ENVIRONMENTAL IMPACT ASSESSMENT OF BREWERY WASTE WATER. (A CASE STUDY OF INTERNATIONAL BEER AND BEVERAGE INDUSTRY, KADUNA)

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A PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUUIREMENT FOR THE AWARD OF POST GRRADUATE DILOMA IN AGRICULTURAL ENGINEERING [SOIL AND WATER ENGINEERING] IN THE DEPARTMENT OF AGRICULTURAL ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

APPROVAL SHEET

This is to certify that this project is an original work being undertaken by Audu A.S. Gatawadata of registration number PGD/AGRIC/97/98/18 0f the Department of Agricultural Engineering under the guidance of Mrs. Z. Osunde and has been prepared in accordance with rules and regulations guiding the preparation and presentation of final year post graduation Diploma Project by Federal university of Technology Minna, academic board.

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DEDICATION

This project is especially dedicated to my beloved wife Madam Zainabu Audu A.S. Gatawadata and children: Hajiya Mama, Salimatu, Ndaliman, Yayaminn and my parents, Alhaji Mansaba and Madam Adama A.S. Gatawada as well as my brothers and sisters. They struggle very hard to get me educated.

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ABSTRACT

This study determines the physical and chemical parameters of Brewery waste water and soil characteristic in International Beer and Beverage Industry Kaduna.

Nine (9) Samples of waste water were taken from three (3) different areas (channel from factory Upstream and downstream), treatments were administered to the water analysis.

Three (3) samples of soils were also taken from three- (3) different areas (channel from factory upstream and down stream), treatments were also administered to the soil analysis.

The analysis carried out on the waste water shown that Dissolved Oxygen (DO) 110.0mg/l, Nitrogen 168.0mg/l and Chemical Oxygen Demand (COD) 165mg/l ranked significantly high compared with the ten (10) parameters .This indicates that there is the danger of environmental degradation if proper treatments are not adopted.

The analysis carried out on the soil shown that values obtained were low which indicated that there is no much danger of environmental degradation.

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CHAPTER ONE

INTRODUCTION

1.0 The last decade marks the growth of interest in the quality of the environment, the depletion of resources and the disruption of the earth's natural ecosystems. The economic and technological advancements over the last generation have brought immense and worth while benefits to millions of a deterioration in our physical environment (Daniel, 1998).

2.0 Maintenance of an environment suited to mans efficient performance and the preservation of comfort and enjoyment of living are the goals for the future in other areas. This level of life and progress can be the basis for action programs in environmental health.

As urbanization increases, mans impact on the environment, and the impact of the environment on man, must be controlled to protect, the human and natural resources essential to life while at the sometime enhance man's well being.

The environment encompasses the aggregate of all the external conditions and influences affecting the life and development of an organism. This includes the air, water and land and the interrelationship that exist among and between them and all livings: (Joseph, etal, 1992).

The major sources of waste can be classified as domestic, industrial, agricultural and shipping waste water. And the typical classification is as follows:

(i) Solid wastes: This is often called the third pollution after air and water pollution, is that material which arises from various human activities and which is normally discarded as useless or unwanted. It consists of the highly heterogeneous mass of discarded materials from the urban community as well the more homogeneous accumulation of agricultural, industrial and mining waste. It also classified based partly on content and partly on mixture and heating value .

(ii) Domestic waste: Consists of waste water from homes and commercial establishments. Also sewage and other oxygen demanding wastes.

1.3. SCOPE

This work includes the study of Brewery waste water (International Beer and Beverage industry, Kaduna) effect on environment.

CHAPTER TWO

2.0 LITERATURE REVIEW

In Thailand, the brewery under investigation is the largest, producing approximately 100,000m3 of beer per annum.

It is located on the cast bank of the Chao Phya River in Thailand and comprises two brewery plants, one large and newer than the other.

Waste water from the factory is discharged without treatment to the Chao Phya River indicated in figure 1. Composite waste from any brewery is a combination of wastes various batch-type operations, its strength and composition vary considerably

2.1 ORIGIN OF BREWERY WASTE

Brewery liquid wastes can be classified as partially or highly contaminated process streams, clean and contaminated storm water, and sanitary waste streams. The brewery generates large volume of waste water from various manufacturing operations. The effluents are polluting being rich in dissolved and suspended substances such as nitrogenous substances, sugar residues of beer, yeast particles of daff (reuse of malt after brewing) and Kieselghur (diatomaceous earth used for improving color of beer). In organic chemicals such as caustic soda, hypochlorites and peroxides, soap and detergents produced from washing and sterilizing of equipment and bottles are also present in the effluents.

Brewery solid waste in the brew houses originates from the following sources:

I .The mashing process where the suspended solid residue called spent grains is produced and sieved off.

ii. The removal of spent Hops from the hopped beer as residual sludge from the whirl –pool tank.

iii. The removal of surplus yeast from the fermenting vessel.

iv. The filter press sludge (Kieselghur) from the clarification tank.

vii. Temperature: Basically important for its effect on the properties e.g. speeding up of chemical reactions, reduction in solubility of gases, taste amplification and odours.

2.3.2. CHEMICAL CHARACTERISTIC

Chemical characteristics tends to be more specific in nature than some of the physical characteristics and are thus more immediately useful in assessing the properties of a sample.

Some chemical characteristics are as follows:

i. P^H: The intensity of acidity or alkalinity of a sample is measured on the P^H scale which actually measure the concentration of hydrogen ions presnt

ii. Alkalinity: Due to presence of bicarbonate HCO_3, carbonate CO_3 or hydroxide OH: Most of the natural alkalinity in waste is due to HCO_3 produced by the action of ground water on limestone or chalk. It is useful in waters and waste in that it provides buffering to result changes in P^H.

iii. Acidity: Most natural waters and domestics sewage are buffered by a carbondioxide and bicarbonate. Carbondioxide acidity is in the P^H range 8.2-4.5, mineral acidity (almost always due to industrial waste).

iv. Hardness: This is property of a water, which prevents lather formation with soap and produces scale in hot water system. It is due the metallic ions .There is no hard water include increased soap consumption and high fuel costs.

v. Nitrogen: This is an important element since biological reaction can only proceed in the presence of sufficient nitrogen.

vi. Dissolved Oxygen (DO): The oxygen in water that is available to support aquatic life and that is used by waste water discharge to a water body. Cold water holds more oxygen in solution than warm water. Gamefish requires at least 4 – 5 mg/l dissolved oxygen and coarse fish will not exist below about

2.4.2 EXCHANGABLE BASES

i. Calcium: In clay soils, the calcium ions from a very high percentage of absorbed cations, the soil becomes well flocculated, that is, the aggregates are able to facilitate good aeration and water infiltration and retention. Calcium compounds are added to acidic soil when its P^H is below 5 to raise it to between P^H 5 and 7 . The presence of calcium raise soil P^H which in turn will increase in exchange capacity and make more nutrients available. It helps in the translocation and storage of carbonhydrate and proteins in to seeds and tubers.

ii. Magnesium: It functions in the soil much as calcium does, and it is an essential constituent of the chlorophyll molecules without which photosynthesis cannot take place. Magnesium – deficient plants show a characteristics cholorosis along the leaf veins and such plants are often started in growth.

iii. Potassium: It is required in relatively large quantities by growing plants because is an important element in connection with soil fertility. It plays important roles in plant metabolism, in carbohydrate formation and translocation of starch to all parts of the plant, and also necessary for the neutralization of organic aids in plants.

Iv Sodium: It is required by some plants but not by all plants. Sodium has an important effect on the quality effect on the quality of irrigation water.

v Cation Exchangeable capacity: These are the ability ofclays and humus to yield cations for plant use. It measures in milliequivalents per 100 grams of soil.

vi Exchangeable Acids: It is the capability of a soil to absorb or fill the positive charges of the soil colloidal with Mg3+ , Al^{2+} , Na and K^+ . Al ions be displaced by leaching with strong salt solutions. Under acid conditions the weathering of clay minerals is accelerated. K is also lost by leaching so that an acids clay remains which is dominated by Al^{3+} with Mg^{2+} .

Vi Base saturation percentage: The proportion of basic cations in percentage on the cation exchange complex is referred to as base saturation percentage. The lower the base saturation percentage, the more acidic a soil is.

2.5.0 ENVIRONMENTAL IMPACT OF WASTE DISPOSAL

Industrial activities is always accompanied with environmental pollution and degradation which is now a global problem. Liquid waste disposals into the surrounding environment without adequate treatment can lead a climax of environmental degradation, economic losses in both aquatic and human resources.

The danger to public health is as a result of consumption of polluted water by innocent and unsuspecting public and the land animals. Sudden pollution can lead to an out right death of the fishes. For example, shell fish thrive in contaminated water and there by becomes toxic to human an beings.

Silt blanket at the stream bottom cut off much of the food supply needed by fishes for survival. Damages also occur through substances that are not toxic like high suspended solids which can cause asphyxiation by informing the gills of the fishes.

Industrial waste and other pollution depletes the Dissolved Oxygen (DO) content needed by aquatic lives. Brewery waste and other industrial food waste of organic origin depletes the DO by consuming it in Biochemical Oxidation reactions. The depletion of oxygen downstream is an important factor of stream pollution. The replenishment of the DO after consumption or reduction follows naturally by recreation of the stream through its surface and by photo synthetic reactions of green aquatic plants. The replenishment is however, hindred by oil – films on the surface or floating suspended solid (SS) which decreases the surface area available. Turbidity colour and suspended solids affects rate of Dissolved replenishment because they diminish light penetration in to the water thereby retarding photosynthesis.

The liquid waste from the breweries are organic in nature and consist of nitrates and phosphates which explains the flourishing of algae on the receiving stream. Algae are microscopic green plants that lives on water and not harmful to man, infact when in limited amounts for they do create oxygen through photosynthesis for other aquatic lives. On proliferation and growth, the algae becomes a unisance and slow

CHAPTER THREE

3.0. MATERIAL AND METHODS

3.1.0 EXPERIMENTAL DESIGN

The specified parameters on water analysis are thirteen in number, considering three different areas and three replicates, which gives on total sample of

13 x 3 x3 = 112.

The specified parameters on the soils analysis are fourteen in number, considering different areas and gives a total sample of 14x3 = 42.

3.1.1 WATER SAMPLING

Water samples from three (3) different areas collected. Plastic containers were used in the sampling. The sample to be taken was used to raise the container three times before the sample was finally taken and each was taken at an interval of one minute. They were taken to the laboratory for analysis.

3.1.2 DETERMINATION OF P^H OF WATER

Apparatus: P^H meter, glass beaker.

Reagents: Buffer solutions P^H 4, 7, and 9.2.

Procedure: The P^H meter was standardised using the butter solution of P^H 4,7 and 9.2.The P^H of the water was then read from the meter when the electrode is inserted into the water sample.

3.1.3 DETERMINATION OF ELECTRICAL CONDUSTIVITY.

Appratus: Conductivity meter, glass beaker.

Reagents: Deionised water, potassium Chloride (KCl).

Procedure: The conductivity meter was standardised using the potassium Chloride and the operating temperature set by using the conductivity meter. The conductivity meter cell was then immersed into the water sample and the conductivity of the water read.

3.1.4 DETERMINATION OF TOTAL DISSOLVED SOLID (TDS).

($K_2 Cr_2 0_4$).

Procedure: The solution employed for the bicarbonate tiltration was employed for the chloride tiltration. One ml of the potassium chromate indicator added to the solution and tiltrated with the silver nitrates solution to the appearance of the first permanent rod colouration. A chloride is determined when a permanent brock red precipitate persists.

3.1.7 Determination of turbidity, dissolved oxygen, chemical oxygen demand, nitrogen, nitrate, copper and total iron are obtained by the use of a computerised spectrophotometer (DR./4000)

3.2.0 SOIL SAMPLING

Soil from three (3) different areas were collected. Composites samples were collected from each area in to a polythene bag, labelled and taken to the laboratory where they were air-died under shade. After drying the soils were then crushed gently with mortar and pistle and sieved with a 2mm sieve.

3.2.1 DETERMINATION OF TEXTURAL NAME

The textural name of the soil was determined using the textural triangle. The percentages of the sand, silt and clay particles were plotted and the textural name read – off. The textural triangle shown in the Table2

3.2.2. DETERMINATION OF SOIL TEXTURE

Apparatus: Measuring cylinders, flasks mechanical stirrer, stop watch, stirring rod, Bouyorcos hydrometer.

Reagents: Distilled water, sodium hexameter phosphate, (calgon) ($Na PO_{36}$), sodium carbonate ($NaC0_3$).

Procedure: 50gms of 2-mm sieved soil was weighed in to a flask. 100ml of calgon and sodium carbonate solution was than added and left for 30 minutes for the completion of the reaction. It was then stirred with the mechanical stirred for 10 to 15 minutes and then pour into a measuring cylinder. Distilled water was added to make up to one – litre mark. The stirring rod was then used to bring back all the soil in to suspension and the stop watch started after stopping the stirring. At 40 seconds, the hydrometer and temperature reading were taken. The suspension was then left on a stable surface and after two (2) hours, the hydrometer and temperature readings were also taken.

The calculation is as follows:

Weight of the soil sample =50g.

Time	Temp. (^{O}F)	Hydrometer reading
40secs	78	33.5
2 hrs	77	15.0

i. Clay percent is given by subtracting the reading at 2 hour taken at 2 hours.

ii. Silt percent is obtained by subtracting the reading at 2 hours from the reading at 40 secs.

iii. Sand percent is obtained by subtracting the reading at 40 seconds from 50.

3.2.3 DETERMINATION OF SOIL P^H

Apparatus: P^H meter, stirring rod, glass beakers, measuring cylinder.

Reagents: Distilled water, 0.0lm CaCl , buffer solution, P^H 4,7 and 9.2.

Procedure: 20gms of 2-mm sieved soil was weighed in duplicate into two beakers. In to one, 20ml of distilled water was added and into another one, 20ml of calcium chlorite (CaCl) was added. They were then stirred for 30 minutes and then left for another 30 minutes after which the P^H were read from the P^H meter. The P^H meter was earlier on standardised using the buffer solution of P^H 4, 7 and 9.2.

3.2.4 DETERMINATION OF ORGANIC CARBON, BY WALKLEY-BLACK METHOD .

Apparatus: Pipette, burrette, measuring cylinder, flasks.

Regents: Sulphuric acid (conc.H_2SO_4)potassium dichromate ($INK_2Cr_20_2$), distilled water , Orthophosphuric acid (Conc. H_3PO_4),Sodium Fluoride (NaF) 0 – Phenanthroline – Ferrous complex indicator, ferrors sulphate ($0.5NFeSO_4$).

ii. DETERMINATION OF CALCIUM (Ca) AND MAGNESIUM (Mg) IN SOIL EXTRACT. (ALTERNATE VERSENATE METHOD).

Apparatus: Burette, pipette, measuring cylinder, flasks.

Reagents: Hydroxylamine hydrochloride, NH_2OH. HCL (10%) sodium hydroxide Na OH (10%), potassium cyanide (KCV) (1%), potassium ferricyanide (KfeCN) (4%), disodium Ethylene Diamine tetraacetic Acid, (Na-EDTA), Ammonium chloride plus Ammonium Hydroxide solution, NH_4 CL – NH OH, murexide indicator, Eriochrome Black T indicator Acetate NH_4 OAC IN (P^H 7.0).

Procedure: 25ml of the soil extract in duplicate were measured into two flasks. Like wire for the to serve as blank. Distilled water was then added in to all the flasks to make up to 150ml. 10ddrops each KCN, KFeCN and NH_4OH. HCL were added in to all the flasks and left for some time for completion of reaction. Into one flask of the soil extract and blank, 15 to 20ml of NH_4Cl – NH_4 OH and 5 drops of Eriochrome indicator were added and then titrated against the Na – EDTA. In to the second flasks, 10 –15ml of NaOH and some quantities of murexide indicator were also added and fitrated against Na – EDTA.

Calcium is determined when the colour changed from orange to purple, and Magnesium was also confirmed when the colour danged from wine red to green.

3.2.7. DETERMINATION OF CATION EXCHANGE CAPACITY.

Apparatus: Funnel, filter paper, flask, flame photometer, measuring cylinder, mechanical shaker.

Reagent: Ammonium Acetate NH_4 OAc In (P^H 7.0),Ethanol 95%,distilled water, sodium AcetaleNH_4OAc IN (P^H8.2), standard solution of sodium 2ppm, 4ppm, 6ppm, 8ppm and 10ppm.

Procedure: 4gms of 2 – mm sieved soil was weighed into a flask and 33ml of NaOAc added. It was shaken for about an hour after which it was then filtered. 33ml of Na OAc was used to leach again three more times. After this 33ml of ethanol was also used to leach soil three times. The decantate was then thrown away and soil was then leaked with NH_4 OAc two times with 33ml and one with 34ml to collect approximately 100ml. The cation Exchange capacity was determined when the

$$= \frac{W_3 - W_2}{W_3 - W_1} \times 100\% .$$

3.3.0 DETERMINATION OF SOIL MOISTURE CONTENT.

Apparatus: Oven, analytical balance, and porcelain dish.

Procedure: The porcelain dish was carefully cleaned and weighed. Then a portion of the soil sample was put in the dish and then weighed. It is then placed in the oven at 105°C for 24 hours after which it was taken out, cooled and then weighed again.

That is weight of container M;

Weight of wet soil and container, M_2

Weight of dry soil + container, M_3

Weight of moisture in the soil sample, $(M_2 - M_3)$.

Weight of dry soil, $(M_3 - M_1)$

Therefore, $Mc = \frac{M_2 - M_3}{M_3 - M_1} \times 100\% = \frac{\text{Weight of moisture}}{\text{Weight of oven dry soil}} \times 100\%$

RESULT FOR SOIL ANALYSIS

TABLE : 3

	PARAMETER	X_O	X_U	X_D
1	Textural name			
A	Sand(%)	65	60	57
B	Silt(%)	12	18	23
C	Clay(%)	23	22	20
2	Soil Texture	Sandy clay loam	loam	Loam
3(a)	P^H(water)	7.3	7.7	7.2
3(b)	P^H(CaCl2)	6.7	6.3	6.6
4	Organic Matter(%)	1.91	0.67	0.50
5	Exchangeable Base			
I	Calcium(Meg/100gms	1.44	0.64	2.88
II	Magnesium(Meg/100gms	2.76	2.37	2.88
III	Potassium(Meg/100gms)	1.67	0.16	0.17
IV	Sodium(Meg/100gms)	0.23	0.11	0.28
6	Cation Exchangeable Capacity(Meg/100gms)	7.58	5.84	5.14
7	Exchangeable Acidity(Meg/100gms	0.02	0.03	0.01
8	Base Saturation(%)	80	56	85
9	Moisture Content(%)	16.6	14.6	20.9

NOTE: X_O =OUTLET
X_U =UPSTREAM
X_D =DOWNSTREAM

CHAPTER FIVE

5.0 DISCUSSION

5.1. WATER ANALYSIS

The result of the water analysis indicates that the P^H value range 6.0. – 7.2, this is within the recommended FAO limit and conforms to FEPA standard of 6 – 9.

Electrical conductivity value range 0.06 – 0.40 Ms/Cm, this conforms with the FAO, 1992 recommended standard of 3.0 Ms/Cm for irrigation use. This indicates that the effluent is not expected to have any salinity related problem as the electrical conductivity gives a good estimation of the dissolved salts.

Alkalinity: It indicates the presence of carbonates and bicarbonates in water. High carbonate level leads to encrustation in plant when the effluent is used for Agricultural purposes like irritation. Sufficient alkalinity in bathing water can cause eye irrigation. The experiment result does not detect carbonate.

Chloride: Value ranges between 0.6 – 1.7 mg/l which is within FAO 1992 (300mg/l), FEPA 1990 (600 mg/l) and WHO recommended values. Chlorides are generally limited to 250mg/l in supplies of water for public use. Chloride ion are absorbed by plant tissues and accumulate in the leaves resulting in leaf burns when present in excessive amount.

Turbidity: Is the estimate of suspended matter and its value is within 7.5 – 43.9 NTU, recommended a values from 50 –70 NTU, WHO 25 NTU and FAO 4-6 NTU. High turbidity above regulation can be responsible for a high deposition of suspended matter down stream, filling of natural aquifer, filling of passage drains and increased high cost of water purification in terms of separation process filtration ion and sedimentation) if at down stream after treatment is used for irrigation, the suspended matter can be good for plant growth.

Dissolved Oxygen: has a value of 40.5 –110 mg/l which above FAO limit of 6 .0 mg/l. Its presence is essential to maintain the higher forms of biological life. For boiler feed water, dissolved oxygen is undesirable because its presence increases the risk of corrosion. It indicates a potential sources of oxidation of organic matter and life matter support when the concentration is high. Cold water holes more oxygen in solution than warm water. The effluent is always warm at point of discharge.

5.2 SOIL ANALYSIS

- The result of the soil analysis indicated that P^H values of water ranges 7.2 –7.7 and values of calcium chloride ($CaCl_2$) range from 6.3 –6.7. From the result, the soils are acidic.

Organic matter: The values range 0.50 –1.91%. Although these percentages are small and has a very significant effect on the soil properties and also on plants growth. Xo (1.91%) value should been as a result of raw materials been used.

Calcium: has values within 0.64 –2.88meq/100gms. It can be added to acidic form when its P^H is below 5 to raise it to between P^H6 and 7 in order to increase bacteriological activities. Calciumdeficiency as a plant nutrient is rare, abundant in plants leaves and helps in the translocation and storage carbonhydrate.

Magnesium: The experimental analysis gives a result of 1.03 – 2.76 Meq/100gms. Magnesium – deficient plants show a characteristics cholorosis along the leaf veins. Such plants are often stunted in growth.

Potassium: It is required in relatively large quantities by growing plants, plays important roles in plant metabolizing in carbonhydrate formation and translocation of starch to all parts of the plant. The values range between 0.16 – 1.67meq/100gms. It is higher at Xo 1.67meq/100gms due to deposition of element.

Sodium - The values within 0.11 – 0.28meq/100gms. It is element that required by some plants but not all plants and has effect on the quality of irrigation water. Cation Exchangeable capacity (CEC) – the values range 5.14 – 7.58 meq/100gms. These low values are manifestation of the low organic matter content and the long period of weathering.

Exchangeable Acidity: The result collected were low which values range from 0.01

- 0.02meg/100gms. The soils of the areas were low in exchangeable acidity.
- Base Saturation Percentage (BSP): the lower the base saturation percentage, the more acidic a soil is. The values obtained were a little bit high, the ranges being 56 – 85%.
- Moisture content: the values range between 14.6 – 20.9%.

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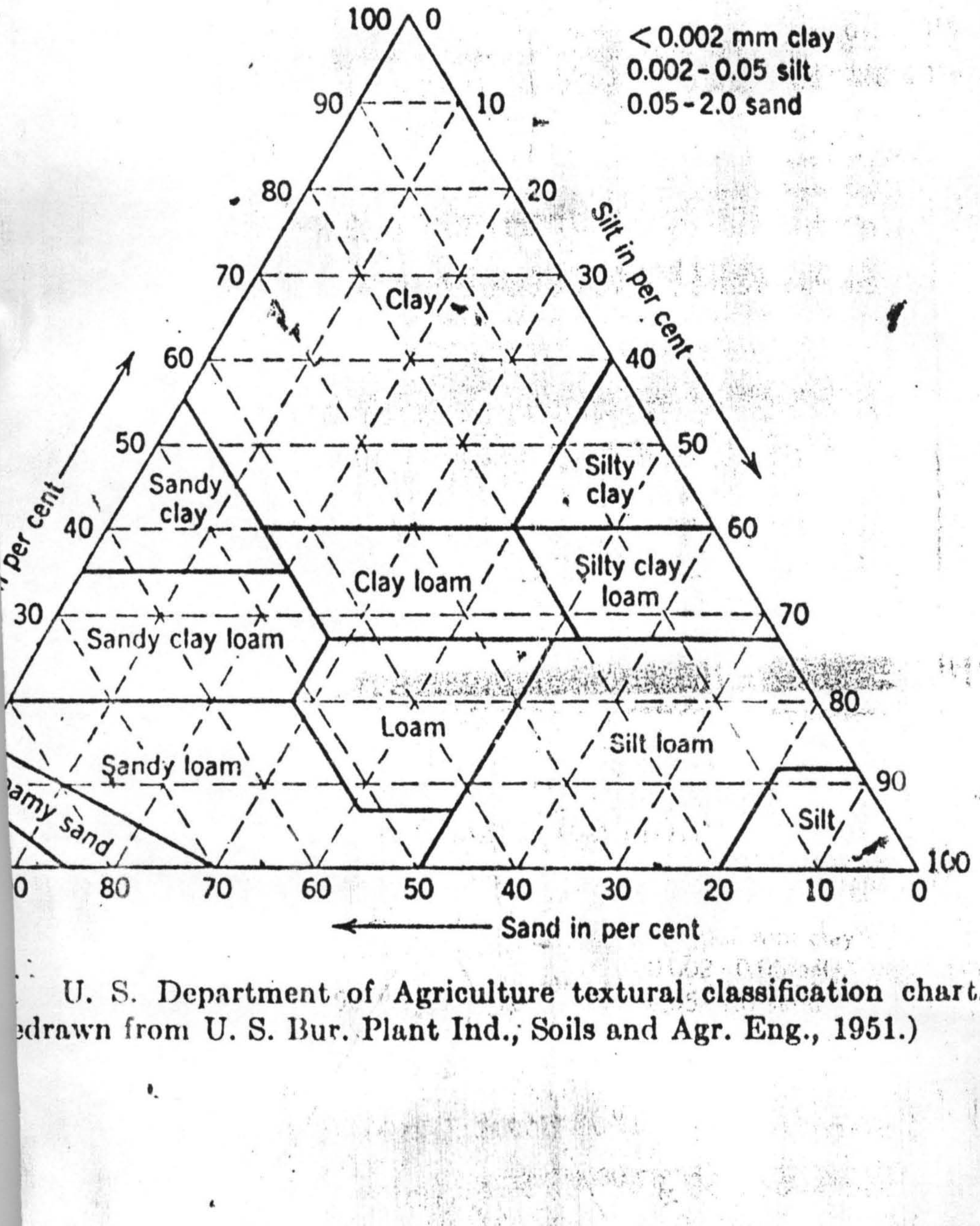
TABLE 1: FIFTY AND EIGHTY PRECENTILE QUALITY LEVELS OF BREWERY WASTEWATER STREAMS																					
		NEW BREWERY SAMPLING STATION										OLD BREWERY SAMPLING STATION									
WASTEWATER		N1		N2		N3		N4		N5		N6		O1		O2		O3		O4	
CHARACTERISTICS	UNIT	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%
BODS	mg/l	100	310	600	920	2	4	0	3	2	10	1250	3200	185	400	52	95	86	190	700	2490
COD	mg/l	150	400	680	1100	15	50	7	24	28	74	6700	400	400	1100	100	180	180	370	900	3400
SUSP.SOLIDS	mg/l	66	130	120	230	55	150	27	62	49	98	1700	90	90	145	69	110	68	125	280	660
TOTAL SOLIDS	mg/l	470	800	1350	1950	480	700	320	460	610	1300	2800	840	1400	760	760	1100	580	790	1300	3000
PH		9.5	10.4	11.5	11.8	8.0	9.0	6.9	7.7	8.2	9.6	8.0	9.5	10.3	9.8	10.7	8.1	8.1	8.2	7.0	7.8
	mg/l asCaCo3	400	650	1050	1240	270	275	285	300	300	400	450	615	450	615	530	240	240	290	185	280
BOD/COD (50 PERCENTILE VALUES)		0.66		0.88								0.58		0.46		0.52		0.47		0.77	

SOURCE: KRITON CURL
ENVIRONMENTAL ENGINEERING SYMPOSIUM, ISTANBUL.

TEXTURAL CLASSIFICATION



U. S. Department of Agriculture textural classification chart. edrawn from U. S. Bur. Plant Ind., Soils and Agr. Eng., 1951.)