in these industries.

2.41 Types of Sealants used in agro-allied and packaging indstries

The types of plastic sealants used in agro-allied (such as food processing

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industries), and packaging industries varies from one establishment to another due to the differences between the nature of the content being packaged and the scope of the business.

In some industries which does not package items greater then 10,000g (i.e 10kg) in weight, they resulted to the use of hand operated type of sealant. Typical example are the small seale industries that packages beans, flour, 7-power (an infant formular), tea, and bevetages etc.

However, in food processing industries that handles heavier items, the foot or pedal operated is preferred to avoid spoilling over of the item during the heat sealing process.

2.5 Problems of existing sealants

Among the types and models of sealant in existence, it is only the hand operated model that is commonly found due to its potability. But it is limited by the following;

1. Inability to handle heavier material
2. Inability to handle packaging material with wider tip (open end).
3. The design does not give consideration to operator's comfort.

Proper remodeling of these past designs by meas of modification to solve these problems is essentially necessary. The parts to be modified are: 1) heating dement bed (provision for longer one to accomodate wider material).

ii) Provision of adjustments for the pedal

iii) Provision of operator's seat with adjustments.

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CHAPTER THREE

3.0 Design Criteria

In the design of any machine, there are usually some factors to be considered. These include:

i. Minimum Cost
ii. Power requirement
iii. Operator's labour requirement
iv. Control of product and equipment during operation
v. Ease of part replacement
vi. Durability.

3.10 Minimum Cost

This factor determines how much will be enough to execute the designed job. And this cost must be at the minimum compare with other model (design). Ofcourse, a new design (model) that is costly may not be appealing to the public and so the idea not welcomedand thus discarded.

Therefore, at the conception stage of this work, the cost has been considered and the use of good and quality materials at minimum cost has been adjudged suitable.

The cost of this materials has been compared with other sealant in existance with respect to functional requirements of the modified design.

For instance, the sealant with sealing span of abour 300mm (3cm) can not handle a nylon bag of about 600mm width (eg 50kg nylon bags).

The impulse sealant in existance with span ranging from 300 - 450mm is sold at three thousand eight hundred and fifty naira (₦3,850:00) for 300mm type and four thousand five hundred naira (₦4500:00) for 450mm (biggest) type.

Despite the exhorbitant cost of this machine, yet they can not handle nylon bags with width greater than 450mm.

Whereas, the total cost of the modefied type designed in this work (project) is three thousand nine hundred naira only, the cost of the operator seat inclusive.

However, if the operator's comfort designed for in this modified design is valued and compared to other models forementioned, this modified design is much more beneficial economically.

Infact the modifications such as adjustment of the pedal and the opearator's seat goes a long way to increase the productivity of the operator.

3.1.1 Power Requirement

The machine requires an electric power of 300w to operate the heating fillament (element) as specified by the manufacturer.

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Since the power source available supplies voltage of 220V, definitely there is a need to step down the voltage to the appropriate value required for the sealing process.

The transformer used for this work recorded the following parameters when connected to the terminals of a digital AVO (Ampere, Volt, Olim) meter.

Primary voltage (Input) = 220V

Secondary voltage (output) = 31V

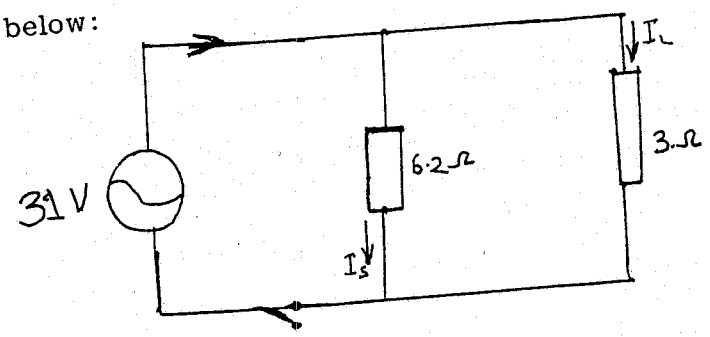
Resistance = 6.2Ω

To know whether the transformer is capable of delivering the voltage and current required; the following calculations is thus necessary.

Power required (P) = 300 Watts.

∴ P = 300w

Considering the circuit diagram shown below:



The 3.0Ω represent the resistance of the element as measured using the digital AVO meter.

To know the actural current (Amp) the transformer can deliver I = V/Re where Re, is the equivalent resistance of the whole connection.

$$Re = 6.2//3 = \frac{6.2x3}{6.2+3} = \frac{18.6}{9.2} = \underline{2.02\Omega}$$

$$\therefore I_T = \frac{V}{Re} = \frac{31}{2.02} = \underline{15.35A}$$

Therefore, the total current the transformer us capable to deliver is The current I_L, that passed through the load (element) is calculated from current divider theorem as

$$I_L = \frac{R_1 . I_T}{R_1+R_2}$$

R_1 = resistance of the transformer = 6.2Ω

I_T = total current the transformer could deliver = 15.35A

R_2 = resistance the element = 3Ω

$$\therefore I_r = \frac{6.2x15.35}{9.2}$$

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$= 10.345 = \underline{10.35A}$

Power delivered to the load

$PWL = I^2R_2$

$= (10.35)^2 x 3 = 321.37 Watts$

$PWL = \underline{321.37}$ Watts.

3.1.2 Operator's Labour Requirement

The comfort of an operator during any operation goes a long way to affects its productivity.

And this depends on occupational biomechanics. Occupational biomechanics is the study of the physical interaction of workers with their tools, machin and materials so as to enhance the worker's performance while minimizing t risk of future musclo skeletal disorders.

This occupational biomechanics bothers on some anthropometrical and ergonc mical data.

3.1.3 Engineering Anthropometry

This is an emperical science branching from physical measurements of human body, such as body size, form (shape), and composition.

However, body measurements of interest to occupational biomechanics inclu segments, lengths, and weight; range of joint movement; strength characte etc.

In this perspective the anthropometric data are fundamental to occupational biomechanics and biomechanical modeling.

Furthermore, anthropometry can be discribed as being of two types:

- physical anthropometry (this deals with basic dimension of human body standing and siting position).
- Functional anthropometry (this is task oriented).

Table 3.0 shows such body dimensions.

Tables 3.0 **Body Dimension (CM) for Age 20-60Yrs[5]**

Demension	Men 5th	Men 50th	Men 95th	Women 5th	Women 50th	Women 95th
1. Stature (Height)[f]	161.8	173.6	184.4	149.5	160.5	171.5
2. Shoulder[f] (acromionheight)	132.3	142.8	152.4	121.1	131.1	141.9
3. Elbow height[f]	100.00	109.9	119.0	93.6	101.2	108.8
4. Kunckle height	69.8	75.4	80.4	64.3	70.2	75.9
5. Height siting[s]	84.2	90.6	96.7	78.2	85.0	90.7
6. Shoulder height[s]	52.7	59.4	65.8	49.2	55.7	61.7
7. Elbow rest[s] height sitting	19.0	24.3	29.4	18.1	23.3	28.1
8. Knee height sitting[f]	49.3	54.3	59.3	45.2	49.8	54.5
9. Buttock Knee distance sitting	54.0	59.4	64.2	51.8	56.9	62.5
10. Hand length	17.6	19.05	20.6	16.4	17.95	19.08
11. Breadth, Metar-capal	8.2	8.88	9.8	7.0	7.66	8.4
12. Weight (in kg)	56.2	74.0	97.1	46.2	61.1	89.9
13. Foot length	22.5	25.0	27.5	20.0	22.5	24.5
14. Foot breadth	8.0	9.0	10.5	7.5	8.5	9.5
15. Elbow finger tip distance.	44.1	47.9	57.4	38.5	42.1	29.7

NB: f = above floor

S = above seat surface

consequenthy, anthropometric misfits may be of biomechanical and perceptual nature, which directly impacts the worker safety, health, and productivity.

When anthrometric requirements of design are not met, biomechnical stresses that manifest themselves in postural discomfort, low back pain, and over exertion injury are likely to occur.

3.1.3.1 Operator's Posture

The posture of human body at work is influenced by several factors, including work station layout (heights of work place, orientation of tools and work objects), hand tool design, work methods and work habits control and force exertion requirements, and anthropometric characteristic of the operator[5].

Poor and unnatural (ie not neutral) working postures have been associated with the on set of fatigue, body disconforts and pains, and muscloskeletal disorder[5].

For example, it was shown that trunk flexion, laterial bending or increases musecle stress and intervertebral disc pressure;

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while prolonged sitting or forward bending leads to increased risk of low back pain and muscle fatigue[5].

This modified design of plastic sealant (project) cater for all these discomfort of the operator. This is because the necessary anthropometrical data are used in the design of the operator's seat.

For instance, the knee-height

for Men:- 5th percentile	=	493mm	Women 5th percentile	=	452mm
- 50th "	=	543mm	50th "	=	498mm
- 95th "	=	593mm	95th "	=	545mm

This means that the operator's seat height should fall within the range of 452mm - 593mm[5].

In the light of the above the seat is designed in an adjustable form that can accomodate the sitting height of 5th, 50th, and 95th percentile men.

Also, position obtained form table 3.0 is used in the positioning or location of the seat which is designed to be an integral part of the machine.

Buttock-kneed distance sitting[5];

Men			Women		
- 5th percentile	=	540mm	5th pecentile	=	518mm
- 50th "	=	594mm	50th "	=	569mm
- 95th "	=	642mm	95th "	=	625mm

To cater for knee clearance for 5th, 50th, and 95th percentile the seat attatchment bar is made adjustable so as to give adequate clearance to operators of any category. If the clearance problems are disregarded, they may lead to poor working postures and hazardous work layout.

Even though consideration of clearance requires designing for the largest user but this design is flexible in the sense that the seat position with respect to the machine is adjustable with the aim to accomodate any operator from any percentage of the population.

3.1.4 Control of product and Equipment during Operation.

The control of equipment is commonly refer to as "reach" problem. It involves consideration of the location of controls and accesibility of control panels in workplace or machine.

The reach criteria is one-tailed constraints, that is it impose the limits in one direction only.

The procedure for solving the reach problems is similar to the one used for solving the clearance problems.

This time, however, the limiting user will be a smaller member of the population, and the design is usually based upon 5th percentile value of the relevant characteristic for female operator.

Concerning the controls on the plastic sealant designed and modified in this work (project).

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The accessiblity of the control switch is the most paramount. Since the 5th percentile (women) has their elbow-finger tip distance to be "385mm", then the switch (regulator) which is just 300mm away is adjudged to be well position and within the reach of the weakest percentile of the population.

Concerning the control of product during operation, the wooden top of the table is slotted at 200mm away from the other end opposite to the operator's sitting position. The slot is 40mm wide and 700mm long. This is to facilitate easy placement of the big Nylon bag tip on the sealing eleme bed. The big nylon bags (i.e those that can contain upto 50kg) containin the packaged product is placed on the "product base" undermeath the tabl and the tip is pushed up though the slot for heat sealing. The product-b has a drawer handles meant for drawing in of the product on a slotted me frame by the operator.

Ergonomically, the strength required to pull in the product on the base through the handle located at 330mm (horizontal) distance away from an operator are

Male		Female	
(i) 390N ----------	5th percentile[5]	5th Percentile[5]	= 3
(ii) 311N----------	50th "	50th Percentile[5]	= 2
(iii) 80N ----------	95th "	95th "	= 7

This shows that if the load is greater than 39kg (i.e 383N), any operator the 5th percentile category of the population will not be able to draw it in However, the bigger loads (400N, 500N, 600N and above) demands that it pushed in by another person at the product-base end of the sealant.

3.1.5 Ease of part replacement

All the components (parts) of this machine is designed to facilitate ea of replacement.

The table top, which is wood, is screwed to main frame. And this c be unscrewed whenever situation demands that. For instance, if there is defect noticed on the wood which may reduce the strength of the compone the component could be easily removed for repaired or replaced depending the nature of the problem.

The sealing arm can also be easily removed and replaced whenever it seams it can no longer perform the designed function. This ease of repla ment is facilitated by the provision of two (2) M10 nuts with which it is to the top of the lever.

The lever can be removed by removing the two (2) springs which su it on the main frame.

Also, the pedal can easily be removed by unscrewing it from the pedal adjustmentpide which themselves are bolted with M5 botts and nuts to the lever.

The electrical components of this machine can also be easily replaced whenever situation demands that. Either as a result of overloading (from the main source) which may cause sparking and burning of the regulator, the transformer and even the 2-core wire used.

3.1.6 Durability

The durability of any machine depends on some factors such as:

(i) Operator's knowledge and skill
(ii) Type of job (i.e condition of work)
(iii) The type of materials used etc.

The type of materials used is the most important factor, this is because the reliability of any material depicts its longetivity or how durable is it. Therefore, the choice of the various materials used in this design is of higher reliability, hence elongated life span of the machine is thus provided for.

The skill of the operator and knowledge goes a long way to determine the longetivity of any machine. Therefore, a sound knowledge of the mode of operation as specified by the designer will help effective operation of the machine.

Concerning the type of job, or the working condition, the sealant designed in this work has taken into consideration various conditions the machine is most likely to function. The table top is made of wood and well polished to make the surface resistance to water and moisture absorption.

3.1 functional Requirement

The plastic sealant designed in this work (project) consists of different parts made of different materials ranging from wood to steel. Each of these components is designed to carryout a particular task which it must be able to do with high level of reliability.

The sealant designed consist of a table which frame is made of 25mm square hollow pipe.
The hollow square pipe is made of steel. This is to serve as the support for other components.
Therefore it is ensured that it is structurally rigid enough to bear the load of other components both at rest and in operation.
Another altenative to steel pipe is wood, but in term of durability, steel is a better choice.

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The top of the table is made of wood planks cut into size and jointed together to cover the entire table surface. In term of strength requirement, the table top should be able to withstand the impact loading which the sealing arm will be exerting on it. And so a red wood, locally refered to as "Aaye" is used. This is placed on the frame described earlier on.
The table top surface (wood) is required to be smoothened polished to avoid rough surface that can lead to punching and bursting of nylon materials to be heat sealed.
Also the polished surface is water and moisture resistance as the surface is prone to water and moisture absorption when in operation (eg during packaging of juices).

The sealing arm is made of another type of red wood, that is locally referred to as iroko. It is ecpected to be able to exert enough pressure needed on the material during heat sealing (upto 17 - 61 MN/M^2.)
The sealing arm is mounted on the lever which is made up of 9mm steel rod suspended by a spring and the foot-operated via an adjustable pedal attatched to the rod. This lever machanism must be of light weight to facilitate easy operation or drawing down by human leg.
Infact the total weight of this mechanism is 19.53N
This load (19.53N) is bore on the pedal when the latter might have turned a vertical displacement of about 70mm (0.07m). This means that the maximum anakle moment required to operate the panel is 1.367Nm. The limit ankle planta flexor stragth for men (95th percentfile) is 230Nm and 130Nm for women[5] since the strength requirement for the lever still falls below both for woman and men.
Therefore the lever is said to meet the requirement for the function it is designed for.

The pedal is designed to accomodate a foot conviniently. According to human body dismension table 3.0 ; the foot breadth is 900mm (0.9m) and this make the pedal plate made of wood to be of 150mm (0.15m) by 200mm (0.2m).

The sealing element (made of platinium) is palced on a smooth wood bar punched notched to the table top.
The element is flat with width of about 3mm (0.00 3m). This flat surface is required to ensure an effective seam area of the nylon after it has been heat sealed.
The element terminals is connected to other electrical parts; the transformer, voltage regulator, indicator lamp, and micro-switch.
The transformer has the following parameters; primary voltage = 220V - secondary voltage = 31v
- Resistance at primary terminal 33.4
- Resistance at secondary : 6.0

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The transformer is to step down the voltage, and boost the current since high current is required to heat up the platinium (Pt) element. According to Joule, the heat energy disspated by an infinitesiomal croos section of the element is directlyprportional to the product of the square of the current and the resistance and the temperature (i.e $E = I^2Rt$).
The regulator is to vary the voltage supply to suit temperature requirement for nylon of different density.

3.2 Design Methodology

The basic features of the plastic sealant are illustrated schematically as in the drawing. As could be seen from the isometric view of the sealant, the material to be sealed is placed on the element bed on which the heating element is laid and the sealing arm is pressed against it for a period of about 3-5seconds.
The sealing arm is operated by an adjustable foot pedal. If the material to be sealed is containing a product (eg food) that is greater than 1,000g (10kg), it should be placed on the product base (a wooden drawer) provided at the other end of the sealant opposite to the operator's position. And the tip of the plastic bag could be passed though the slot on the table to the element bed where it will be sealed.
Incase of a roll (or rim) of Nylon, the rim could be hunged on the rim hanger provided at the top of the grame; it could be cut with the thin circular element and then sealed with the flat element as required.

3.3 Materials and Method

While selecting suitable materials, the requirements of the relevant part relating to the function, stress conditions and service life are first of all considered.

The selection is also governed by the requirements as in regard to the operations to be carried out on them (eg cutting, drilling, welding ect.) and finishing of the part, so also the cost of these materials.
To be candid, the cost these materials and the operations to be carried out on them are the major factors considered in the eselection of materials used in the construction of this machine.

3.3.1 Frame

25mm hollow square pipe made of steel is used to construt the main frame of the sealnat. The reason is not far fetch from its workability (ability to be easilty to be easily cut weldability etc) and its rigidity.

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That is, the steel pipe is workable because it can easily be cut, bent and jointed together by are welding.
Also the portability, of the machine is also considered. Since the frame is made of hollow pipe, then the overal weight is reduced to enhance easy transportability, which is an advantage over another atternative material such as angle-iron. The option of angle-iron is not also fiscally (economically) beneficial. These reasons knowed the choice of angle iron out of contension totally. As production at minimum cost is essentially important in any engineering design.

3.3.2 Table Top

The top of the table with which the frame is covered could be made of two materials:

(i) Plywood and
(ii) Wood

The major factors considered here are
- cost
- Finishing
- Strength and durability.

Plywood has a good, pfcourse excellent surface finishing chacteries but more expensive than wood.
Interm of strength, wood is stronger and durable under most working conditions. Also interm of workability to give good surface finishing, wood stand a good chance (even though energy and experience demanding).
For these reasons, wood is chosen as the material for the table top. Wood plank is cut into size and jointed together to cover the table top.

3.3.3. Sealing Arm

Weight is the major factor that is considered in the selection of the material for this component. The reason for this is that an appreciable amount of pressure (average $16MN/m^2$) is required to be exerted on the material during heat sealing of any type of polyethen (Nylon).
And this component again must be too heavy as it is going to be placed on the lever which itself is being suspended by a spring on the main frame. If the weight is too much it will constitute problem of stability (ie inability of the system of the arm amd the lever to be suspending vertically upright).

Therefore an heavy wood of 50mm square cross section is chosen.
The wood used is a type of red wood that is locally known as "Iroko".

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3.3.4 Pedal

The pedal designed for is an adjustable tyoe. To reduce the weight so as to facilitate easy operation at minimum strength requirement with respect to human strength ergonomy; a light weight, 12.5mm dia, hollow steel pipe is chosen.

3.3.5 Heating Element

Two type of heating element are designed for and used in this work; the flat type and the thin circular type.
The flat type is to ensure a seam of wider width, as proposed in the objectives of the work (project), after heat sealing. While the thin type is to be functioning as the cutting tool on the sealing machine.

3.3.6 Transformer

The type of transformer needed in this plastic sealnat is a step dowm transformer. There are two options in the selection of this component.

(i) Winding of the core according to specification required.
(ii) Purchase of special transformer for heat sealing.
Considering the reliability of the component, it is better to incure or purchase the special type.

3.3.7 Heating Element bed heat Protector.

The wood bar on which the element is laid is referred to as element bed. It is made of red wood of retangular cross section of 15mm x 40mm.

The device that prevent direct heating of the nylon material is referred to as heat protector. Teflon cloth (poly tetraluoro ethylene) is used in this sealant[7]. This is because of its characteristics properties under listed:

(i) Hight temperature stability
(ii) Surface lubricity
(iii) High metting point (327 °C)[7].

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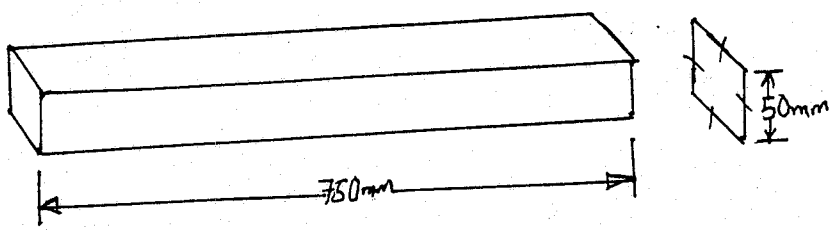
3.4 Design of Components and System

3.4.1 Sealing Arm

It is made of a local red wood called "Iroko". And work into shape show in fig below.



Volume = Cross Sectional Area x length

= $(0.05 \times 0.05)m^2 \times 0.75m$

∴ volume of the bar (sealing arm) = $0.001875m^3$

Mass of the bar is calculated as thus : Mass (kg) = Density (kg/m^3) x volume (m^3)

Density (γ) of red wood = $28lb/ft^3$

but $0.06243\ lb/ft^3 = kgm^3$

∴ $1lb/ft^3 = \frac{1}{0.0243}\ kg/m^3$

∴ γ red wood = $\frac{28}{0.06243}\ kg/m^3$

= $448.502kg/m^3$

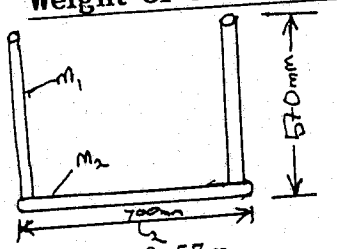
Mass (kg) = 448.502 x 0.001875

= 0.840kg = 0.841kg

3.4.2 Pedal Adjustment

The basic calculation done here is only to compare the overall weight acting on the pedal to the maximum weight or force (in Newton) that the feet of at least 95th percenfite woman (the weakest category in the population will be able to exert on the pedal.

Weight of the Lever



volume of the rod = (volume of $2m_1+m_2)m^3$

volume $= \frac{\pi D^2 L_1}{4}$

L_1 = 0.57m

D = diameter = 9mm = 0.009m

∴ Volume $(2M_1) = 2\left\{\frac{\pi D^2 L_1}{4}\right\}$

$= 2\left[\frac{\pi(0.009)^2 \times 0.57)}{4}\right]$

$= 2[3.6262 \times 10^{-5}]m^3$

$= \frac{7.2524 \times 10^{-5}m^3}{2}$

Volume of $M^2 = \frac{\pi D^2 L_2}{4} = \frac{\pi (0.009)^2 \times 0.7}{4}$

$= 4.4532 \times 10^{-5}m^3$

Total volume of the rod = $(7.2524 + 4.4532) \times 10^{-5}m^3$

$= 1.171 \times 10^{-4}m^3$

From density, $\gamma = \frac{\text{Mass}}{\text{Volume}}$

∴ Mass (kg) = Density (kg/m^3) x Volume (m^3)

Density of steel (steel) = 7.8×10^3 kg/m³

Le e steel = 7.8×10^3 kg/m³).

Mass (kg) = 7.8×10^3 kg/m³ x $1.171 \times 10^{-4}m^2$

= 0.913kg

∴ Weight of the lever = 9.13N.

3.4.2.1 Weight of pedal adjustment pipes.

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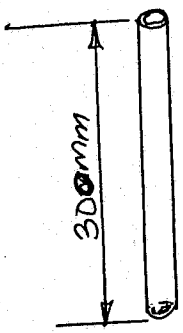

External diameter (D) = 14.5mm

Internal diameter (d) = 0.0125mm

Volume = $\frac{\pi D^2 L}{4}$

L = 300mm = 0.3m

∴ Volume = $\frac{\pi}{4} L (D^2 - d^2)$

= $\frac{\pi}{4}$ x 0.3 $(0.0145^2 - 0.0125^2)$

= $1.2724 \times 10^{-5} m^3$

Density of steel, ρ = 7.8×10^3 kg/m^3

∴ Mass (kg) = ρ x Volume (Density x Volume)

= $7.8 \times 10^3 \times 1.2724 \times 10^{-5}$

= 0.09925kg

∴ Weight of each pipe = 0.9925N

so Weight of both (2) pipes

= 2 (0.09925) = 1.985N

Total weight (Force) acting on the pedal = Weight of lever + weight of pedal adjustment pipe + weight of sealing arm

= (9.13 + 1.985 + 8.41)N

= 19.525N

The moment of the operator's ankle while depressing the pedal over a displacement of 70mm (0.07m) = 19.525N x 0.07m = 1.36675m

(i.e. the torque required to depressed the pedal = 1.367 Nm).

since teh ankle plantar and dorsiflexor[5] for 95th percentile women are: 35 - 130Nm plantar flexor[5]

25 - 45Nm siflexor[5].

Then, it is obvious that the pedal could be conviniently operated by all characters in the population.

3.4.2 Operator's Seat

Average weight for 95th percentile men is taken into consideration. (i.e. the heaviest category in the population).

95th percentile Men - 97.1kg[5].

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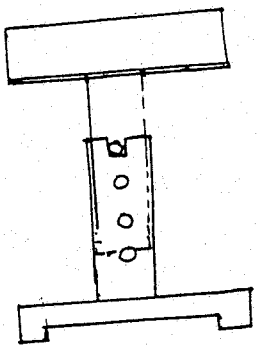


NB: The antropometrical datas used in the design of this seat is as stated under "Operator's posture" in section 3.1.3.1.

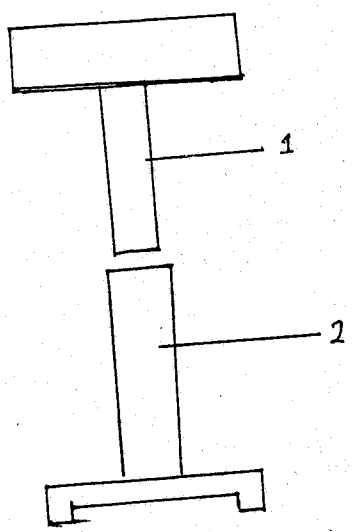
Total weight (W) is the sumation of the weight of the operator and that of the material.

Weight of material

i) Weight of the pipes;

mass (kg) = demsity x Volume

$$\text{Volume} = \frac{\pi D^2 L}{4}$$



Length (L) = 270mm = 0.27m

for pipe 1: D = $1\frac{1}{4}$" = 31.25mm = 0.03125m

" pipe-2; D_2 = 2" = 50mm = 0.05m

Thickness (t) = 2mm = 0.002m

Volume of pipe - 1:

$$= \frac{\pi L (0.052^2 - 0.05^2)}{4} \times 0.27$$

$$= \underline{4.32597} \times 10^{-5} m^3$$

Mass = steel x volume

$= 7.8 \times 10^3 \times 4.32597 \times 10^{-5}$

= 0.3374kg = 3.310N

Volume of pipe - 2:

$$= \frac{\pi L (0.03325^2 - 0.03125^2)}{4} \times 0.27$$

$$= \underline{2.7355 \times 10^{-5} m^3}$$

Mass of pipe - 2: Mass = V

$= 7.8 \times 10^3 \times 2.7355 \times 10^{-5}$

= 0.2134kg

∴ Total weight of the pipes

= (0.3374 + 0.2134)kg

= 0.551kg

= 5.51N

Assuming the weight of the seat cover (plywood and foam) to be neglegible.

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∴ W = 97.1kg = 971N (95th percentile Men)
+ 5.51N (weight of the material)

∴ W = 976.5N

Since the greatest streas will be occuring on the bosl for adjustment.
∴ Maximum stress, $\sigma_{max} = \frac{Force}{Area} = \frac{F}{A}$

F = W
Area = (thickness of the pipe x Length of the slot) x 2.
= (0.002m x 0.012m) x 2 = $4.8 \times 10^{-5} m^3$

So $\sigma_{max} = \frac{976.5N}{4.80 \times 10^{-5} m^2} = 20343750\ N/m^2$

∴ $\sigma_{max} = 20.344\ MN/m^2$

For steel:- Utimate tensile strength = $120Ksi^9$
- Yeild stress (Shear) = $36Ksi^9$
- Utimate compressive strength = 120Ksi

∴ Yeild stress (N/m^2) = 36 x 6.894757
= $248.211\ MN/m^2$

Since σ_{max} is far less than (1) utimate compressive strength and (II) yeild strear stress, than the operator's seat can withstand the weight of any operator of any category in the population.

3.5 Method of Construction and Modifications

The modified (redesigned) plastic sealant was constructed following the design parameters and using the selected material as earlier stated in this chapter under equipments and material required.
The epitome of it could only be given here.

3.5.1 Frame

The 25mm square pipe used was cut with hacksaw after markingout and then weldied together with gange-12 electrode.
(i.e E6013, diameter 2.0mm).

3.5.2 Table Top

The wood plank used was cut using panel saw, marked out on the workbench and mailed to each other at one side to make up for the size of the table cover required.
It was later on screwed to the frame.

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3.5.3 Sealing Arm

The wood (Iroko) used was cut into size required and drilled at 25mm away from both ends with hand auger (wood drill) using 12mm drill bit.

3.5.4 Pedal

The pedal is made of wood plate cut into a size required as stipulated by the anthropometrical data needed.
The length is 200mm and the breadth is 150mm.

3.5.4.1 Pedal Adjustments

This is a mechanism of pipes that can slide in each other. Two (2) 300mm long, 12.5mm pipes are drilled at 50mm internal with 7mm drill bit. Another two pipes with diameter of 19mm (3/4") were cut into 100mm length and welded to the lever.
And the two 12.5mm pipes slides in the later (19mm diameter pipe).

3.5.5 Lever

This is made from 9mm steel rod cut into size and welded together as required and shown in the drawing. A stopper is also welded at the upper end of each vertical member of the lever to stop the sealing arm from moving downward further than desired

3.5.6 Electrical Components

These comprises of the heating element, the transformer, and the regulator. These components were connected together using 1.5mm, 2 core wire. The circult diagram is shown on the drawing.

3.6 Testing

After fabrication, performance test was carried out on the sealant, this was aimed at assessing the performance and the ease with which the sealant constructed will seal plastic (nylon) materials of different density.

3.6.1 Test Procedure

The test was carried out as follow:

- The machine is pluged to the power source.
- The supply to the heating element is switched on using the regulator switch
- On noticing the indicator light on; the material to be sealed is placed on the teflon cloth which is protecting the material from direct heating by the element.
- The pedal is depressed and held in that position for about three seconds (3secs.)

- Then the pedal is released and the sealing arm is thus raised up and the plastic material removed.

- This operation is repeated for nylon of different density by regulating the voltage drop across the element via a voltage regulator.

Immediately the strip that is almost of thesame width with the element is noticed, then the sealing process is completed. This flat perfect seal observed showcase the efficiency of the sealant.

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3.6.2 COSTING

S/N.	ITEM DESCRIPTION	QUANTITY	UNIT PRICE	Total Amount
1.	Transformer	1Pc	₦1,200:00	₦1,200:00
2.	Element	1Pc	₦100:00	₦100:00
3.	Thing Element	1Pc	₦ 50:00	₦ 50:00
4.	Micro switch	1Pc	₦100:00	₦100:00
5.	Hooks	2Pc	₦ 12.50	₦ 25:00
6.	25mm Sq. pipe	2 length	₦290:00	₦580:00
7.	32mm dia. Circular pipe	-	₦ 30:00	₦ 30:00
8.	25mm thick Circular pipe	-	₦ 30:00	₦ 30:00
9.	9mm mild steel Rod	-	₦ 30:00	₦ 30:00
10.	20mm flat bar	-	50	₦ 50:00
11.	Angle Iron	-	20	₦ 20:00
12.	Washer (Flat)	6Pcs	₦05:00	₦ 30:00
13.	Indicator lamp	01Pc	₦180:00	₦180:00
14.	Regulator	1Pc	₦350:00	₦350:00
15.	Teflon cloth	1 Yard	₦150:00	₦150:00
16.	M10 Bolt & Nuts	2Pcs	₦ 25:00	₦ 50:00
17.	25mm wood Screw	12Pcs	₦ 2:50	₦ 30:00
18.	Adhesive (Evostic)	-	₦ 10:00	₦ 10:00
19.	Wood (Plank)	-	₦500:00	₦500:00
20.	Wood (Sealing arm)	-	₦145:00	₦145:00
21.	Paint	1 tin	₦100:00	₦100:00
22.	Polish	-	₦ 50:00	₦ 50:00
23.	Gauge 12, Arc electrode	15Pcs	₦ 4:00	₦ 70:00
24.	1.5mm 2 Core Wire (Nig.)	1 Yard	₦ 20:00	₦ 20:00
			TOTAL =	₦3,900:00

N.B: The Cost of Operator's seat inclusive but the labour cost is not added.

CHAPTER FOUR

4.0 Result and Discussion

After the sealant has been tested with plastic materials (nylon) of different density (ie low, medium and high density).
The seam formed is seen perfect and with high degree of leak-proof ability. The seam has therefore met the anticipated objectives. Any nylon used as package for any agricultural products (eg foods) could be heat - sealed using this sealant.

4.1 Comparism of the performance of the Modified Plastic Sealants to the existing Sealants.

In order to establish a better performance analysis on the modified sealant (this project) and that of those in existence, there is a need to know what are the features and limitations of the respective models.

4.2.1 Sealant with thin element

The actual models of plastic sealant that was modified uses a thin element with circular cross section to cut and seal plastic materials.

However, due to the type of element used, this type of sealant is able to seal a low density nylon perfectly, medium density nylon can only be cut, but could not be sealed.
High density plastics can not be cut, and this sealant is incapable to seal the same type of palstic.
Every altempt to increase

(i) The sealing pressure
(ii) The " time

Could not help to improve the situation.

4.2.2 Impulse Sealant (eg 200H series)

This type is able to handle sealing of nylon of any category but it is limited in application to packaging of light weight products (such as up to 10,000kg).
This is because the sealant itself is placed on a table and so can not be used to seal any package that can not be easily put on the table (such as 50kg Nylon bag).

4.2.3 Modified Plastic Sealant

The plastic sealant constructed has some advantages over the first two (2) types (models) earlier mentioned in section 4.2.1 and 4.2.2.

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These merits include:

(i) Ability to seal nylon materials of various density (low, medium, and high.

(ii) Ability to handle heavier product unit (due to provision of product base and slot) with the machine.

(iii) Reduced labour requirement; since teh operator's comfort is catered for by provision of adjustable operator's seat.

(iv) increased productivity as the operator's efficiency has been enhanced.

In epitome, the result of the output of this sealant showed that the modified plastic sealant is capable of handling any sealing job in packaging at domestic, small and medium seale industry level.

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CHAPTER FIVE

5.0 Conclusion and Recommendations

5.1 Conclusion

This report entails in chronological order the processes involved in the design and construction of the modified plastic sealant.
The essential occupational biomechanics that bothers on engineering anthropometry and ergonomics are used in the design and construction of the sealant to ensure high productivity and operator's efficiency at least operator's labour requirement.

However, the ability of the sealant to handle all sealing jobs in packaging at domestic, small and medium scale level revealed that the targets (objectives) of this project has been met with expected performance.

5.2 Recommendations

Critical observation reveals that the sealant could still be improved to increase its efficiency and productivity. The following is hereby recommended.

1) A knife-like cutting tool (such as on paper gullotine) should be incoporated for smooth cutting of the nylon materials.

2) Table top should be covered with furmica to ensure water resistance surface.

3) There should be a provision for mounting the sealant on an handling equipment such as conveyor in a production line of a processing/ packaging Industries

4) There should be a means of controlling the sealing arm automatically to enhance easy operation if synchronised with other equipment on a production line.

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