EFFECT OF LAUNDRY WASTE WATER ON SOIL HYDRAULIC PROPERTIES: A CASE STUDY FROM LAUNDRY TUNGA MINNA NIGER STATE

BY

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BIORESOURCES ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING

TECHNOLOGY MINNA, NIGER STATE

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BEING A FINAL YEAR PROJECT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA IN PARTIAL FULFILLMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE

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CERTIFICATION

This is to certify that this project research was carried out by Bello Haruna of Agricultural and Bioresources Engineering Department, School of Engineering and Engineering Technology, Federal University of Technology, Minna, Niger State.

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DEDICATION

This Project Research is dedicated to Almighty Allah and my lovely mother and father late Hajiya Daiyaba, Na Allah and Alhaji Na, Allah Rini Jega.

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My appreciation and profound gratitude goes to Almighty Allah for his protection over me throughout my study in the University. Alhamdullihi!

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ABSTRACT

This study was carried out to determine both the qualitative analysis of the waste from laundry and to estimate the effect of laundry waste water on hydraulic properties on the receiving soil from Tunga Laundry Minna, five s ample of soil and two sample of waste water were taken. The research showed factors responsible for low permeability, texture traffic compression nature of the site due to closeness to the road. The study determined the hydraulic conductivity (Ksat) of three soil texture; sandy, clay and silt, my observations were that the sandy textured soil had the highest rate of hydraulic conductivity because of its large particle size and low bulk density. The qualitative test carried out on the waste water showed that the laundry detergents contain appreciable amount of sodium while the SAR and EC value of waste from the result obtained were 85.929 to 100.577 and 4.11825 to 4.8662ds/m respectively this indicate that saturated hydraulic conductivity (Ksat) of a soil may be significantly reduced if the SAR of the waste water applied to the soil greater than the result value . The high level of nutrient and phosphate in the sample make them useful crop grown the required nutrient without the application of expensive inorganic fertilizer.

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CHAPTER FIVE

ABBREVIATIONS

C – Pit - Content in Pit one

Pd – Pit in depth

S – Soil

Ms – Mass of dry soil

OM – Organic matter

Fc – Field capacity

Mfc – Mass of field capacity

W_p – Wilting point

MW_p – Mass of wilting point

S_k – Saturated hydraulic conductivity

MS_k – Mass of saturated hydraulic conductivity

ρb – Bulk Density

$M\rho b$ – Mass of bulk density

COD – Chemical Oxygen Demand

BOD – Biochemical Oxygen Demand

DO – Dissolved oxygen

FEPA – Federal Environmental Protection Agency

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CHAPTER ONE

1.0 INTRODUCTION

In many countries water is becoming an increasingly scarce resource and planners are forced to consider other source of water which might be used economically and effectively to promote further development. At the same time with population expanding at a high rate the need for increased food production is apparent, the potential for irrigation to raise both agricultural productivity and the living standard of the rural poor has long been recognized.

Laundry water may be defined as unwanted water or waste water of any type or it is the failure to use something wisely properly, fully or to good effect (Proter, 1996).

Thus the definition of gray water or waste can be very subjective.

In agricultural when ever good quality water is scare water of marginal quality will have to be considered for irrigation. Although there is no universal definition of marginal quality water that possess certain characteristics which have the potential to cause problem. When it is use for an intended purpose.

Water are those waste water from bath, car wash, kitchen, laundry and others domestic uses. Excluding the urinary and toilet through it is marginal quality water because of its association of health hazards, the risks associated with its use are minimum (Blade 1989) properly planned use of municipal gray water alleviates surfaces water pollution problem and not only conserves valuable water resources but also take advantage of the nutrients continued in them to grow crops. The availability of this additional water near pollution centres will increase the choice of crops which farmers can grow. The nitrogen and phosphorus content of gray water might reduce or eliminate the requirement for commercial fertilizer.

In most part of Nigeria especially the northern region during the dry season, gray water effluents are use for irrigation.

When waste water is untreated is poses a lot of hazards of the health of the final this irrigation practice less than 1% of waste water is treated in Nigeria (Mohammed, 2001)

Irrigation water must be suitable to the crop that are being irrigated, harmless to the soil under which it is grown and the crop pathogen free to the consumers.

1.1 STATEMENT OF PROBLEM

Laundry activities if not properly controlled may pose dangers to the farmers, environmental as well as people that are living within the area.

Laundry effluent reaching stream may contribute significant level of nitrogen, phosphorus and biochemical oxygen demand (B.O.D) and other nutrient there by resulting in stream pollution. (Http:en.wikipedia.org/wiki/waterquality).

These are some of the main reason that led to the analysis of waste water or gray water from Tunga Laundry service. Information obtained from the study will be used to design efficient end – use treatment and mitigation measure toward the impact of gray water on our environment.

1.2 OBJECTIVES

1. To carry out qualitative analysis of the waste water from laundry
2. To estimate the effects of laundry waste on the soil and to study the effect of the laundry waste water on hydraulic properties on the receiving soil.

1.3 JUSTIFICATION

The gray water is generated by various laundry service device, thus this contributes to the increasing result in substantial reduction in soil hydraulic conductivity. Lowering of (Ksat) around plant roots after laundry waste water application may result in local saturation.

The scarcity of organic and inorganic compound generally not present in irrigation water. The waste water from laundry services which contain the access of some of detergents that contribute to the waste water to be irrigation water. Therefore the impact of these waste water on soil and plant must be understood before using them for irrigation purposes.

In a developing country like Nigeria the cleaning process industries (LAUNDRY) are generally less developed when compared with the advanced counties, because in these countries (developed) gray water generated analysis and treatment are being considered while constructing the laundry.

1.4 BRIEF STUDY ON PROJECT SITE

The study area is located at Tunga, Minna in Niger State on latitude $8^0$20'N and $7^0$30'N and longitude $3^0$30'E and $7^0$20'E

The study area is located at Tunga, Minna, Niger State. Minna town lies on latitude $8^0$20'N and $7^0$30'N and longitude $3^0$30'E and $7^0$20'E the laundry service is located at Tunga, along Shiroro road, Minna. As at the time of this research there is no any known documentation about the laundry. The laundry is an open place such that more than 100people are involved in these day to day running of the business.

This cleaning industry (laundry) was established about 25years ago. The method and procedures of laundry waste disposal are done by pouring out the waste water on the ground level or surface around the area.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 WASTE WATER

Waste water samples from four locations in Minna municipal area of Niger state were collected and examined for physical, chemical and bacteria logical parameter with a view to assessing their potentials for dry season irrigation farming. The electrical conductivity (Ec MHas / mm) for all the samples was less than 5 which implies that the water can be used with little likelihood of salinity developing the total dissolved solids (TDS) of all the sample were less than 200 mg / 1 which shows that irrigation can be carried out on all soils. The sample generally have low electrical conductivity which show that the irrigation can be carried on with most crops, with little likelihood of soil salinity developing the level of nitrate and phosphate are generally very high; this implies that compound fertilizer will not be regarded for optimum growth of crops in irrigation with the grey water. The Faccal caliform density (FC) was detected at over 1000 cfu / 100 ml the BOD were 165mg/c sample s.I and over 60mg/c in the other sample which indicate that sample cannot be used for restricted irrigation without treatment grey water in the municipality have great potential for being used for unrestricted irrigation. (A.B Isa & B. Mohammed).

2.2 WASTE MANAGEMENT IN NIGERIA

Waste management involves the collection, transportation, storage, treatment and disposal of waste including the after care of the disposal sites.

Disposal involves the storage, tipping of deposited on or below the ground as well as transformation operation utilized for waste recovery, recise or recycling (Adeyoke 1992).

Thus the best option in waste management is a no-waste technology approach (zero-option); that is no waste is generated. This represents an ideal situation against which any other waste management option must be assessed. This is directly followed by waste minimization and last option is waste management.

Waste minimization is mandatory for existing industries to eliminate or minimize waste being generated from their production processes. Proper waste analysis at the design stage is therefore imperative. Industries should adopt processes where there is no waste, and where that is impossible, they should practice waste minimization where the quality of waste, whether harmless or not, should be reduced to the bearest minimum.

This is because waste even when non-polluting results in the depletion of the earth's resources including the energy required their processing waste recycling is mandatory for waste minimization (SUS, 1995).

The generation of waste can be said to be an inevitable fact of living. Continuing advancement in science and technology is contributing significantly to the increased volume and toxicity of waste generated. All form of wastes such as municipal solid waste, and waste water, household wastes, industries wastes, livestock waste, abattoir wastes, hospitals wastes, radio active wastes, and other hazardous wastes continue to find their way to the waste stream. This constituted a threat to the nation's environment.

This degradation also affects the soil, ground water and other aqual-system (Meetham and Bottom, 1985).

One thing is agreed upon: the menace constituted by improper waste management on the environment is worrisome in Nigeria. It appears that rapid urbanization, industrialization and the quest to keep pace with the rest of the world is turning out to be a curse in disquise as far as the environment is concerned yet, environment and development are intimately dependent on each other. For the hospitals for instance it has become an emotional issue; having to contribute to a problem they are established to solve, as many people have become patients out of the reckless abandon with which some "health care" facilities disposal off their waste to the detriment of public health (Coker et al 2000).

2.3 HYDRAULIC PROPERTIES OF SOIL

This project was to determine the hydraulic conductivity (Ksat) of four soil textures, clay, loam, silt and sand the hypothesis was a sandy textured soil would have the highest rate of hydraulic conductivity because of the large particles size and low bulk density.

Four soils with different textures were identified a local agricultural soil survey. Each of these soil located and their sampled in the field. The soil were then read out on drying trays and allowed to air dry for two weeks. Any root or rocks were removed from the samples.

In the mean time an apparatus was constructed to aid in the measurement of the hydraulic conductivity. Mr. Hooper, a soil scientist with the Natural Resources Conservation Service, provided a diagram for this apparatus. The dry soil samples were then compacted and pre-saturated. Next a hydraulic head was placed over each sample. The time it took for 125cc of water to move through the soil was measured. The rate of water flux was calculated for each of the samples. Also, samples of each soil were weighed in order to calculate their bulk density. (Nicholas E. Forsburg, 2003)

As expected, the sandy textured soil had the highest rate of water permeability. One unexpected result was that the clay – textured soil did not have the lowest rate of permeability. The silt-textured soil was found to have the lowest hydraulic conductivity. The result from a soil particles size analysis done for me by Mr. Hooper showed that the sand textured soil had the largest soil particle of the soil textures. But is also showed that the silt – textured soil had the smallest soil particles, not the clay which was why the silt- texture soil had the lowest rate of water flux. After completion, these experiments I have found that soil texture particles size and bulk density are the biggest factors influencing the hydraulic conductivity of soil. My hypothesis was partially correct; however, if the soil sample had a larger difference in particles sizes, the bulk density and hydraulic conductivity of the soil would have a greater variation. (Nicholas E. Forsburg 2003)

2.4 WASTE WATER IRRIGATION

Water for irrigation is obtained from surface and ground water source. Surface source include lake, reservoirs, streams, water user association are well and facilities and waste water, while the primary ground source are wells and spring. The suitability of a water source for irrigation depends on several factors including legal constrains. The quality of water (i.e. the amount and identity of suspended and dissolved material in the water) as well as ability of the source to supply the total irrigation required year after year.

This is to describe the characteristics of several surfaces and ground water source of water the effect of water quality of water (i.e. salinity exchangeable sodium and toxicity) on the suitability of a water source for irrigation is discussed and several salinity control measure described. (Larry G. James 1988)

2.4.1 Land Treatment Of Wastes

Land disposal methods are based on the fact that matter can not be destroyed, only transformed from one form to another. Not the least of the benefits o these methods is the recycling of the water – and the nutrients and the organic matter contained in it – back to the land and the crops growing on the land. Both marginal and productive farm lands can be improved by irrigation with chlorine – disinfected liquid matter from secondary sewage treatment plant. The nutrient in the liquid reduces the amount of fertilizer required for the crop; the organic matter improves the soil: and the water provides irrigation thus improving the yield.

Adverse public opinion is probably the greatest obstacle to the recycling of municipal and industrial waste by land treatment systems. Such adverse opinion stems from fear of sewage odor insect problems, and depressed land values. These fears are unfounded.

2.4.2 Sludge Treatment Before The Project

Sludge treatment before the project. In 1960 the salinity district treatment, about 500 tons a day, was heat dried until it had become almost completely solid. Then it was said to be broker who record it as fertilizer. Because the drying process used coal as a fuel, an air pollution problem required. With odors and gases billowing from smokestacks furthermore, the storing of the remaining sludge in lagoons tied up areas of valuable land.

The sanitary district engineers lessened air pollution by changing to gas as a fuel and by installing after bunners, these steps reduced stack emission from 200 to 5 tons a day, but the cost was very high. Some 400 acres of lagoons near the west southwest treatment works already stirring a 30year accumulation of sludge. Public objection prevented the needed expansion of the lagoon system in the area.

2.4.3 Sludge Transportation and Distribution

In the summer of 1971 the sanitary district began barging digested sludege from Chicago to Liverpool, III. This involved a two day trip for a low of four barges. The district is now transporting to Liverpool some, 7, 500 tons of sludge, about half of the districts daily output. The sludge is unloaded at Liverpool basins some 230ft, higher than the river where the sludge is aged and stabilized.

The sludge distribution system includes distribution pipeline, an above ground header system and a spray carriage known as the "big gun" the carriage may take all day to travel the 1, 320ft, length of a typical field. The gum sweeping in a are, sprays, up to 30ft. three or four passes a year can supply the needed volumes of sludge. (Microsoft (R) Encarta (R) 2007)

2.5 LAUNDRY WASTE WATER

Detergent term applied to material, the solutions of which aid in the removal of dirt or other foreign matter for contaminated surface. Until the 1940s soap was the only important detergent. Today soap is but one of a great many detergent products. The ingredient of detergents are often called surface active agents. Or surfactants, because they act upon a surface. A common feature of detergents is that they are made up of comparatively large molecules (Molecular weight over 200). One part of the molecule is soluble in organic material and the other part is soluble in water.

During World War II the shortage of fats, from which soap is made spurred the development of soapless or synthesis detergents, primarily in the United States. After the war the need for new types of detergents for automatic washing machine accelerated the trend.

Detergents are made by treating an aromatic, or benzene – type compound with sulfuric acid, followed by neutralization with alkali to convert the produce to its sodium salt. The detergent product of these reactions came into wide use in the late 1940s and early '50s and proved to be effective in hard water and cool or cold water, whereas soap is often wholly ineffective under both condition. These detergents however become a public nuisance because, unlike soaps, they were neither soluble nor biodegradable; that is, once put into water tended to remain there resisting conversion into less complex and more soluble substances. The detergents tended to create foam in cesspools and in sewage – disposal plants as well. They even appeared in naturally occurring ground and surface waters.

Replacing the aromatic compound with a so – called linear alkyl – type compound in the process described above led to a more desirable product. It was as effective as the former kind in its detergent action but was more bio degrable and soluble. The new linear alkyl ate sulfonate in changed to harmless product by micro organism in cesspools, sewage – treatment plant and ordinary soils.

Manufacturers of detergent in the U.S. have changed their processes to produce only bio degradable or soft detergents. The change over was done voluntarily between 1963 and 1965. (Microsoft (R) Encarta (R) 2007)

CHAPTER THREE

3.0 MATERIAL AND METHOD

3.1 DESCRIPTION OF THE STUDY AREA

This study area Tunga Minna in Chanchaga local government of Niger state lies on latitude $9^0 34$ and $9^0 37$'N and longitude $6^0 36$' and $6^0 39$'Falade (2005). This research work is carried out base on estimate the effect of laundry waste on the soil and to study the effect of laundry waste water on hydraulic properties on the receiving soil also to carried out qualitative analysis of the waste water from laundry.

The project research study period is July were by is the months that rainfall is heavy and resulted to wash away some material on the top soil of the project site and still where was properties and hydraulic effect on the site so that the research is carried out successfully.

3.2 MATERIAL AND METHODOLOGY

3.2.1 Field Experiment

The materials used include: core samples, mallet, shovel, hoe, wood ruler etc.

One square pit about 100cm away from the road sites 10 x 10m were cleared using hoe and shovel, five soil core samples were taken progressively at each zoom downward. Soil samples at these depths were also taken for particle size analysis and wilting point water content determination water content at various depths hydraulic conductivity and colour content were also measurable from this sample of soil.

And we take soil samples from other place some around the area some 10-20m apart from previous one in order to determine and compare with other sample for differentiated.

Independent variable

1. sand
2. clay
3. silt
4. colour

Dependant variable

1. wilting point [%vol]
2. field capacity [% vol]
3. saturation [%vol]
4. available water [%vol]
5. saturated hydraulic conductivity [cm/hr]
6. bulk density [g/cm^3]

3.2.2 Saturated Hydraulic Conductivity Measurement

Soil sample were collected from five different depth of 0-20cm, 20-40cm, 40-60cm, 60-80cm and 80-100cm depth using core samplers and were taken to laboratory for analysis. The core samplers were labeled and completely basin filled with water to about 4cm.

The experiment was set up by attaching another empty core samplers to the top of the filled are samplers with the aid of a cello-tape.

Water was slowly introduced into the core cylinder and a constant heard was maintained for one hour. Water was allowed to drain gradually through the soil sample into the graduated beaker.

The volume of the perculate was measured. This was repeated for the samples. The saturated hydraulic conductivity was determined as follows water was slowly introduced into core cylinder and a constant head was maintained for one hour. Water was allowed to drain gradually through the soil sample into the graduated beaker. The volume of the perculate was measured. This was repeated for the remain samples. The saturated hydraulic conductivity was determined as follow:

$$\text{Saturated hydraulic conductivity} = \frac{\text{volume of water per hr}}{\text{cross sectional areaa of the core}} \quad \ldots\ldots\ldots\ldots 3.1$$

3.4.2 Bulk density measurement.

Core samplers are commonly used and take undisturbed soil samplers. The cylinder of the core samplers which has its cutting edge is driven into the soil and uncompacted core obtained within the tube. The samplers were carefully trimmed at both ends. Empty label d cans were weighed, they were then filled with soil core samples and weighed again and were oven dried at 105^0C for about 24hrs, samples were again weighed.

Bulk density was determined as follow

$$\rho_b = \frac{M_s}{V_s} \qquad \text{.......... 3.2}$$

Where

ρb = Bulk density

Ms = mass of dry soil

Vs = volume of soil

3.4.3 Water Content at Field Capacity Measurement

Soil core samples were then oven dried at 1050C for 24hrs. Water content at field capacity was determined as follows

$$\text{Gravimetric water content} = \frac{\text{mass of water}}{\text{mass oven dried soil}} \qquad \text{.......... 3.3}$$

3.4.4 Water Content at Saturated Measurement

Empty cans were weighed: completely saturated soil core samplers were placed in them and then weighed again. The samplers were oven dried at 105^0c for 24hrs. Water content at saturated was determine as:

$$\text{Gravimetric water content} = \frac{\text{mass of water}}{\text{mass of oven dried}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.4$$

3.4.5 Water Content at Wilting Point Measurement

Ordinary fresh soil samples were air dried for a week. Weight of empty can plus the weight of can plus soil were taken using a sensible weighing balance. The samples were oven dried at 1050C for twenty four hours. Water content at wilting point was determined as follows

$$\text{Gravimetric water content} = \frac{\text{mass of water}}{\text{mass of oven dried soil}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.5$$

3.4.6 Available water content = $\frac{\text{water content at field capacity - water}}{\text{content at wilting}}$ 3.6

3.5 DETERMINATION OF PARTICLES SIZE ANALYSIS BY HYDROMETER METHOD

Procedure:

Two millimeter [2mm] air dried soil was several and 50g of the sample was weighed, 100ml of distilled water was added to the sample in a bottle and 5% sodium hexametephorsphate solution which serve as a dispersing agent was added. The mixer was placed in a shaker shacked content was transferred quantitatively without loosing any particle into the sedimentation cylinder, up to 1 litre marked with distilled water. The soil sample was disturbed with aid of a plunger for proper soil suspension. The hydrometer reading was taken by immersing the hydrometer into the sample, and the stop clock was used to the reading. The temperature of the suspension was also taken by immersing the thermometer into the sample.

The 40 second reading was also taken to measure the percentage of silt and clay in suspension. A blank sample was also prepared but without soil and the reading also obtained.

$C = R - RL + [0.36 \times T]$ 3.7

Where C = corrected hydrometer reading

R = sample reading

RL = blank reading

T = temperature [^{0}C]

0.3 = Multiplication Factor

% clay = C x 100/50

% silt = C + clay - % clay

% sand = 100 - % silt + clay

3.6 PERMEABILITY TEST BY CONSTANT HEAD METHOD

Procedure:

Core were forced horizontally into the cross section of the profile and sample at 0-20cm, 20-40cm, 40-60cm, 60-80cm and 80-100cm. the sample were then taken to lab and marked overnight for 24hrs with bottom end covered with cotton so as to prevent fall of the soil sample within the core rings. The samples were removed and the processes of permeability commence immediately obengin the law of Henri Darcy of 1856. a known quality of water 50ml was poured for about 5 minutes and water collected within the elapsed time there was variation in water collection as a result of texture of the horizon differ.

Apparatus:

Core ring, beaker, measuring cylinder, clamp, cell-otape and ware cloth [white cotton] rubber band, stop watch getting where the 3 name meet will the class of texture.

3.7 PRETREATMENT OF WATER SAMPLES

The physical chemical and bacteriological characteristics of grey water sample take at laundry designated location in Minna were examined sample [W_1]was collected at the right hand side of the laundry site and sample [W_2] was collected at the other hand side of the location.

The analyses were basically carried out as certain whether the water[s] would have any detrimental effect on the soil or crops grown. Samples were collected in labeled sampling rubber bottles to identify each sampling point.

All samples collected were delivered to the laboratory within 24hrs of collection for investigation. On arrival of field trip, water samples collected in bottles were kept under a room temperature, which did not exceed 25^0C: the idea was to reduce microbial activities to the barest minimum.

3.8 LABORATORY ANALYSIS OF WATER SAMPLES

In consequence of recent advance in technology automated technique for water characterization was adopted. A hatch DR2000 multi parameter spectrophoto meter was used and the determination of the concentration in water was carefully noted. They included

3.8.1 Physical Parameters

1. temperature [^{0}C
2. pH
3. turbidity [N T U]
4. conductivity
5. total solids [mg/l]
6. total dissolved solids [T D S] [mg/l]
7. Oil in water

3.8.2 Chemical Parameters [mg/l]

a) Sulphate [SO_4^{2-}]

b) Reactive phosphate {PO_4^{3-}}

c) Sulphide {SO_2^{-}}

d) Nitrate {NO_3^{-}}

e) Alkalinity

f) Chlorine

g) Calcium {Ca^{2+}}

h) Iron {Fe^{2+}}

i) Magnesium {Mg^{2+}}

j) Sodium {Na^{+}}

k) Potassium {K^{+}]

l) Sodium absorption ratio {SAR}

3.8.3 Bacteriology parameter {mg/l}

i. Chemical oxygen demand {COD}

ii. Biochemical oxygen demand [BOD}

iii. Dissolved oxygen {DO}

3.9 METHOD OF ANALYSES

This section contains the method of analyses. The analyses data were soured from observation, measurement, computation, exiting records information from structural questionnaires, and collection of waste.

3.9.1 Solid and Liquid Waste

The analyses of the waste were done using bar chart, pie chart, component bar chart, arithmetic mean and standard deviation. These approaches were used to analyze the solid and liquid waste.

3.9.2 Properties of waste considered.

The discharge ports, circular or rectangular as the case may be, were measured in order to know their areas and the amount of waste discharge per unit time.

For the effluent {liquid waste} a 600ml container was placed at the discharge port 10 seconds and depended on type of work that their have and available water that their have and volume collected noted. This measurement was taken trice at different days.

$$\text{Rate of flow} = \frac{volume\ \text{discharge}}{\text{time taken}} \{m^3 / s\} \ldots\ldots\ldots\ldots\ldots\ldots 3.8$$

B physical, chemical and bacteriology parameter of the effluent {liquid waste}

3.10 SAMPLING TECHNIQUE/ PROCEDURE

The objective of sampling is to determine all the parameters for the liquid waste {effluent} to sample of grey water were colleted at the same time. 1 litre of rubber bottle for each sample was carefully collected labeled and sent to the analytical laboratory for analysis.

3.11 DETERMINATION OF THE QUALITY CHARACTERISTIC OF THE WASTE

3.11.1 Liquid waste {effluents}

The composition of the liquid waste was evaluated experimentally in order to determine the physical, chemical and bacteriology of the effluent.

i. *pH:* pH of an aqueous solution is a measure of its acidity or alkalinity. The PH test was done using calorimeter indicator method / ph lovibond comparator. The following indicators were used: bromothymol blue, phenol red, and methyl red.

During the test 10ml of liquid waste sample was put inside a ph comparator cell and 10 drops of indicator was added. Shaken and reviewed in ph loivnbond colour dise.

Values between 6.8 - 7.4 are termed alkaline.

Values between 4.4 – 6.0 are termed acidic.

Values at 6.0 are termed neutral.

ii. *Turbidity:* light scattering turbid meter was used for the measurement. The unit of the measurement is {NTU}.

iii. *Conductivity:* a conductivity meter was used to determine the conductivity of the effluent sample in $EXC10^{-4}$.

iv. *Alkalinity*: this was determine by carrying out 2 test, which are titrable alkalinity and separated determing the amount of carbonates present in the water while the other is titrable alkalinity complete which determines both carbonate and hydrogen carbonate.

Reagent and chemicals: 0.1m hydrochloric acid.

1% phenolphthalein

1% methyl orange

Procedure: 100ml of liquid waste sample was pipeted 250ml conical flask, 2 drops of phenolphthalein was added and titrated with 0.1 HCL to colourless. Original the colour was grey {ash}.

$$Ta = \frac{VA \times 100}{vs} \quad \text{.......... 3.9}$$

Where TA = titrable alkalinity

VA = volume of acid {hcl}

VS = volume of sample which was 50ml.

$$TAC = \frac{VA \times 100\, mgl}{50} \quad \text{.......... 3.10}$$

TAC = titrable alkalinity concentration.

v. *Total iron {Fe}:*50ml of the sample was added to 1ml of hydroxylamine and 20ml of concentrated HCL.The mixture was digested by evaporating it to about half the original volume. The process of digestion removed all unwanted materials {organite} and left only iron to be determined. The digestion mixture was poured into 50ml standard flask and made up to the 50ml mark with distilled water. The results were compared with standard preparation using the calorimetric method.

vi. *Total hardness:* this is the sum of alkaline earth {calcium and magnesium} ions bond as carbonate, sulphate, chlorides and phosphorus expressed in {mg/l}.

Reagent 15% NH_3 solution {ammonium chloride} N.A.N.A indicator {hydroxyl – 1- {2 hydroxyl} – 4 sulp- 1-naphthlazo} - naphthoic acid.

Black eriochrome T

Ethyleme diamine tetrucetic acid {EDTA}

Procedure: 100ml of effluent sample was pipette into a conical flask. 5ml of NH_3 buffer solution was added followed by the addition of very little quantity of black Erich Rome T and the mixture warmed to 50^0c titration with 0.01m EDTA was carried out until colour turns from grey {ash} to blue.

$$\text{Total hardness} = \frac{V_A \times 100}{V_S} \quad \{mg/l\} \ldots\ldots 3.11$$

Where V_A = volume of 0.01 EDTA used

V_S = volume of sample used

vii. *Chloride* {Cl}: to determine the chloride ion concentration, the sample of liquid waste {effluent} was titrate with 0.01m Ag NO_3

{Silver trioxonitrate {v}

Reagent/chemicals: 0.01m $AgNO_3$ solution

0.1m HNO_3

10% potassium chromate

Procedure: 100 of effluent sample {filtrate} were pipette into a 250ml conical flask and 1-2 drops of phenolphthalein was added. A grey {ash} colour was produced. 0.1m HNO_3 was added until solution become colourless, 2-3 drops of potassium chromate {K_2Cro_4} was added and the resulting yellow solution was titrated with 0.0.1m Ag NO_3 solution until the colour changes from yellow to reddish brown.

$$\text{Concentration of } Cl^- \{mg/l\} = \frac{\{v_1 - v_2\} x 100}{vs} \ldots\ldots 3.12$$

Where, vo1= volume of $AgNO_3$

V_2=blank

V_3=volume of sample

viii. *Nitrate and nitrate:* nitrate in effluent was determine by measuring 20ml of effluent sample into a 50ml volumetric flask and titrated with sulphanide acid.

ix. *Chemical oxygen demand {COD}:* the test for oxygen consumed from potassium dichromate in acid solution is COD. It is a measure of the amount of carbon in many types of organic matter. It is of considerable value as an estimate of the strength of those sewages and laundry waste water for which bio chemical oxygen demand {BOD} cannot be determined because they are toxic to the organism activating the BOD test.

Reagent: 0.01 oxalic acid {$c_2 h_2 o_4$}

0.01m $km_n o_4$

8% NaOH {8g dissolved in 100ml distilled {water}

Procedure: 10ml of the effluent sample was transferred into a conical flask and diluted to 100ml with pure water. 2ml of 8% NaOH solution was added and the mixture heated to boil. 10ml of $kMnO_4$ was added and boiling continued for about 15 minutes. Finally, add 10ml oxalic acid and back titrate the solution {hot}.

$$COD = \frac{\text{ml of } 0.1\text{m KNn } O_4 \times 0.08 \text{ NaOH} \times 1000}{\text{ml of sample}} \quad \text{.................................. 3.13}$$

x Dissolved oxygen {DO} and biochemical oxygen demand {BOD}:

The BOD test evaluates the loss of DO that accompanies the decomposition induced and maintained by micro organism in the waste waters.

Therefore, the BOD is an indirect measure of the amount of decomposable matter present and a direct measure of the respiratory oxygen requirement of the living organism that are responsible for the decómposition.

The dissolve oxygen will be determined on days and days 5{i.e. DO, and DO5}. After 15 minutes preparation, the DO for the diluted sample was measure {blank with water only}. The dilution of 850ml of clean tap water and 50ml of filtrated sample was fed into an incubator bottle.2ml of concentrated h2so4 was added and shaken until the precipitate dissolved. 100ml of the resulting solution was transferred into a conical flask and allowed to filter with an oil dilution of sodium thiosulphate {na_2 s_2 o_3}. Few drops of starch solution were added as an indicated until the mixture became blue colour. The quantity if $Na_2S_2O_3$ which turned sample colour to colourless {neutralization point} was recorded as the DO in the sample. The determination of BOD_5^{20} was done using the following equations.

$$BOD_{520} = \frac{DO_1 - DO_5}{D_1} \quad \ldots\ldots\ldots\ldots 3.14$$

Where DO_1 = dissolved oxygen of diluted sample after 15minutes after preparation.

$DO5$ = dissolved oxygen of diluted sample after 5days

D_1= decimal fraction of dilution water used.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 WATER CONTENT AT SATURATION C- PIT 1

For normal soils like those in the tropics, water content at saturation decrease downward, because of the increase in clay content down the profile, this is reflected in pit one (C – Pit 1), water content at saturation decreases from 0-60cm, though the clay content increases only from 0-40cm. the decrease at 40-60cm, can be an error in the laboratory measurement or change in the nature of the soil (sandy) at that profile depth.

The increase in percentage saturation from 60-100cm as shown in the table 4.1 below maybe as a result of increase in sand content at these levels. The model predicted values for the percentage saturation has some degree of consistence with the laboratory measures value. From statistical analysis the predicted saturation values at 5% significance are accepted, since the table value at 5% and nineteen degree of freedom is 30.14 which is greater than the chi square value (See table 4.1 below).

Generally, soils with high degree of saturation have less trafficability and floatation. This type of soil will require more drainage in case of excess rainfall or irrigation. The growth of non water loving crops is also hindered by this type of soil. From the table below it could be seen that the soil degree of saturation is just below 50% and so will not pose much treat of excess water to the plant or hindered floatation and trafficability.

Table 4.1 S, MS, OM, X^2 and particle size analysis values

Pd	S	Ms	X^2	Sand	Clay	Silt	OM
0 - 20	37.5	47.7	2.2	59.1	31.6	9.3	0.5
20 - 40	36.2	48.8	3.3	59.1	36.6	7.3	0.8
40 – 60	35.3	45.4	2.3	63.1	25.6	11.3	1.2
60 – 80	37.8	45.3	1.2	69.1	25.6	5.3	0.3
80 - 100	41.4	47.7	0.4	69.1	27.6	3.3	0.3

$$\sum X^2 1 = 9.327$$

4.2 WATER CONTENT AT FIELD CAPACITY C- PIT 1

The field capacity decreases from 0-60cm; this could be due to the lightness in the nature of the soil as a result of high sand and silt content. Field capacity is lower in light soils than in heavy soils, ranging from 5 and 25-30cm, it then increases from 60- 80 cm and then decreases (40 – 60cm) The model predicted field capacity show some level of consistence, however, the inconsistence in some values of field capacity to the laboratory measure values could be due to the fact that the prediction is dependent on the values of the laboratory measure independent variables.

The statistical analysis showed that the field capacity is well predicted. (See table 4.2 below).

Soils with good field capacity support plant more, especially when there is break in rainfall, so therefore will require less frequent irrigation. From the table below the field capacity could be said to be fair since it values is below 50% and therefore will require irrigation in cases of long break in rainfall.

Table 4.2 Fc, Mfc, OM, X^2 and particle size analysis values of C-Pit 1

Pd	Fc	Mfc	X^2	Sand	Clay	Silt	OM
0-20	34.5	27.2	2.0	59.1	31.6	9.3	0.5
20 – 40	33.2	28.2	0.9	59.1	36.6	7.3	0.8
40 – 60	32.3	24.1	2.8	63.1	25.6	11.3	1.2
60 – 80	34.8	23.5	5.4	69.1	25.6	5.3	0.3
80 – 100	33.1	24.2	3.3	69.1	27.6	3.3	0.3
				$\sum X^2 1 = 14.342$			

4.3 WATER CONTENT AT WILTING POINT C-PIT 1

The laboratory measured wilting point from 0 – 60 cm and then decreases at 80 – 100cm. The zero wilting point at 60 – 80 cm indicates that the soil was completely dried during the period of one week exposure to atmospheric air. This could be as a result of high sand content, since water content at wilting point decreases with increase in sand and low clay content.

The model predicted values are higher, though they both maintain the same matter of fluctuation down the profile. The statistical analysis showed that the wilting points were not well predicted by the model. (See Table 4.3 below).

Soils with low wilting point loss their water faster and therefore needs to be irrigated more often for crops survival. Considering the model predicted values, the soil could be said to be having high water content at wilting point, and therefore can support plant better especially during breaks rain fall.

Table 4.3 WP, MWp, OM, X^2 and particle size analysis values of C-Pit 1

Pd	Wp	MWp	X^2	Sand	Clay	Silt	OM
0-20	0.8	18.1	16.5	59.1	31.6	9.3	0.5
20 – 40	1.6	19.1	16.0	59.1	36.6	7.3	0.8
40 – 60	1.1	15.4	13.3	63.1	25.6	11.3	1.2
60 – 80	0.0	15.5	15.5	69.1	25.6	5.3	0.3
80 – 100	0.7	16.4	15.0	69.1	27.6	3.3	0.3

$\sum X^2 1 = 76.377$

4.4 SATURATED HYDRAULIC CONDUCTIVITY C-PIT 1

The laboratory measured saturated hydraulic conductivity decreases from 0 – 40 cm. The higher value at the upper part (0 – 20cm) is as a result of relatively high sand and relatively low clay. Conductivity increase with increase in sand and decrease with increase in clay. The lower value from 20 – 40cm is due to relatively high value of clay. The saturated hydraulic conductivity increases from 40 – 100cm; this is as a result of increase in sand low clay content, and lower organic matter content. However, it is difficult to co-relate the laboratory measured values with the model predicted values, since the latter has higher values and manner of fluctuation differs. (See Table 4.4 below). The statistical analysis showed that the Saturated Hydraulic Conductivity is well predicted since it chi^2 value is lower than the table value at 5% and 19^{th} degree of freedom. Soil with hydraulic conductivity values below 0.1m day^{-1} require excessively close drain and spacing and hence some artificial modification of subsoil water movement by moiling or sub-soiling is essential for practical and economic field drainage design, and greatest accuracy in measuring k is required in this range.

In soils with abrupt horizon changes, corresponding changes in the hydraulic conductivity values can have serious effects on the movement of irrigation or drainage water within the profile. Considering the table just below it could be seen that conductivity values are high, so therefore this soil will require more irrigation and less drainage.

Table 4.4 K, MSk, OM, X^2 and particle size analysis values of C-Pit 1

Pd	Sk	MSk	X^2	Sand	Clay	Silt	OM
0 – 20	28.0	19.0	8.4	59.1	31.6	9.3	0.5
20 – 40	13.2	22.0	3.5	59.1	36.6	7.3	0.8
40 – 60	12.7	24.0	5.3	63.1	25.6	11.3	1.2
60 -80	15.1	26.0	4.6	69.1	25.6	5.3	0.3
80 – 100	26.5	21.0	1.4	69.1	27.6	3.3	0.3
				$\sum X^2$ 1 = 23.270			

4.5 BULK DENSITY C – PIT 1

The laboratory measured bulk densities are the same form 0-60cm as the clay content increase from 0-40, but deceases from 60-100 as the sand content increase with increases in clay and the organic matter decreases at the same depth. Bulk density decrease with increase in sand, with increased in clay and also increase with increase in organic content .the laboratory measure values are not the same with the model predicted values but nature of fluctuation of the values down the profile is closely related.

The percentage sand increase downward with the highest values of 69.12 from 60 to 100cm. The clay is highest at the depth of 20-40 cm and is shown by the model predicted textural class as sandy clay (SC) The statistical analysis showed that the bulk density well predicted since it calculated Chi2 values is less than the bulk density is well predicted since it calculated chi value is less than 30.14 chi table value . See table 4.5 below

Bulk density is affected by compaction, the more the compaction the higher the bilk density, and there rate of infiltration is reduce and so the tendency for erosion will be high. Element of compaction include heavy farm machinery and grazing animals considering the table it below it could be see that the bulk density soil is normal.

Table 4.5 ρb, Mρb, OM, X^2 and particle size analysis values of C-pit 1

Pd	ρb	Mρb	X^2	Sand	Clay	Silt	OM
0 – 20	1.5	1.4	0.0	59.1	31.6	9.3	0.5
20 – 40	1.5	1.4	0.0	59.1	36.6	7.3	0.8
40 – 60	1.5	1.5	0.0	63.1	25.6	11.3	1.2
60 – 80	1.4	1.5	0.0	69.1	25.6	5.3	0.3
80 – 100	1.4	1.4	0.0	69.1	25.6	3.3	0.3
			$\sum X^2 1 = 0.0$				

4.6 WATER CONTENT AT SATURATION, AND F.C C- PIT 2

The laboratory measure water content at saturation is highest at 40-60cm, likewise the model predicted and it is lowest at 20-40 for both. This is due to the high sand relatively low silt content. From statistical analysis the predicted saturation values at 5% significance and nineteen degree of freedom is 30.14 which is greater than the chi square. (see table 4.6 below).

Table 4.6 S, MS, FC, MFC, X^2, and particle size analysis values of C- pit 2

Pd	S	Ms	X^2	Fc	Mfc	X^2	OM	Sand	Silt	Clay
0 – 20	40.3	47.8	1.2	37.7	24.8	6.7	1.2	69.1	11.3	25.6
20 – 40	41.2	47.2	0.8	36.9	24.5	6.3	1.0	69.1	11.3	25.6
40 – 60	43.2	48.9	0.7	39.2	27.7	4.8	0.9	63.1	3.3	33.6
60 – 80	41.4	45.8	0.4	40.0	25.2	8.7	0.1	65.1	5.3	29.6
80 - 100	40.9	47.0	0.8	38.9	25.9	6.5	0.5	63.1	7.3	29.6
		$\sum X^2 2 = 3.823$			$\sum X^2 2 = 32.970$					

4.7 WILTING POINT SATURATED HYDRAULIC CONDUCTIVITY AND BULK DENSITY C- PIT 2

The laboratory measure wilting point is highest at 80-100cm. this is as a result of relatively high clay content. The model predicted wilting point is highest at 40-60cm. this could be high clay content.

The highest values of laboratory measure saturated hydraulic conductivity at the depth of 20-40cm & 60-80cm are as a result of high sand content and relatively low clay content. However the model predicted values are not consistent with the laboratory measure values, since the former decreases from 0-80cm and then increases from 80-100cm, the laboratory measure saturated hydraulic conductivity is lowest at 80-100cm. this due to relatively high clay, silt, and organic. Bulk density is highest at 60-80 as a result of high clay. The laboratory measure and model predicted textural classes are the same (SCL).

Table 4.7 Physical Parameters of the Liquid Waste

S/N	Parameters	X	FEPA
1	Temperature (^{O}C)	30.60	40
2	pH	6.50	6 - 9
3	Turbidity (NTU)	9.10	>10
4	Conductivity (μs/cm)	0.48	NS
5	Total Dissolved solids (mg/l)	240.70	2000
6	Oil in water (ppm)	5.63	10

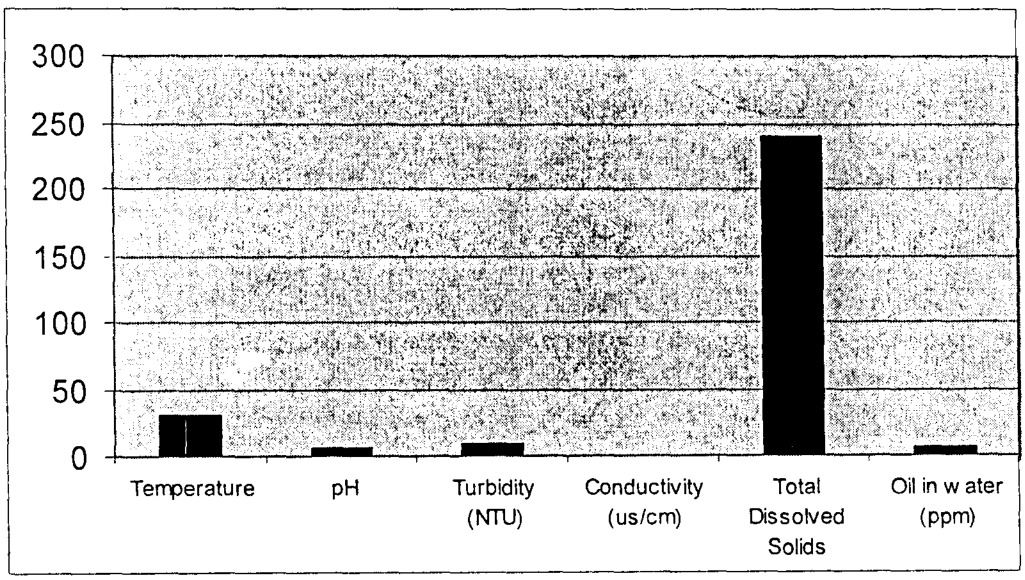

Figure 4.1 Physical Characteristic of the Liquid Waste from Tunga Laundry

Table 4.8 Chemical Parameters of the Liquid Waste

S/No	Parameters	X	FEPA
1	Sulphate (SO_4^{2-}) mg/l	64.30	500
2	Reactive phosphate (PO_4^{3-}) mg/l	0.90	5.0
3	Sulphide (SO^{2-}) mg/l	0.08	0.2
4	Chromium (Cr^{6+}) mg/l	0.45	>0.1
5	Chloride (Cl^{-}) mg/l	110.41	600
6	Total Iron (Fe) mg/l	2.49	20
7	Copper (Cu) mg/l	0.96	1.5
8	Nitrate (NO^{3-}) mg/l	14.00	10
9	Nitrite (NO_2) mg/l	0.22	NS
10	Alkalinity mg/l	ND	NS
11	Chlorine (Cl_2) mg/l	0.46	1.2

NB NS = Not specified ND = Not Detected

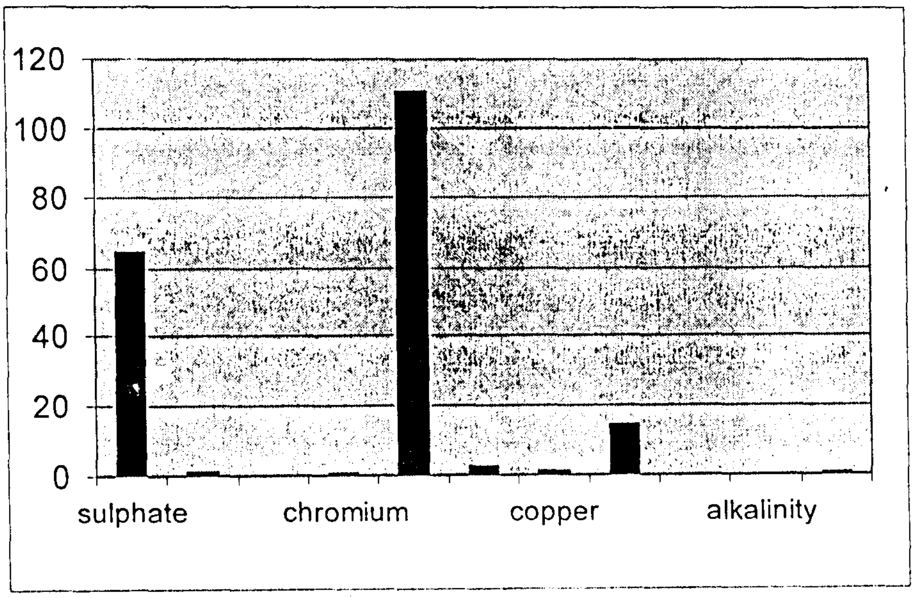

Figure 4.2 Chemical Parameters of the Liquid Waste

Table 4.9 Bacterial Parameters of the Liquid Waste

S/No	Parameters	X	FEPA
1	Chemical Oxygen Demand (COD) mg/l	153.00	80
2	Biochemical Oxygen Demand (BOD) mg/l	98.00	40
3	Dissolved Oxygen (DO) mg/l	3.43	NS

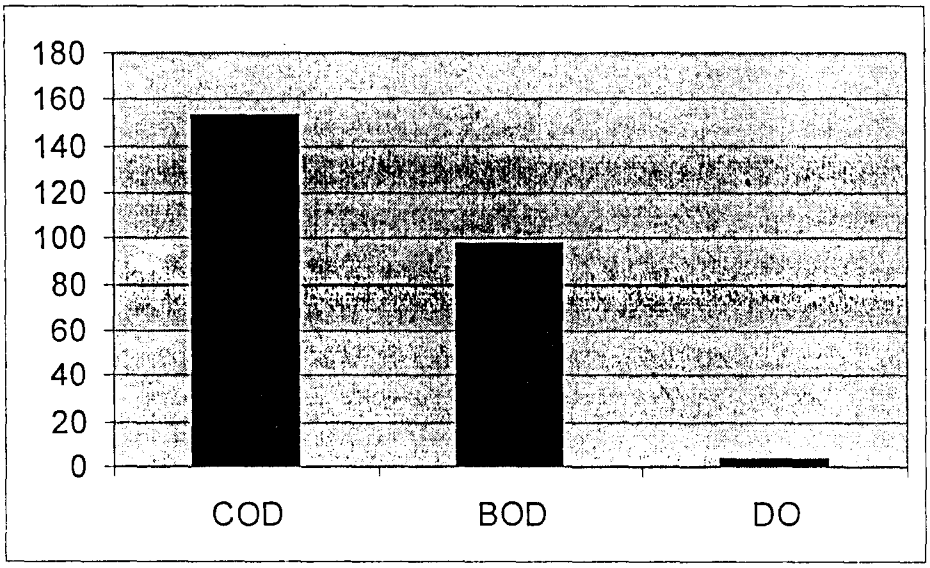

Figure 4.3 Bacterial Parameters of the Liquid Waste

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the result of the analysis and the comparison with FEPA (2007) the allowable recommended values for both soil and water analysis of the laundry waste and the parameters for the saturated hydraulic conductivity of sand, clay and silt soil samples. Based on the result of saturated hydraulic conductivity Ksat measurement using difference Na and surfactant solution, it appears that surfactants in laundry detergent have a greater negative impact on the soil hydraulic conductivity than Na alone. Most surfactant used in the detergent is generally high in Na. Therefore, it is not possible to distinguish whether or not reduction in Ksat is impacted by the replacement of the other content by Na on the soil exchange sites. The soil texture particle size and bulk density are the biggest factors influencing the hydraulic conductivity of soil however if the soil sample had a larger difference in particle size the bulk density and hydraulic conductivity of the soil would have had a greater variation however based on the result of this research and previous work reported by amoozegar (1998) and Amoozegar and Niewohner (1998),the use of waste water from laundry machineries may result in substantial reduction in soil hydraulic conductivity lowering of Ksat around plant root after laundry waste water application may result in local saturation. Which could adversely impact the growth and appearance of ornamental plants did assess it in this research base on previous report by Amoozegar et., al 2004 that the application of a Ca amendment and laundry waste water may reduce the negative impact of Na on soil hydraulic conductivity.

The liquid waste analysis shows that Tunga Laundry waste is at an average M.C. of 27.6% which makes the waste vulnerable to microbial attack especially at the discharge temperature of 30.6^0C. It also observed that the waste is notorious and these may be supplemented with other materials to make a balanced livestock feed Furthermore, the waste can serve as organic manure production and "bio-gas generation" Feken Felder (1989).

The result also shows that out of the 20 parameters examined for the liquid waste (waste solid) the dissolved solid, Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) are significantly different in item of their concentration, which is registered than any other parameters. The COD – 153.00 and BOD – 98.00, exceed the FEPA limits – 80 and 40. These two parameter are potential source of environmental degradation and pollution of receiving streams that may be around the research site.

5.2 Recommendation

Detergents, term applied to materials, the solutions of which aid in the removal of dirt or other foreign matter from contaminated surfaces. Until the 1940s soap only important detergent. Today soap is but one of a great many detergent products. The ingredients of detergents are often called surface active agents, or surfactants, because they act upon a surface. A common feature of detergents is that they are made up of comparatively large molecules (molecular weight over 200) Nicholas (2003). One part of the molecule is soluble in organic material, and the other part is soluble in water.

The management observed that the cost involved as in compliance with this environment pollution control is high, but is not all unreasonable in view of the inherent changes of taking these problem lightly. In addition to the treatment to the liquid of the waste by Tunga Laundry advance treatment of the effluent using ultraviolet radiation methods should be introduce in to the system in system in other to improved the quality of the effluent that is being discharge into the flowing stream. The industry must conform to FEPA limits.

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