ANALYSIS AND TREATMENT STUDY OF DAIRY WASTE WATER

PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING IN CIVIL ENGINEERING OF THE BHARATHIYAR UNIVERSITY, COIMBATORE-46

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1989-90

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Certificate

This is to certify that the Report entitled

Analysis and Treatment Study of Dairy Waste Water

has been submitted by

Mr ______________________________

in partial fulfilment for the award of Bachelor of Engineering in the Civil Engineering Branch of the Bharathiyar University, Coimbatore-641 046 during the academic year 1989-90

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ACKNOWLEGEMENT

The author wish to record their appreciation and gratitude to **Er. GUNASEKARAN B.E** and **Er. V.SELVAN B.E** A.M.I.E Faculty, the department of Civil Engineering for their unflinching support judicious counselling and perspicuous guidance given to us.

We are extremely obliged to **Mr. RAVIKUMAR** Dairy Engineer and all other staff members of The Coimbatore District co-operative milk producers union Ltd. for the valuable helps and suggestion rended by them then and there.

We wish to take the Privilege of Thanking **Prof N.S. MONI B.E, M.Sc (Engg) H.O.D** of Civil Engineering for permitting and encouraging us to carry out this project.

We would be failing in our duty if we do not express out gratitude to our principal **Prof R. PALANIVELU MSc (Engg)** for his kind patronage and inspiration.

We would like to thank all the staff members of Civil Engineering department for their kind co-operation given to us for the successful completion of the project.

CONTENTS

SYNOPSIS

The modern world which is already heavily industrialized, and further developments in the field of industry, Science and technology may definitely pose problem in the treatment and disposal of wastes. The numer of spiralling chimneys in a country while indicating the prosperity also indicates the amount of pollution in that place. For people to lead a healthy life, pollution has to be eradicated. Also it is a well known fact that we now itself face the problems of pollution through many sources and we are trying to invade pollution. Hence the field of environmental engineering is going to play a vital role in the development of the country, concerning the health of the people.. So we feel ourself proud to choose a project in the field of Environmental Engineering. We have chosen our Project "ANALYSIS AND TREATMENT Study of Dairy Waste".

AIM:

This project aims at treatment process that can be gien to a dairy waste. This increases the load in the Municipal waste and hence, we aim at giving a new treatment process, which can work with required efficiency.

To find the physical and chemical characterisation of the Sewage the analysis is carried out. The procedure adopted for analysis is based on the standard methods. The analysis was done for

1) PH
2) Total Solids
3) Alkalinity
4) Acidity
5) Biological Oxygen demand
6) Hardness
7) Chlorides.

Based on the results mainly on total solids and B.O.D., treatment process are suggested. Following are the units suggested.

1) Grit Chamber
2) Skimming tank
3) Equalisation Tank
4) Primary settling tank -
5) Trickling filter
6) Oxidation pond

The complete treatment process suggested here should be checked for its acceptability by conducting laboratory and pilot plant studies for the dairy waste.

CHAPTER - I

INTRODUCTION

1.1 GENERAL:

Every community produces both liquid and solid wastes. The liquid portion waste water is essentially the water supply of the community after it has been fouled by a variety of uses. Waste water is defined as a combination of liquid (or) water which carries wastes are removed mainly from residence, institutions, commercial and industrial establishment, together with such ground water, surface water and storm water may be present.

The ultimate disposal of waste water can only be on to the land or into the water. Wastes find their way into the air, also. These changes the natures equilibrium. Pollution is not a threat but, the effect of pollution due to various activities create enormous problem. But the intensity of pollution then was not so heavy, demanding any treatment before disposal. But the problem of pollution is now to fold-treating the waste adequately meeting the standards and disposing it off effectievely without causing nuisance with the available sources.

Since, most of the cities where industries are concentrated or situated on the banks of river, the disposal of the wastes are done usually in the river causing heavy pollution of the river water making the same unfit for best usage. Through the streams can assimilate to an extent some quantity of particulr waste, it may lead to polluted state and septic due to many factors like concentration of pollutants, quantity and self purifying capacity of streams etc, and the consequence is more nuisance than resourceful utilty factor.

Milk is collected from farmers and different milk foods are produced from it. Large quantity of waste water originates due to differentoperation. The organic substances in the waste comes in the form in which they were present in milk. Mainly the waste water are due to washing of bottling plants, cheese plant, butter plants etc., and also by washing the cans obtained from farmers. These waste contain larger amount of organic substances. The liquid wastes originate out of rinse and washing of bottles , cans and equipments. Thus contain milk dippings and chemicals used for cleaning containers and equipments. (Waste water from casein plants include mainly the discarded and the waste water used for cleaning equipments, floors etc.

Ruttermilk and wash waters are used to clean the churns and small quantity of butter comes out as the wall from the butter plant&casein plants. (creamery process). The dairy waste's are very often discharged intermittently. The nature and composition of waste also depends on the types of products produced and size of the plants. Mainly the waste contains pH, Alkalinity, Total solids suspended solids, BOD, COD, Total Nitrogen Phosphorous oil and gease, chlorides etc.

The wastes which carry bacteria are responsible for tuberculosis. Though alkaline in fresh condition the waste becomes acidic due to decomposition of lactose into latic acid under anaeorobic condition. This precipitates casein from the waste, which decompress further into a highly odourous black sludge. The dairy waste is found to be toxic to fishes. These waste when discharged into sewer cause corrosion of the sewers and reducing the carrying capacity of sewer.

As the BOD and COD ratio are less in dairy waste can be treated by biological processes. A provision of grease trap is also necessary as a pretreatment to remove fat and other greasy substances from the waste. An aeration for a say prevents the formation of lactic acid and reduces the BOD by 50%.

Oxidation diteh aerated Lagoon, waste stabilisation pond etc has (less maintenance) Oxidation ditches in India is designed with a low organic loading (0.2Kg/Kg of MLSS) for period of alteration 1.5days. Reduction of BOD is 97% In stabilisation pond BOD reduces to 52 to 74% (12 days) loading of 550 to 585Kg/hectare/day.

In lagooning method for 7 days BOD reduction is 95% of 3m depth. Loading 0.48Kg/m^3/day. Dairy waste after treated in a er ated Lagoon is used for irrigation purposes. This is also be a good result for disposing the Dairy Waste.

1.2 ORIGIN AND CHARACTERSTICS OF DAIRY WASTE

Dairies collect the milk from the producers, and either simply bottle it for marketing, or produce different milk foods according to their capabilities Large quantity of waste water originates due to their capacities and their different operations. The organic substances in the wastes comes either in the form in which they were present in milk or in a degrade form due to their precastings. As such the dairy wastes, through biodegradable, are very strong nature.

The liquid wastes from a large dairy originate from the following sections or plants receiving station, bottling plant, cheese plant, butter plant, casein plants, condensed milk plant, dried milk plant, and ice cream plant. Waste also comes from water softening plant and from bottle and can washing plants.

At the receiving stations the milk is received from the farm and after inspection the same is emptied into large containers for transport to bottling (or) other processing plants. The empty cans are rinsed, washed, starilized and are returned to the farmers.

At the bottling plant, the raw milk delivered by the receiving station is stored. The processing includes cooling classification, filtration pasteurization and bottling.

In the above two sections the liquid wastes originate out of rinse and washings of bottles cans and equipments and thus contain milk drippings and chemicals used for cleaning containers and equipments.

In a cheese plant, the skimmed milk is pasteruized and cooled and placed in a vat, where a starter. (lactic acid producing bacterial culture) are added.

This separates the casien of the milk in the form of curd. The whey is then with drawn and the curd compressed to allow excess whey to drain out. Waste water from this plant include mainly the discarded whey and the wash water used for cleaning vats, equipments, floors etc. In the creamery process, buttermilk and wash waters used to clean the churns and small quantity of butter comes out as the waste from the butter plants.

In addition to the wastes from all the above milk processing units, some amount of uncontaminated cooling water comes as wastes, these are very often recirculated.

The dairy wastes are very often discharged intermittenly the nature and composition of waste also depend on the types of products produced and the size of the plants. For a typical Indian dairy handling about 3-4,00,000 lit of milk in a day.

1.3 DISPOSAL OF DAIRY WASTE

We have three alternatives for the disposal of dairy waste.

(i) Direct disposal of dairy waste on land without any treatment.

(ii) Discharge of the waste into the municipal sewers for combined treatment.

(iii) Separate treatment of the industrial wastes before discharging the same into the waster bodies. The selection of a particular process depends on various factors like,

1. Self-purification capacity of the streams.

2. Permissible limits of the pollutants in the water bodies established by law.

3. Economic interess of both the municipalties and the industries.

4. Technical advantages, if any in mixing the industrial wastes with domestic sewages.

1.4 POLLUTION DUE TO DAIRY WASTES

The milk solids present in dairy waste water contains butter fat, casein and other milk proteins like lactose and inorganic salts. These components may be present in the form of solution (or) as a collidal suspension depending on the type of Process applied to the milk. Milk and its by products are of high polluting nature because of the high BOD. The presence of milk in water has a marked deoxygenating charactor caused by the biological activity. As this activity progresses the oxygen present in the water is consumed and this results to an aerobic condition, allowing proteolysis (proteolysis is nothing but spliting of proteins by enzymes) of casein present and the production of objectionable colours. This deoxygenating effect of milk in water causes serious consequences for adequate plant and marine life.

Thus it is, very important that untreated milk waste are not directly discharged into streams and nallas. In addition to milk solids a dairy waste water may also contain chemicals, used in the plant cleaning operation. It contains caustic soda, phosporic acid, nitric acid, ammmonium compounds and stabilizing agents including sodium hypochloride. The detergents normally used have low concentrations and they do not provide any significannt pollutional loads. But they are important in the sense and they have an influence on the pH value of the effluent which in turn influences the biological treatment.

1. PURPOSE AND SCOPE OF THIS PROJECT

The main purpose of studying the characteristics is to examine the degree of polluting powder of dairy waste, and to determine the required

Treatments in order to neutralise or purify the wastages. Also this is necessary to reduce the value of BOD to 50ppm is the effluent is discharged intc the municipal sewer system.

In our treatment the maximum amount of the solid particles are settled in the fedimentation tanks, because these solid particles may adhere to the walls of sewers and erode the surface are; these may also cause silting the above treatment can be done more efficiently by providing some additional units like

flash mixel etc the sludge obtained from these tanks can be effectively used as fertilizer. For this purpose the sludge obtained should be dried on a sludge Drying Bed for a certain period.

If the BOD value is further reduced to 30ppm means the final effluent water can be used for cultivation purposes.

The quantity of wastages obtained from manufacture of by products here (the Coimbatore District Milk Producers Union Ltd) is very less as compared with milk processing water. So a separate study may also be made if the quantity of wastages from by products manufacture is considerably increased.

1.6 EFFECTS OF WATER

The normal life of the stream is affected by the following factors.

1. Grease and oil
2. Suspended solids
3. Organic matter
4. Alkalis

1.6.1. GREASE AND OIL

These make the river unsighty and the passage of light through the water, retarding the vital plant food. Specific objections to oil in streams are;

1) If creats a fire hazard when present in water surface in sufficient amount.

2) If causes trouble in water treatment

3) It renders boiler feed and cooling water unstable

4) If lowers recreational interest

5) If creates an unsightly film on the surface of water.

6) It destroys vegetation

7) It is toxic to certain species of fish and acquatic life.

8) It interfers with natural reacration.

1.6.2. SUSPENDED SOLIDS

Settles at the bottom of the river where the velocity of the river is reduced to 3m/sec. The settled sludge at the bottom decomposes aerobically. This condition may lead to production of colour and unsighty conditions. During heavy floods deposited sludge may be scoped up causing an oxygen demand. Fishes often die due to lowering of oxygen content and solids settled at the bottom will cover their spinning grounds and inhibit propogation. Sludge settled at the bank of the river causes unsightly condition. The solids also increase the turbidity of water and in turn affecting the transmission of sun rays. Accumulation of sludge may enhance flooding by reducing the stream bed volume.

1.6.3 ORGANIC LOADING

Organic matter exhausts the oxygen resources of rivers and creates unpleasant taste and odours and general septic conditions. Fish and most acquatic life are stifled by lack of oxygen and the oxygen level, combined with other stream conditions, determines the life or death of fish. It is generally conceded that the critical range for fish survial is 3 to 4 parts/million of dissolved oxygen. This oxygen shortage, caused by organic matter, is other considered to be the most objectionable single actor in stream pollution. Some of the organics may impart objectionable taste to water.

1.6.4 ALKALIS

Alkalis is discharged by industrial parts make a stream unsuitable not only for recreational uses but also for propagation of fish and acquatic life. It is generally agreed that the pH of the stream must be not less than 4.5 and not more than 9.5. If fishes are to survive. Alkaline water causes skin irritation and burns to swimmers.

In high pH value toxic gases like ammonia may be prevalent in free form. The high pH is responsible for increasing the suspended solids in the stream due to chemical precipitation of carbonates of calcium, resulting in the increase of solids in water body.

1.7 TREATMENT OF THE DAIRY WASTES

An evident from the low COD BOD ratio the dairy wastes can be treated efficiently by biological process. Moreover these wastes contain sufficient nutrients for bacterial growth. But for economical reasons attempt should be made to reduce volume and strength of the waste. This may be accomplished by

i) The prevention of spilts, leakages and dropping of milks from cans.

ii) By reducing the amount of water for washer

iii) By segregating the uncontaminated cooling water

iv) By utilising the butter milk and whey for the production of dairy by products of good market value.

The conventional methods generally used, which are most effective one.

(i) Aeration

(ii) Trickling filteration

(iii) Activated sludge process

(iv) Irrigation

(v) Lagooning

(vi) An Anaerobic digestion

Due to the intermittent nature of the waste discharge it is desirable to provide Equalization tank, with or without ceration, before the same is gent for biological treatment. A provision of grease trap is also necessary as a pretreatment to remove fat and othe rgreasy substances from the waste. An aeration for a day not only prevents the formation of lathic acid, but also reduces the BOD by about 50%.

Both fish rate trickling filters, and activated sludge plants can be employed very effectively for a complete treatment of the dairy waste. But these conventional methods involve much maintenance, skilled personnel, and special type of equipments. On the other hand the low cost treatment methods like oxidation ditch, Aerated sludge waste stabilisation pond etc. Can be employed with simpler type of equipments and less maintenance.

Oxidation ditches in India may be designed with a low organic loading (about 0.2Kg (Kg of MLSS) high biological mass concentration (in the order of 4000mg/l/ and extended period of aeration (in the order of 1.5 days) for BOD reduction of about 95 to 98%.

In a waste stabilisation pond a BOD reduction of 52 to 74% Could be achieved after 12 days of retention and an organic loading of 550 to 585 Kg/ hectare/day.

BOD reduction of about 90% may be obtained with a rention time of 7 days and a depth in the order of 3m, in an anarobic lagoon. An organic loading in the order of 0.48Kg/m^3/day is suggested for the above.

Use of dairy waste for irrigation after primary treatment in an aerated lagoon may also be good answer for the disposal of Dairy Waste.

CLASSIFICATION OF TREATMENT METHODS

The contaminants in waste water are removed by physical, chemical and biological means. The individual methods usually are classified as physical unitoperations, chemicla unit processes and biological unit process.

PHYSICAL UNIT

Treatment methods in which the application of physical forces predominate are known as physical unit operations. Because most of these methods evolved directly from man's first observations of nature. They were the first to be used for waste water treatment screening, mixing, floculation Sedimentation flotation and filtration are typical unit operations.

CHEMICAL UNIT PROCESS

Treatment methods in which the removal or conversion of contaminants is brought about by the addition of chemicals or by other chemical reactions are known as chemical unit process. Precipitation gas transfer, adsorption, and disinfection are the most common examples used in waste water treatment. In chemical percipitation, treatment is accomplished by producing a chemical precipitate that will settle.

BIOLOGICAL UNIT PROCESS

Treatment methods in which the removal of contaminants is brought about by biological activity are known as biological unit process. Biological treatment is used primarily to remove the biodegradable organic substances (colloidal (or) dissolved) in waste water. Basically these substances are converted into gases that can escape to the atmosphere and into biological cell tissue that can be removed by settling.

CHAPTER - 2

WASTE COLLECTION, CHARACTERISATION ANALYTICAL DETERMINATION AND EXPERIMENTAL STUDY

2.1 COLLECTION OF SAMPLE FOR ANALYSIS

The composite samples of the dairy waste was collected for examination. The samples are collected at different outlets.

The dairy waste consisted of the flush out of the pipes with Nitric acid (2 litres) caustic soda (4 kg) and water (5001) and of can washing -1.5 lakhs lit of water the quantity of flow of milk daily was found to be 60,000 litres.

We collected the samples from the common drains at a point where the flow of waste is likely to be most representative of the entire volume of mixing.

Care was taken whiles handling samples in such a way to maintain the proportion of suspended solids. Glass bottle were used to collect the samples with tight cork to hold on its top. The bottles were initially cleaned and dried thoroughly.

The samples were collected in the bottles at 10 A.M and preserved at low temperature (5°C) by incubator. The sample obtained for the analysis prupose were likely to be more than 10 litres. The samples required for analysis pruposes were thoroughly mixed to keep the solids in suspension and further analysis was carried out.

2.2 MATERIALS

2.2.1 WASTE SAMPLE

The waste sample used in this experimental work was obtained from Coimbatore milk society and brought to the laboratory for study purpose.

2.3 ANALITICAL DETERMINATION

2.3.1 pH MEASUREMENT

This process of finding out the pH value is

First we have to connect the three pin plug to a 230 volts 50Hz main with the mode switch back panel in pH. The instrument should be in position. Then select the range switch to pH position. After that the electrode with distilled water and connect the chanel electrode in the socket provided in the front panel. Ta[illegible] the buffer solution 7pH in a clean beaker and set the temperature of the solution using temperature knob. Adjusting the standadise knob so that the display reads 7pH. Then cleaning the electrode and dip it in 4pH solution now using the constant maker '9' Set the display to read. Dip it set the temperature solution. The value on the display indicates the pH value in the question.

2.3.2 ESTIMATION OF ALKALINITY

Standard sulphuric acid N/50:

6ml of concentrated sulphuric acid was diluted to 1 litre. The sulphuric acid was standardised again standard sodium carbonate solution and then properly diluted to get N/50 solution.

(a) PHENOLPHTALEIN INDICATORE

Five gram of phenolphthalein was dissolved in 500ml 9.95 percent ethyl alcohol and diluted to 1 litre with distilled water.

(b) METHYL ORANGE INDICATOR

Methyl orange 0.59 was dissolved in carbon-di-oxide free distilled water and the volums was raised to 1 litre.

ALKALINITY PROCEDURE

Take 20ml sample is taken in two conical flask.

2. In one flask 0.5ml phnolpthalin indicator is added

3. If the sample becomes pink titrate with 0.02N sulphuric acid from the Burette until the pink colour just disapears.

4. The quantity of ml used is noted

5. In both flask 2 drops of methyl orange indicator is added and one of them is Titrated with 0.02N sulphuric acid. The end point is orange. The end point can be best judged by compain with the plain one.

6. The ml of acid used is recorded

   Let P = ml of acid used for the fitration with Phenolpthalin

2.3.3. DETERMINATION OF TOTAL SOLIDS, DISSOLVED SOLIDS AND SUSPENDED SOLIDS

PROCEDURE (A) TOTAL SOLIDS

The empty weight of silica crusible is taken by using a physical balance. 25ml of the given sample is taken in a dry crusible and evaporated to dryness by using water bath at 103°C to 105°C

The container is cooled to dryness in a dissicator the increase in weight is noted.

$$\text{Total Solids} = \frac{\text{Mg of residue} \times 1000}{\text{Volume of sample}} \text{ Mg/lit}$$

SUSPENDED SOLIDS AND DISSOLVED SOLIDS

The given sample is filtered through a water man filter paper. 25ml of the filtered sample is taken in a weighed dry crusible and evaporated to dryness by using a water bath at 103°C to 1C °c.

The container is cooled to dryness a dissicator

The increase in weight is noted

$$\text{Dissolved solids} = \frac{\text{Mg of resider x 1000}}{\text{Volume of sample}} \text{ mg / lit}$$

Suspended solids = (total solids - Dissolved Solids) Mg/lit

2.3.4 BIOCHEMICAL OXYGEN DEMAND

BOD refers to the quantity of oxygen required by bacteria and other microorganisms in the biochemical degradation and transformation of organic matter under aerobic conditions.

TEMPERATURE

Apart from all temperature is an important factor in the determination of BOD. The standard temperature for the test is 20°C. The temperature should be kept constant throughout the 5 day period Even slight increase (or) decrease of 1°C causes increase (or) decreasing of BOD 4.7%.

PRECAUTIONS TO BE OBSERVED

Sample must be free from all added

preservatives. The test should be performed as soon as possible after the sample has been collected. When it is impracticable to conduct the test immediately samples can be stored at 5°C on any account, samples should not be stored at room temperature.

DILUTION METHOD

PRINCIPLE

The dissolved content of the sample is determined before and after five days at 20°C. Samples devoid of oxygen, or containing less amount of oxygen are diluted several times with special type of dilution water staturated with oxygen in order to provide sufficient amount of oxygen for oxidation.

REAGENTS

Use good quality distilled water containing less than 10Mg/l copper and free from chloride.

(1) CALCIUM CHLORIDE SOLUTION

Dissolve 27.59 anhydrous calcium chloride $CaCl_2$ in distilled water and dilute to 1000ml.

2. MAGNESIUM SULPHATE SOLUTION

Dissolve 25g magnesium sulphate hepta hydrate MgSo4 7H2O in distilled water and dilute to 1000ml.

3. FERRIC CHLORIDE SOLUTION

Dissolve 0.25g ferric chloride hexa hydrate FeCl2 6H2O in distilled water and dilute to 1000ml.

4. PHOSPHATE BUFFER SOLUTION

Dissolve 8.59 potassium dihydrogin Phosphate KH2PO4, 21.75g dipotassium hydrogen phosphate, K2HPO4 33.49 disodium - hydrogen phosphate hepta hydrate, Na2HPO4 7H2O, and 1.79 ammonium - chloride. NH4cl in 500ml. Distilled water and make up to 1000ml. The pH of this butter solution should be 7.2.

5. STARCH INDICATOR

Starch powder 0.5gm was dissolved in a minimum volume of distilled water and purred into 100ml of boiling water. It was boiled for few minutes, cooled and used.

6. SODIUM THIOSULPHATE SOLUTION 0.1N

Sodium thiosulphate ($Na_2S_2O_3$, $5H_2O$) 24.82 gms was dissolved in boiled and cooled distilled water and dilute to 1 litre. The solution was standardised against standard potasium dichromate and preserved by adding 5 ml of chloroform.

SODIUM THIOSULPHATE TITRANT 0.025N

The 0.1N sodium thiosulphate solution 250ml was diluted to 1 litre with freshly boiled and cooled distilled water. This solution was also presented by adding 5ml of chloroform.

The disolved oxygen was calculated from the formula.

$$\text{D.O in mg/lit} = \frac{\text{volume of sodium thiosulphate consumed} \times \text{normality} \times 8000}{\text{Volume of sample}}$$

THE BOD in ppm was then worked out by the following 5 day

BOD = (Initial DO - final DO) x dilution ratio in DPM

PROCEDURE FOR DISSOLVED OXYGEN

Collect the sample in a 300ml BOD bottle with care. For the collection of samples for DO and BOD determination special sampling devices are necessary. Add 2ml manganous sulphate solution, followed by the addition for 2ml alkali iodide-azide solution. The tip of the pippet should be below the surface of the liquid. Stopper the bottle without entrainment of air and mix by inverting the bottle atleast about 10 times.

Allow the precipitate to settle completely leaving a clear supernatant liquid. Carefully remove the stopper and add 2ml conc. H_2SO_4 by the side of the bottle. Stopper the bottle and mix throughly until dissolution is complete. Messure 203ml of the solution from bottle into a conical flask of 500ml capacity. Titrate immediately with 0.025N sodium thiosulphate solution using starch as indicator.

2.3.5. DETERMINATION OF HARDNESS

Standardisation of EDTA by standardisation hard water solution. The burette is washed with water and rinsed with distilled water and finally rinsed with EDTA solution. It is filled with the same EDTA upto zero mark. The initial burette reading is noted. The 20ml pipette is washed with distilled water and then rainsed with a given standard hard water solution. Exactly 20ml of it is pipetted out into a clean. Conical flask about 20ml of ammonia buffer solute is added. A pinesh of solid erichrom black T indicator is also added to the flask. The colour becomes wine red The contents of the flask are filtrated against EDTA solution from the burette. The end point in change of colour from wire red to blue the burrette reading is noted. The filtration is repeated to get concordent values. The EDTA solution is standardised.

Estimation of hardness of sample water. the burette is filled with same EDTA solution. Upto zero . A 50 ml pipette is washed with distilled water and rinsed with sample of hard water. Exactely 50 ml of hardwater is pipetted put into a conical flask and 10 ml of buffer solution is added. A pinch erichrome black-T is added. The contents of flask are filtrated against the EDTA solution taken in the buffer. The end point colour change from wire red to blue. then burette reading is noted.

2.3.6 DETERMINATION OF CHLORIDES:

Procedure:

1) The given standard silver nitrate solution is taken in the burette.

2) About 20 ml of the sample is taken in a conical flask.

3) Add 2 or 3 drops of pottasium chromate indicator into the conical flask.

4) The sample is titrated against 0.02 N silver nitrate solution.

5) The sharp appearance of brick red pricipitation is the end.

6) Note down the volume of silver nitrate solution used.

7) The above procedure is repeated until you will get concordant value.

8) The amount of chlorides present in the given sample calculated.

2.3.7 DETERMINATION OF ACIDITY

Reagent:

Methil orange Indicator.

Dissolve 50 mg of methyl orange powder in distilled water and dilute to 100 ml.

PROCEDURE:

1) Measure suitable volume of sample in 250 ml conical flask.

2) Add 2 drops of methyl orange indicator and titrate with standard 0.02 N sodium hydroxide solution till colour changes to fint orange.

3) Note down the volume of NaoH solution used .

4) Add 3 drops of phenopathalin indicator in the same conical flask and continue titration with sodium hydroxide solution.

5) Note down the volume of addition NaoH Used.

CHAPTER - 3

DESIGN OF PROPOSED TREATMENT SYSTEM

INTRODUCTION:

3.1 The disposal of dairy waste is the last stage of getting rid of sewage after subjecting it to various steps of process of transforming sewage into a harmless liquid which fulfill the minimum standards of health and sanitation. The main objects of controlling disposal of dairy waste are to render the waste inoffensive, to climanate the danger of contamination of water suplies, to save the aquatic life in the streams.

The method of disposal are classified into two main groups.

a) **Natural Methods:**

By which the untreated or treated Dairy waste is disposed off by

a) Dilution of disposal into sea, river or lakes.

b) Land treatment i.e, sewage farming and irrigation

b) **Artificial methods:**

By which the sewage is disposed off only after subjecting to the various processes of treatment such as

a) Preliminery treatment

b) Primary treatment

c) Secondary or bilogical treatment and

d) Complete final treatement.

a) **Preliminary Treatment:**

It consists solely in separating floating materials and also the heavy settleable inorganic solids. This treatment reduces the BOD of the waste by 15 to 30 %. The processes used are screening, for removing floating materials. Grit chambers or detritus tank for removing grit and sand and skimming tanks for removing oils and grease.

b) **Primary Treatment:**

It consists in removing large suspended organic solidds. This is usually done by sedimentation in settling tanks.

c) Secondary Treatment:

It includes further treatment for oxidation of the effluent from the primary treatment unit. This is generally accomplished through Biological processes using filters, aeration tanks, oxidation ponds or other methods. The effluent from secondary treatment will usually contain 5 to 10 % of original BOD and it may even contain several Mg/l of D.O.

d) **Complete final Treatment:**

Final or advanced treatment sometimes called as teritary treatment consists in removing the organic load left after secondary treatment and particularly to kill pathogenic bacteria and harmful micro-organisms.

3.2 PROPOSED TREATMENT SYSTEM:

Out treatment - system consists of

1) Grit chamber
2) Skimming tank
3) Equalisation tank
4) Primary settling tank
5) Trickling filter

6) Secondary settling tank

7) Oxidation by ditches or ponds.

Then design and details are as follows:-

3.2.1 GRIT CHAMBERS:

Grit chambers are designed to remove grit, consisting sand, gravel, cinders or other heavy solid materials that have subsiding velocities of specific gravities substantially greater than those of the organic putrescible solids in waste water. Grit also includes eggshells, bore chips, coffee grounds and large organic particles such as food waste. Grit chambers are provided to protect moving mechanical equipment from abrasion and accompanying abnormal wear to reduce formation of heavy deposits in pipe lines channels and conduits and to reduce the frequency digester cleaning that may be required as a result of excessive accumulations of grit in such unit. The removal of grit is essential a head of centrifuges and heat exchanger and high pressure diaphragm pumps. On the other hand, where untreated sludge is to be dewatered on vaccum filters and incinerated grit chambers that are far less efficient have given satisfactory service.

Grit chambers may be located ahead of all other units in treatment plants where removal of grit would facilitate operations. However the insulation of mechanically cleaned bar racks or comminutors ahead of grit chaambers makes the operation of grit removal and cleaning facilities easier.

Loacating grit chambers ahead of waste water pumps, when it is desirable to do so would normally involve placing them at considerable depth at added expense. It is therefore usually deemed more economical to pump the wastewater including the grit chambers located at a convenient position ahead of the treatment plant units, recognizing that the pumps may require greater maintenance.

TYPE:

There are two type of grit chambers.

1) Horizontal flow and Square grit chamber
2) aerated grit chamber.

In horizontal flow type the flow passes through the chamber in a horizontal direction and the st. line velocity of flow is controlled by the dimension of the unit.

The aerated type consists of a spiral flow aeration tank where the spiral velocity is controlled by the dimensions and the quantity of air supplied to the unit.

QUANTITIES OF GRIT:

The quantity of grit will vary greatly from the location to another, depending on the type of sewer system the characteristics of the drainage area, the condition of the sewers the frequency of street sanding to counteract icing conditions the types of industrial wastes, the number of house hold garbage grinders served and the proximity and use of sandy bathing beaches.

DISPOSAL OF GRIT:

The most common method of grit disposal is as fill. In large plants, grit is inclinated with the sludge. In New York city grit and screenings are barged to sea and dumped the grit must be washed before removal.

DESIGNOF GRIT CHAMBER:-

Average flow value = 3.5lakhs lit/day

Assume that the aerated grit chamber will be designed for the 1 day sustained peak flow rate. The peaking factor is found to be 2.75

And they peak design flow rate is, Peak flow rate

$$\frac{3.5 \times 10^5}{1000 \times 24 \times 3600} \times 2.75$$

$= 0.011\ m^3/Sec.$

Aeration chamber volume = QT

Assume detension period is 3 minitues

$= 0.011 \times 3 \times 60$

$= 1.98 m^3$

$= 2 m^3$

Length; Breadh : Depth = 2:1:1

Increase the length by 15% to account for inlet exist condition

$= 2 + 0.300$

$= 2.3$ m

Assume that $0.04 m^3/min/$ m length of air will be adequate.

Air required (lengthbasis) $= 2.3 \times 0.04$

$= 0.092 m^3$

Quantity of grit that is handled.

Assume a value of $50 \times 10^{-3}\ m^3/\ 10^3\ m = 50 \times 10^{-6}\ m^3/m.$

Volume of Grit $= 0.011 \times 24 \times 60 \times 60 \times 50 \times 10^{-6}$

$= 0.04752 m^3$ / day

$= 0.048 m^3$/ day.

Size of the tank provides is $= 2.3m \times 1m \times 1m$

3.2.2 SKIMMING TANK:

PURPOSE:

Grease and oil is milk waste should be removed because they:

i) form odourous and unsighty skin when discharged into steams; this scum retards reaeration of streams from the atmospheric and thus lead to anaerobic action.

ii) Interfere with the operation of some of the apparatus employed in sewage treatment by promoting physical clogging.

iii) Hard to inhibit the biological growth on trickling filters, and also adversely affected bacterial and protozoan life useful for biological treatment of waste water.

iv) do not design readily, occupy large in digesters and make their operation costly.

They can be removed from waste water by means of floatation or settling as a sum or sludge. The scum formation can be encouraged by passing it through diffused air aeration tanks called the skimming tanks.

THE SKIMMING TANKS:

These are provided here in the form of narrow rectangular tank with hopper bottom. Longitudinal baffle wall sure provided dividing the body of he tank into three compartments which are interconnected by large slots to the top and bottom. These baffle walls help inputting the rising coagulated greasy material into the side compartments (called stilling compartments). The rise of grease and oils is brought about the blowing compressed all into the sewage from diffusers placed at the bottom of the tank.

Sewage enter the tank from one end, flows through longitudinally and finally goes but through a narrow inclined duct as shown in fig. This is so narrow that the suspended heavier particles are carried up its slope and out of the tank. A detention period of about 2 to 5 minutes is usually sufficient. Here a detention period of 5 minutes is adopted. The amount of compressed air required is about 300 to 6000 m^3 per million litres of sewage. The surface area required for one tank can be found out by using the formula.

SKIMMING TANKS

A skimming tank is a chamber so arranged that floating matter rises and remains on the surface of waste water until removed. While the liquid flows out continuously through deep outlets or under partitions, certain walls or scumboards.

The objective of skimming tanks is the separation from the waste water of the lighter floating substances. The material collected on the surface of skimming tanks when it can be removed, includes oil, grease, soap, pieces of cork and wood and vegitable debris and fruit skins. Most skimmings tanks are rectangular or circular and provide for a detention period of 1 to 15 minutes. The outlet, which is submerged, is opposite the inlet and at a lower elevation to assist in flotationand to remove any solids may settle.

Skimming tanks are about 1.0 m deep and have a reduced detention period from 5 - 15 minutes. The scumboards are fixed 100 - 150 mm below the scum surface.

$$A = 0.00622\ Q/V^2$$

Where Q = Rate of flow of wastein m^3 /day.

V^2 - minimum rising velocity of gready material to be removed in m/minutes

= 0.25 m /(minutes(in most cases)

The aeration of sewage in skimming tanks has the following additional advantages:

1) the sewage is freshened

2) Hydrogen sulphide and other gases of decomposition are driven off

3) floculation of colloidal matter takes place so that it can be more easily removed in settling tanks ahead.

Passing chlorine (2 mg per litre of sewages) along with the air has been found to increase the grease removal by 3 to 4 times, Flotation and foaming agents like the oil, grease, resin, glue, promote scum formation and also enhance grease removal

DISPOSAL OF SKIMMING:

The skimmings are therefore usually disposed off by burial or burning. Treatment in digesters can be beneficial if the mineral oils are less in amount and organic and vegetable oily materials predominate. The later digests easily and gives gas of high fuel value.

5. DESIGN OF SKIMMING TANK:

Average discharge = 3.5×10^5 lit/day.

= 350 m3 / day

= 350 / 24

= $14.833\ m^3$ / hr.

take peak discharge as 2.75 times Q

Q = 2.75×350

= $962.5\ m^3$ / day

Surface area required A = A = 0.00622 Q/V

Where

Q is the rate of flow of waste in m^3 /day

V = minimum rising velocity of greasy material to be removed m per minute.

V = 0.25 m/min.

$$A = \frac{0.00622 \times 962.5}{0.25}$$

A = $23.947\ m^2$ $24\ m^2$

Provide Breadth = 2.0 m

Length L = 12 m

Area = 24 m^2

Taking detention period = 5 minutes.

Velocity = L/T 12/5 = 2.4 m/min.

Velocity = 2.4 m/min.

Cross sectional area Q/V

$$= \frac{962.5}{2.4 \times 24 \times 60}$$

$$= 0.2785 \text{ m}^2$$

1/2 x D x (a + b) = 0.2785

1/2 x D x (2 + 0.5) = 0.2785

D = 0.2228 m

D = 23 cm

Provide depth = 50 cm

And a free board of = 15 cm.

Therefore total depth = 0.65 m

Dimensions of the tank:

Length = 12 m

Top width = 2 m

Bottom width = 0.5 m

Depth = 0.65 m

3.2.3 EQUILISATION TANK

Equalisation is a method of retaining wastes in a basin until the effluent discharged is fairly uniform in its sanitary characteristics. Air is some times injucted into these basin to provide 1) better mixing 2) chemical oxidation of reduced compounds 3) some degree of biological oxidation and 4) agitation to keep suspended solids from settling out.

The size and shape of the basins vary with the quantity of waste and the pattern of its discharge from the dairy plant. The capacity of the equalising tank should be adequate to hold and render homogenous, all the wastes from the plant. Almost all industrial plants operate on cycle basis, thus if the cycle of operation is repeated for every two hour, an equalisation tank which can hold two hour flow will usually be sufficient. If the cycle is only repeated every twenty four hours, the tank should be big enough to hold 24 hour flow of waste.

The more holding of waste however is not sufficient to equalise it, adequate mixing must take place, so that each unit volume of waste discharged will be mixed with other unit volume of waste discharged many hours ago. This mixing may be brought about in the following way:

1) Proper distribution in baffling
2) Mechanical agitation
3) Aeration
4) Combination of all the three

Proper distribution in baffling:

It is the most economical method of mixing However for many plants this method may suffice Horizontal distribution of the waste may be achieved by using either several inlet pipes, spaced at regular intervals across the width of the tank or a perforated pipe across the entire width. In and around baffles are advisable when the tank is wide, since they provide efficient distribution Baffling is especially important . when several types of waste entered the basin. The influent should be forced to the bottom of the basin so that the entrance velocity prevents suspended particles from sinking and remaining at the bottom.

Aeration of equlising basins:

It is the most efficient way to mix waste, but also the most expensive. Aeration does the following it facilitiess mixing and equilisation of wastes, prevents are decreases accumulation of settled material in the tank and provides preliminary chemical oxidation to reduced compounds, such as sulphur compounds. to aerate an equalising basin takes about half a cubic foot of air per gallon of waste. Aeration is of special benefit in situations where wastes have varying character and quantity, excess of reduced compounds and some settleable suspended solids.

DESIGN:

Total volume of dairy waste to be treated per day

$= 2.75 \times 3.5 \times 10^{5}$

$= 962500$

Assuming a detention time = 4 hours

Quantity of dairy assume to be treated in 4 hours.

$$= \frac{962500}{1000} \times 4 \times 1/24$$

$= 160.42\ m^{3}$

Assume the velocity through the channels as 0.3 m/Sec.

Now the length of the flow

$$= 0.3 \times \text{Detention period}$$

$$= 0.3 \times 4 \times 60$$

$$= 72 \text{ m}$$

Therefore required cross sectional area of each channel between the baffles.

$$= \frac{\text{Capacity of the tank}}{\text{Total length of flow}}$$

$$= \frac{160.42}{72}$$

$$= 2.23 \text{ m}^2$$

The distance between the baffles is kept as equal to minimum permissible = 0.45 m

Therefore depth A water in the basin

$$= \frac{\text{C.S of each channel}}{\text{Distance between baffles}}$$

$$= 2.23/0.45$$

$$= 4.96 \approx 5 \text{ m.}$$

The clear opening between the baffle and the wall may be taken as equal to 1.5 x distance between the baffles

= 1.5 x 0.45

= 0.67

= 0.7 m

Assuming the width of channel as 6 m the effective length of each channel = Clear width of the tank

- 2 x 1/2 opening

= 6 - 2 x 2 1/2 x 0.7

= 5.3 m

Number of channels required

$$= \frac{\text{Total flow length}}{\text{effective lengthof each channel}}$$

= 72/5.3

= 13.58

= 14

The clear length of the tank excluding the baffle walls and side walls = No. of channels x 0.45

= 14 x 0.45

= 6.3

Assuming the thickness of each baffle as 7.5 cm the overall inside length of the tank

= 6.3 + 7.5/100 x (14 - 1)

= 7.275 m

= 7.5 m

Dimension of the tank provided:

Length of the tank	=	7.5 m
Breadth of the tank	=	6 m
Depth of the tank	=	5 m
No. of channels	=	14

3.2.4 SEDIMENTATION TANKS (or) SETTLING TANK:

Forms of Settling tank:

1) Rectangular tanks
2) Circular tanks
3) Peripheral feed circular tank
4) Upward - flow tanks

Primary Settling Tank:

Effluent of the grit chamber, containing mainly light weight organic matter, is settled in the primary sedementation tanks. In addition to the settling characteristics, some other characteristics also interfere in the process of sedimentation. the organic matter tends to agglomerate during settling. After agglomeration they settle at a rate higher than that of the parent particles. As depth of liquid increases, chances of contact between the particles, and thus the size of the agglomerated particles incresed which in turn makes the process of settling more rapid. This is

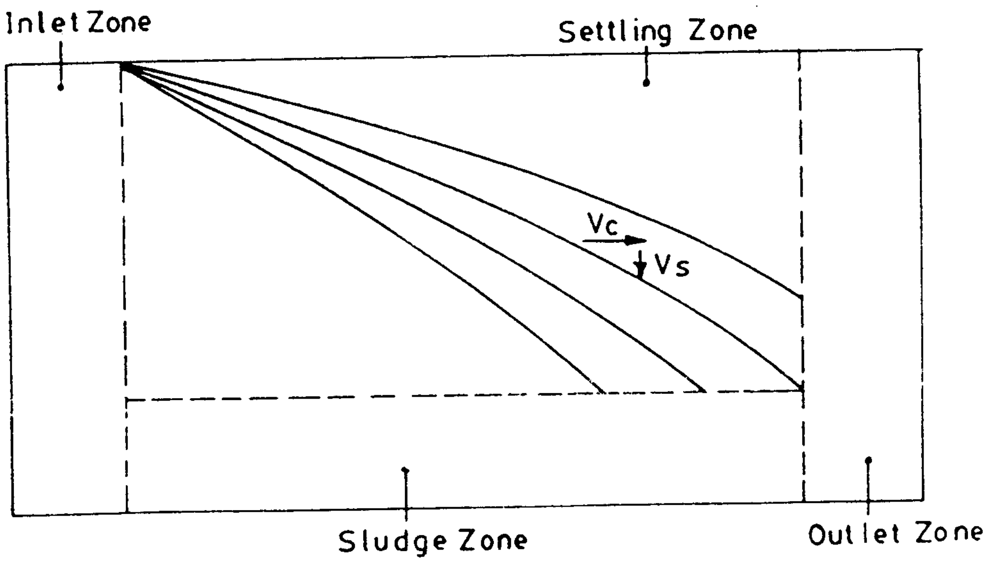

Figure 3.5

true for any settlement of particles in a dilute suspension. The entire process is dependent on the range of particle sizes, the concentration of particles, mean velocity gradient in the system and many other known and unknown parameters.

Figure (   ) shows the typical plot of the settling path of particles in an idealized settling tank.

Principle of Sedimentation:

The very fundamental principles under -lying the process of sedimentation is that the organic matter present in dairy waste, is having a specific gravity greater that of water. In still dairy waste, these particles will therefore tend to settle down by gravity whereas, in a flowing sewage they are kept in suspension, because of the turbulence in water. Hence, as soon as the turbulence is retarded by offering storage to dairy waste, these impurities tend to settle down at the bottom of the tank offering such storage. This is the principle behind sedimentation.

The basin in which the flow of sewage is retarded is called the settling Tank or Sedimentation tank or sedimentation Basin and the theoritical average time for which the water is detained is called the Detention period.

Theory of Sedimentation:

The settlement of a particle by gravity in a liquid, when brought to rest, is opposed by the following factors:-

i) The velocity of flow which carries the particles horizontally; the greater the flow area, the lesser is the velocity and hence more easily the particle will settle down.

ii) The viscosity of water in which the particle is travelling; The viscosity varies inversely with temperature. Warm water is less viscous and therefore offers less resistance to settlement. However, the temperature of sewage cannot be controlled to any appreciable extent in the "Sewage Treatment Processes", and hence this factor is generally ignored.

iii) The size, shape and specific gravity of the particle: The greater is the specific gravity, more readily the particle will settle. The size and shape of the particle also affect the settling rate. For example, the weight and volume of a spherically shaped particle varies with the cube of its diameter or its size, and its area varies with the square of the diameter. Hence very small particles will settle very slowly. It therefore, clearly follows that the shape and size of the particles do affect the settling velocities.

The clarification of dairy waste by the process of Sedimentation can be affected by providing conditions under which the suspended materials present in dairy waste can settle out. This is brought about in specially designed tanks called sedimentation tanks.

Out of the three forces which control the settling tendencies of the particles, the two forces, ie, the velocity of flow and the shape and size of the particles are tried to be controlled in these settling tanks. The third force is the viscosity of sewage or the temperature of sewage is left uncontrolled as the same is not practically possible.

The velocity of flow can be reduced by increasing the length of travel, and by detaining the particle for a longer time is the sedimentation basis. The size and shape of the particles can be altered by the addition of certainchemicals in water.

These chemicals are quite called coagulatns, and they make the sedimentation quite effective, by leading to the settlement of even very fine and colloidal particles. However their use is not made in "Plain Sedimentation"" but is being made in the process called"Chemical precipitation" or sedimentation with coagulation.

Sedimentation basins are thus designed for effecting settlement of particles by reducing the flow velocity or by detaining the sewage in them.. They are generally made of reinforced concrete and maybe reactangular or circular in plan. Long narrow rectangular tanks with horizontal flow are generally preferred to the circular tanks with radial or spiral flow.

The capacity and other dimensions of the tank should be properly designed so as to effect a fairly high percentage of removal of suspended organic material. A plain sedimentation tank under normal conditions may remove about 60 to 65 % of the suspended solids and 30 to 35 % of BOD from the Sewage.

Types of Sedimentation tanks: Sedimentation tanks may function either intermittently or continuously.

In a continuous flow type of a Sedimentation tank, which is generally used in modern days, the flow velocity is only reduced and the sewage is not brought to complete rest, as is done in an intermittent type. The working of such a tank is simple as the water enters from one end, and comes out from the other end. The velocity is sufficiently reduced by providing sufficient length of travel. The velocity is so adjusted that the time taken by the particle to travel from end to another is slightly more than the time required for settlement of that particle. The theory and design of such a tank is discussed below in details.

Design of a continuous flow type of a Sedimentation tank:

In the theory which is applied to the design of such sedimentation basin, it is assumed that the sediment is uniformly distributed as the dairy waste enters the basin. In figure ( ) let the water containing uniformly distributed sediment, enters the rectangular tanks with a uniform velocity V. If Q is the discharge entering the basin, the flow velocity V is given by

$$V = Q / BH$$

Where B = width of basin and

H = Depth of sewage in the tank.

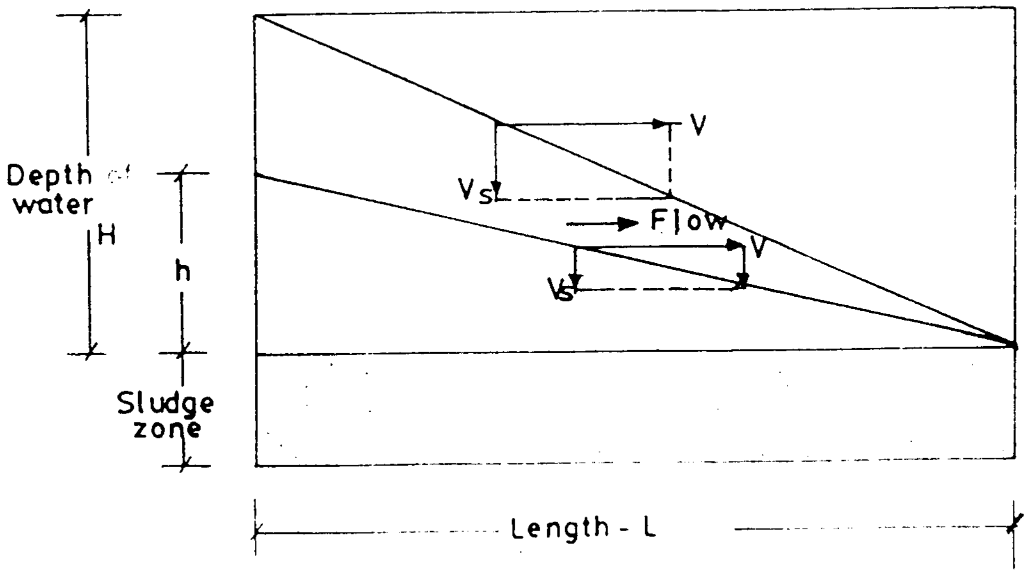

Figure 3.6

Now, every discrete particle is moving with a horizontal velocity V and a downward vertical velocity Vs. The resulant path is given by the vector sum of its flow velocity (V) and its settling velocity (Vs).

Now, assuming that all those particles, whose paths of travel are above the line BD, will pass through the basin we have from geometric considerations:

$$V/V_s = L/H$$

$$V_s = V.H/L$$

But $$V = Q/B.H$$

$$V_s = Q/B.H. \quad H/L$$

$$V_s = Q/BL$$

It shows that all those particles with a settling velocity equal to or greater than Q/BL will settle down, and be removed. In other words, no particle having a settling velocity more than or equal to Q/BL will remain suspended in such a tank.

It was mentioned above that a particle having settling velocity greater than or equal Q/BL will be removed. In fact, it was the case when the particle entesting at full height H of the tank, was considered, Truely speaking, even the smaller particle having settling velocities lower than Q/BL will also settle down if they happen to enter at some other height h of the tank. In that case , when the particles are entering at some other height h of the tank, all those particles having their settling velocities h/H.Q/BL will settle down.

If Y_o represents the number of particles of a given size that are settled out and Y being the total number of particles of that size, then the percentage of that particular sized particles which shall be removed is Y_o / Y and is equal to h/H for an assumed uniform distribution of particles. Hence if 70 % of particles of a given size are proposed to be removed in a settling tank, then the settling velocity of that sized particles must be kept = 70/100.Q/BL. In other words Q/BL must be kept equal to 100/70 x settling velocity of that sized particle.

It therefore, follows that the quantity Q/BL is the discharge per unit of plan area is a very important term for the design of continuous flow type settling tanks; and is known as overflow rate or surface loaoding or overflow velocity.

Normal values of overflow rates ranges from 40,000 to 50,00 litre/sq.m /day for plain sedimentation tanks and about 25,0000 to 35,000 litres/sq.m,/day for secondary sedimentation tanks.

Decreasing the overflow rate will lead to the settlement of even those particles which are having lower values of their settling velocities. Hence, smaller particles will also settle down, if the overflow rate can be reduced by increasing the plan area of the basin. It therefore, follows than an increase in plan area will increase the efficiency of sedimentation tank; and theoretically speaking, depth does not have any effect on the efficiency f sediment removal. However, it is important for practical considerations, and also for making allowance for deposition of slude ang silt.

Usual values of effective depth (ie. depth excluding the bottom sludge zone) ranges between 2.4 m to 3.6 m (generally not exceeding 3 m).

Another important term which is used in connection with the design of sedimentation basins is its detention time or detention period or retention period. The detention time (t) of a settling tank may be defined as the average theoretical time required for the sewage to flow through the tank. It is thus, the time that would be required for the flow of sewage to fill the tank, if there were no outflow. Inotherwards, it is the average time for which the sewagee is detained in the tank. The detention time for a circular tank

$$= \frac{d^2(0.011\ d + 0.785\ H)}{Q}$$

d = Dia. of the tank

H = Vertical depth at wall or side water depth

The detention time for a sewage sedimentation tank usually ranges between 1 to 2 hours. The lower value of detention period (ie. 1 hour) is generally adopted when activated sludge treatment is used in secondary treatment after the sedimentation; and the higher and more normal value (ie 2 hours) is generally adopted when trickling filters are used as secondary treatment.

Larger detention periods will result in higher efficiency than shorter periods; but too long a period induces septic conditions, and should be avoided. However, if the secondary sedimentation is to be avoided, a longer detention period of about 2½ hours to 3 hours may be adopted. The maximum diameter of a circular tank may be kept 60 m or so. The cross sectional area of the Sedimentation tank is such ass to provide a horizontal flow velocity of about 0.3 m/minute. The total amount of flow from the tank within 24 hours, generally equals the maximum daily flow of sewage.

Design of circular settling tank:

The flow rate = 3.5×10^5 lit/day

Maximum flow rate = $2.75 \times 3.5 \times 10^5$

= 962500 lits/day

The quantity of sewage to be treated per 2 hours.

$$\frac{962500}{1000} \times \frac{2}{24}$$

= 80.208 m^3

= 80.21 m^3

Capacity of the tank= 80.21 m^3

Now, Surface loading= $\frac{Q}{\text{Surface area of tank}}$

Assume surface load = 45.000 lit/m^2/day

$$45,000 = \frac{Q}{\frac{\pi d^2}{4}}$$

$$45,000 = \frac{962500}{\frac{\pi d^2}{4}}$$

d = 5.27248 m

Assume d = 6 m

Effective depth of the tank

$$= \frac{\text{Capacity}}{\text{Area of cross section}}$$

$$= \frac{80.21}{\frac{\pi}{4} \times 6^2}$$

= 2.8365 m

= 3 m

Hence use a settling tank 6m dia and 3m water depth

Assume free board = 30 cm

Depth = 3 + 0.3

= 3.3 m

Dimensions of the tank provided

Dia of the tank = 6m

Depth = 3.3m

3.2.5 OXIDATION PONDS

In addition to the two major methods of secondary treatment given to sewage a third method in the form of oxidation ponds is also sometimes adopted, especially in hot countries, and in rural areas, where sufficient land is available away from residential areas. Oxidation ponds, are, this quite suitable to Indian conditions especially in towns and rural areas, where lot of land and sun-shine is available.

Principal and Operation:

Oxidation ponds are, infair nothing but shallow underground ponds surrounded on all four sides by high embarkments. The raw sewage on more generally. The primarily settled sewage is allowed to collect in this pond, where along with sedimentation, the organic matter is stablised through the combined action of algae and otther micro-organisms. Input, in such a pord, a symbiotic relationship exists between the algae and the other micro-organisms such as, bacteria and protozoa, which like other two process oxidise the organic matter. Algae, which one microscopic plants, produce oxygen while growing in the presence of sunlight. The oxygen so produced, is utilised by the bacteria for oxidising the waste organic matter..

End products of the process are carbon dioxide, ammonia and phosphates, which are required by the algae to grow and Produce oxygen. The results of the oxidation pord treatment in the oxidation of the original organic matter, and the production of algae which are discharged with the effluent. This results in a net reduction in BOD, since the algae are more stable than the organic matter in waste water, and degrade slowly in the river Gream into which the effluent is discharged. The oxidation ponds throwing their effluents in rivers, just upstream of some lakes (or) reservoirs are therefore, generally not preferred, as the discharged algae may settle in the reservoirs and cause anaerobic decomposition and other water quality problems. However, the effluents from oxidation ponds can be easily used for land irrigation, particularly at such places.

Constructional Details

Atypical plan and section of an oxidation pond is shown in fig. It is an earthern underground pond, with shallow depth. The pond should be atleast 0.9m deep to discourage growth of aquatic weeds but best results are obtained, if the depth does not exceed 1.8m as large surface area exposed to sunlight is necessary. The detention time in the pond is usually 3 to 6 weeks.

Better efficiency of treatment is obtained, if several ponds are placed in series, so that the sewage flows progressively from one to another unit until it is finally discharged.

The efficient should be entered at centre above or below the liquid surface for a uniform mixing of the influent with the oxygen saturated pond liquor. The outlet should provide with drawal of effluent from different depths of pond.

Design of Oxidation ponds:

The quantity of dairy waste to be treated per day	=	3,50,000 lit
	=	350 cu.m
	=	.35M litre
The 5th day BOD	=	9000 PPM
	=	.350 x 9000 lit
	=	3150 litres
Assuming the SP. gravity of organic load as 1 we have the wt. of BOD per day	=	3150 Kg

Now assuming the organic loading in
The pond 3500 Kg/hectare/day

The surface area required $= \frac{3150}{3500}$ hectares

$$= \frac{3150}{3500} \times 10^4 \ m^2$$

$$= 9000 \ m^2$$

Assuming the length of the tank (L) as twice of its width (B) we have

$$2.B^2 = 9000$$

$$B = \frac{9000}{2}$$

Say $= 67m$

$$L = \frac{9000}{67} = 134.32$$

$$= 135 \ m$$

Use a tank with effective

depth as 1.5m, we have

The provided capacity $= 135 \times 67 \times 1.5 = 13570 \ m^3$

Now capacity = sewage flow per day x Detension time in days

Detention time in days

$$= \frac{\text{Capacity in Cu.m}}{\text{Sewage flow per day in cu.m/day}}$$

$$= \frac{13570}{900}$$

$$= 15.1 \text{ days}$$

Hence use an oxidation tank with length 135 m width = 67m and over all depth as = (1.5+1) = 2.5 m and a detention period as 15.1 days. Ans//

Design inlet pipe:

Assuming an average velocity of sewage as 0.9m/sec and daily flow for 8 hours only.

Discharge = $\frac{350}{8 \times 60 \times 60}$ cumecs

Area of inlet pipe required

$= \frac{\text{Discharge}}{\text{Velocity}}$

$= \frac{350}{8 \times 60 \times 60} \cdot \frac{1}{0.9}\ m^2$

$= 0.0135\ m^2$

$= 135\ cm^2$

Dia of inlet pipe

$= \sqrt{\frac{4 \times 135}{\pi}}$

$= 13.1$ cm

$\simeq 15$ cm

Dia of outlet pipe may be taken as 1.5 times that of the inlet = 1.5 x 15 = 22.5 25cm

3.2.6 SLUDGE

Sludge which settles at the bottom of primary sedimentation tank. This is also called a Raw sludge and the sludge which is deposited in a secondary clarifier is called secondary sludge. Raw sludge is odour our contains highly putrescible organic matter, and is very objectionable. Secondary sludge is also Putrescible, though a little less objectionable.

The sludge withdrawn from the bottom of the sedimentation basin must be stabilised before its final disposal. Another problem is it moisture content. The case of raw sludge moisture content in 95% and in secondary sludge it is 97%. The sludge obtained may be viscous and becomes very bulky and difficult to handle. Complete removal of moisture is done by special treatments, since water is so tenaciously held in sludge.

Disposal of Digested Sludge

The digened sludge from the digestion tank contains lot of water and is, therefore, first of all, dewatered before further disposal either by burning or dumping. In India the water of sludge is removed by drying the sludge on Drying beds.

Dewatering of sludge by sludge drying beds :

Drying of the digested sludge on open beds of land is quite suitable for hot countries like India.

Sludge drying beds are open beds of land 45 to 60cm deep and consisting of about 30 to 45cm thick gradel layers of gravel on crushed stone varying in size from 15cm at bottom to 1.25cm at top, and overlain by 10 to 15cm thick coarse sand layer. Open jointed under-drain pipes (a) 5 to 7 cm c/c spacing are laid below the gravel layer in valleys.

The sewage sludge from the digestion tank is brought and spread over the top of drying beds to a depth of about 20 to 30 cm, through distribution troughs having openings of about 15cm x 20cm at a distance of about 2m or so.

A portion of the moisture, drains through the bed, while most of it is evaporated to the atmosphere. It is usually takes about one to two months to dry sludge, depending on the weather and condition of the bed.

Sledge should never be applied to a bed until the preceding dose has been removoed. Hence, several drying beds will generally be required, with their number increasing with an increase in the number of days for which sludge is kept on the beds. The dried sludge is generally used as manure in our country

3.5.7 TRICKLING FILTER:

These filters consist of tanks of coarser filtering media, over which the sewage is allowed to sprinkel or trickle down, by mens of spray nozzles or rotary distributors. The percolating sewage is collected at the bottom of the tank through a well designed under drainage system. The purification of sewage is brought about mainly by aerobic bacteria which forms a bacterial film around the particles of the filtering media. The action due to the mechanical straining of the filter bed is much less. In order to ensure the large scale growth of the aerobic bacteria sufficient quantity of oxygen is supplied by providing suitable ventilation facilities in the body of the filter; and also to some extent by the intermittent functioning of the filter.

The effulent obtained from the filter must be taken to the secondary sedimentation tank for settling out the organic matter, oxidised while passing down the filter. The sewage influent entering the filter must be given pre-treatments including screening and primary sedimentation.

CONSTRUCTION AND OPERATION:-

Trickling filter tanks are generally constructed above the ground. They may either be rectangualr filters or circular Rectangular filters are provided with a net work of pipes having fixed nozzles, which spray the incoming sewage into the air, which then falls over the bed of the filter under gravity. The circular filter tanks on the other hand are provided with totally distributors having number of distributing arms. These distributors rotate around a central support either by an electric motor, or more generally by the force of reaction on the sprays. Such self propelled reaction type of distributors are now a days preferred and used. The rate of revolutions vary from 2 RPM for small distributors to less than ½ RPM for large distributors. The advantage of having two or more arms is not only to get reaction sufficient to rotate the entire mechanism but is also to pass the fluctuating demands by taking low flows in two arms, and the remaining two arms coming inits operation only at timer of higher flows. The distributing arms should remain about 15 to 20 cm above The top surface of the filtering media in the tank.

There is an important difference between the action of rotary distributors and that of spray no 33les with a rotary distributor, the application of sewage to the filter n practically continuous where as with spray no33lcc, the filter is dosed for 3 to 5 minutes and then rested for 5 to 10 minutes before the next application. In any case, however dosing tanks, with siphons receiving sewage from the primarly clarifires and supplying it to the filters with circular distributors will be designed to have a smaller capacity as against a higher capacity for filters with spray no33les.

The filtering media, as pointed out earlier, consists of coarser material like cubically broken stones or slag 1 free foom dust and small pieces. The size of the material should be washed before it is placed in position. The quality of the stone used should be such as not to be easily affected by acidic sewage and should be sufficiently hard. Its resistance to brezzing and throwing is another important properly especially in northern regions.

Usually is tones from rocks like granite or lime stone may be used.

The depth f the filtering media may vary between 2 to 3 metres. The filtering material may be placed in layers. With coarsest stone used hear the bottom, and finer material towards the top the walls of the filter tank are made honey combed or otherwise provided with openings for circulation of air, all though sometimes, instead of constructing supporting walls, the filtering material may be stacked above the ground with its natural angle of repose, so as to ensure better circulation of air from the surrounding atmosphere.

Sometime, forced ventilation by forcing the air vertically upwards through the filter by the use of tans or other mechanical equipment, may be used; but it has not been found to increase the capacity of well- constricted trickling filters.

A satisfactory ventilation is achieved when properly designed under drains having adequate openings, are provided under the filter bed. Besides ensuring satisfactory drainage, such drains, will also ensure satisfactory ventilation and aeration of the filter bed. Verified clay blocks are generally used as under drains. The blocks have top openings of such size that the stone can be placed directly on them and yet they furnish flow channels with sufficient capacity for the heaviest Hydraulic loading. These blocks are laid on a reinforced concrete floor towards a central effluent channel, as shown. The in this channel has, characteristics similar to the flow in a washwater trough of a rapid sand filter used in water suplies. the slope of the channel should be sufficient to ensure a flow velocity of about 0.9 m/Sec. the depth and width of this central channel should be such that the maximum flow is carried below the level of the under drains.

Types of trickling filters:

Trickling filters can be broadly classified into

i) Conventional trickling filters or ordinary trickling filters or standard or low rate trickling filters.

2) High rate filters or high rate trickling filters.

The high rate filters of modern advancements, also function on the same lines, and are having the same constructional details but with the difference that provision is made in them for recirculation of sewage through the filter, by pumping a part of the filter effluent to the primary settling tank, repassing through it and the filter. The high rate filters make it possible to pass sewage at greater loading, thus requiring lesser space and lesser filter media. The process of recirculation and its use in making high rate filters shall be discussed thourghly, a little late after we finish the general description of trickling filters and the comparative characteristics of both types.

Merit and Demerits of Trickling filters:

i) Rate of filter loading is high, as such requiring lesser land areas and smaller quanitities of filter media for their installations.

ii) Effluent obtained from trickling filters is sufficiently nitrified and stabilised. They can remove about 75 % of BOD and about 80 % of suspended solid. The effluent can, therefore be easily disposed of in smaller quantity of dilution water.

iii) Working of trickling filters is simple, and does not require any skilled supervision.

iv) They are flexible in operation, and they can, therefore, with stand the application of variety of sewages having different concentration and composition. Even if hey are over-loaded, they can recoupe after rest.

v) They are self-cleaning.

vi) Mechanical wear and tear is small, as they contain less mechanical equipment.

vii) Moisture content of sludge, obtained from trickling filters is as high as 99 % or so.

viii) Trickling filters have been found to operate more efficiently in warm weather, and produce an effluent appreciably tower in BOD. Hence, they are immense - use in hot countries like India.

The disadvantages of the trickling filters are:-

i) the head loss through these filters is high, making automatic dosing of the filters necessary

ii) cost of construction of trickling filters is high

iii) these filters cannot treat raw sewage, and primary sedimentation is a must.

iv) these filters pose a number of operational troubles such as given below.

a) fly nuisance, the filter fly, psychoda, which develops in the filter particles, may prove to be a nuisance, as the same may be carried away to human habitation.

Thiss problem may be controlled by flooding the filter with sewage for 24 hours or more the flooding will destory the larvel, and usually interface slightly with the result of operation.
However two or more filters will be needed, in order that, one is flooded, another is available to treat the sewage.

b) Odour Nuisance:

Odours, generally do not prevail in trickling filters using rotary distributors; but however, when fixed nozzles are used H_2S and other odourous gases are frequently released from the sprays into the atmosphere. The usual remedy is to chlorinate the sewage to prevent formation of H_2S gas, or to neutralise that already formed.

Some odour may also evolved due to sludge and also due to anaerobic conditions which may prevail as and when the avilable oxygen becomes short due to some reasonns, or when the sewage becomes state. The remedy is to chlorinate the sewage and to keep sewage fresh by recirculation, as is done in rapid filters.

c) Ponding trouble:

Sometimes, the voids in the filter media gets clogged due to heavy growth of fungi and algae. This may result in ponding of sewage over the filter bed. This trouble posed by algae and fungi can be controlled by chlorinating the sewage which kills the algae, thus eausing unloading of the accumulated material other methods of controlling algae all to add copper sulphate to the sewage, and resting the bed for some time.

Besides these external controlling factors, the algae is utilised by the worms and larve particularly of the psychodatly, which feed on the vegetble matter, and in the process bring about a biological change.

Ponding at the surface is, therefore, most common during the winter months when the worms and larve are driven down from the surface. breaking up the vegetable growth in the filter, and causing heavy discharge of humus from the bed. This process is called spring off loading.

The human so produced is easily seffleasle and is allowed to settle down in the secondary clarifier. Sometimes, separate tanks, similar to setting tanks called humus, may be used for this purpose. They are provided, particularly when the effluent from the filters is to be discharged in to the rivers and a high degree of Purification is needed. Although humus is inert, get it cannot be allowed to pars into river streams, because ultimately it produces a large quantity of mud, and impedes the course of the river stream in question.

FILTER LOADING:-

The loading on the filter may be expressed in two ways:

(i) By the quantity of sewage applied per unit of surface area of the filter puday. This is called hydraulic loading and expressed in million litres per hectre per day. The value of hydraulic loading for conventional filters may very between 22 to 44 million litres per hectre per day. The hydraulic loading can still be increased to about 110 to 230 ml/ha/day in the high rate trickling filters.

(ii) By the wt of BOD per unit volume of the filtering media per day. This is called organic loading and expressed in Kg of 5 days BOD per heet are metre of the filter media per day. The value of organic loading for conventional filters may vary between 900 to 2200 Kg of 5 days BOD per ha-m this organic loading value can be further increased to about 6000 - 18000Kg of 5 day BOD per ha-m in high rate trickling filters.

PERFORMANCE OF CONVENTIONAL FILTERS AND THEIR EFFICIENCIES:

The effluent obtained from a conventional trickling filter plant is highly nitrified and stabilised the BOD is reduceed to about 80 to 90 og original value the BOD left in the effluent is generally less than 20 ppm or so. The sludge obtained in the secondary clarifier is trick, with moisture content about 92% . It is heavy and easily digestible the filter is very flexible, and can ever take intermittent shock loads without any detrimental effects. Hence a conventional or standard rate filter plant is very useful to medium towns and industrial cities requiring full treatment of sewage.

The efficiency of such a conventional filter plant can be expressed by the equation evolved by national reserch coulcil of V.S.A and given by

Where $$(\%) = \frac{100}{1 \pm 0.0044}$$

= Efficiency of the filter and its secondary clasifier, in terms of percentage of applied BOD removed u = Organic loading in Kg/ha-m/day applied to the filter.

This equation shows that the BOD removed by the filter plant depends upon the organic loading adopted. Greater is the loading holds good when there is no recirculation. In case of recirculation this equation modifies to as given in the above equation.

DESIGN OF HIGH RATE TRICKLING FILTTER:-

Flow rate = 3.5×10^5 lit/day

Maximum flow rate = $2.75 \times 3.5 \times 10^6$

= 962500 lit/day

= 0.965×10^6 lit/day

Provide 3 units

flow in each unit = $\frac{0.9625 \times 10^6}{3}$ =

0.320833×10^6 lit/day

B.O.D present in waste = 10.300mg/lit

B.O.D removed in primary settling tomk = 30%

B.O.D to be removed by trickling filter = $\frac{7210}{3}$ = 2403.3 mg/lit

Total B.O.D present in desing waste to be treated per day = $2403.3 \times 0.320833 \times 10^6$

= 771068643.3mg

= 771.07 Kg.

Assume the value of organic loading as 2200 Kg/ham/day

(Between 900 to 2200 Kg/ ham /day)

Volume of filtering media required = $\frac{771.07}{2200}$ =

= 0.35 hour

= 3504.8 m^3

Assuming the effective depth of filter as 4m

The surface area of the filter required $= \frac{3504.8}{4}$

$= 876.2m$

Using a trickling filter of diameter 40m we have the number of units required $= \frac{876.2}{\Pi/4 \times 40^2} = 0.7$ units $\simeq$ 1 unit

CHECK FOR HYDRAULIC LOADING:-

The surface area of the filter bed can also be worked out by assuming the value of hydraulic loading say as 25 milion lit/ham/day

(i.e between 221.0 44 million lit/ham/day

surface area required $= \frac{\text{Total waste to be freeted /day}}{\text{Hydraulic loading /day}}$

$= 0.01284$ he

$= 128.4m^2$

Provided $876.2m^2$

$128.4m^2 < 876.2m^2$

CHECK FOR ORGANIC LOADING:-

B.O.D present in sewage = 771.07 Kg

Organic loading = $\frac{\text{Total B.O.D}}{\text{Volume of filter}}$

$= \frac{771.07}{0.35}$

= 2195.7 Kg/ ham/day

This lies between 900 kg/ ham /day to 2200Kg/ ham/day. Hence safe.

DIMENSIONS OF THE TANK

Diameter of the tank = 40m

Depth the tank = 4m

C H A P T E R -4

C O N C L U S I O N

In this project, an attempt has been made to analyse ~~is~~ and study the characteristics of dairy waste and to suggest the treatment unit for the disposal of the waste from coimbatore cooperative milk society. Analysis of Dairy waste for physical and ehemical properties were earried out. The experimentation work was to analyse the waste wait for (i) PH value, (ii) Total solids (iii) Allkality (iv) B.O.D Acidity Hardness

The proposal of the treatment unit is based on the treatment analysis. On analysing the waste water; it was found that the total solids in the waste ranges from . . 7500 mg/lit to 8500mg/lit

PH value ranges from 6.10 6.79 chloride ranges from 56.72mg/lit. Alkalinity varies from 240mg/lit hardness varies from 3171.4 mg/lit. Acidity varies from 5393.33mg/lit and B.O.D ranges from 10300 mg/lit due to the presence of gr.ease and oil we have provided glit chamber of size 2.3 m x 1m x 1m since the PH is almost to neutral and while it is kept for a long time, the lactic acid content increases, increasing the acidity.

So we have provided an equalization tank to neutralize the PH and also to adjust the variation in flow. As the organic loading is high, two trickling filter in parallel have been provided. So due to all the above mentioned fact it is not possible to dispose the dairy waste water into municipal sewer or disposing it in to river. We came to a conclusion that disposing of Dairy waste water on land which may be used for Agricultural purpose is better.

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C H A P T E R - 5

RESULTS AND DISCUSSION

5.1 RESULTS:-

Table No.1 P_H value of Dairy Waste sample

Sample	Date of Sampling	Temperature	P_H value
I	25-8-89	32°C	6.10
II	30.8.89	31°C	6.30
III	5.9.89	32°C	6.86

Table No.2 Acidity of Dairy Waste Sample

Sample	Date of Sampling	Acidity
I	25-8-89	5400mg/lit
II	30-8-89	5333.33 mg/lit
III	5-9-89	4200 mg/lit

Table No.3 Alkalinity of Dairy waste Samples:-

Sample	Date of Sampling	Total Alkalinity
III	5-9-89	240 Mg/lit

Table No.4 Chlorides of Dairy Wasste Sample.

Sample	Date of sampling	Chlorides
I	25-8-89	62.62 mg/lit
II	30-8-89	56.72 mg/lit.
III	5-9.89	42.75 mg/lit.

Table No.5 Hardness of Dairy Waste Sample.

Sample	Date of sampling	Hardness
I	25-8-89	2751.8 mg/lit
II	30-8-89	3171.4 mg/lit.
III	5-9-89	4200.00 mg/lit.

Table No.6 Total solid, Disolved solids, Suspended Solids Of Dairy Waste Sample.

Sample	Date of sampling	Total Solids	Dissolved solids	Suspended solids
I	26-8-89	8000 mg/lit	7000mg/lit	1000mg/lit
II	31-8-89	8500 mg/lit	7500mg/lit	1000mg/lit
III	5-9-89	7500 mg/lit	7000mg/lit	500mg/lit

Table No.7 Biochemical oxygen Demand of Dairy Waste Sample.

Sample	Date of Sampling	B.O.D Present
I	25-8-89	10300mg/lit
II	30-8-89	9100mg/lit

RESULTS AND DISCUSSION

Result:-

Dairy waste water samples collected from the out fall of Coimbatore Milk Society were analysed for its characterictics discussed and presented.

PH:-

The PH value of the sample collected ranged from 6.10 to 6.86

Total Solids:-

Total solids values ranges from 7500 mg/l to 8500 mg/l.

Dissolved solids varied from 7000 mg/l to 7500 mg/l supsended solid varied from 500 mg/l to 1000 mg/l.

Acidity:

The value of acdity for the dairy wste was found to be 5333.33 mg/lt.

Alkalinity:-

The value of alkalinity for the dairy

waste was found to be 240mg/l

Hardness:-

The value of hardness for the dairy waste was found to be 3171.4 mg/lit

Chlorides:-

The value of chlorides for the dairy waste water is to be found as 56.72 mg/lit.

Biochemical oxygen demand:-

The one day value of BOD is 10,300 mg/lit

The 5 day value of BOD is 9100mg/lit

DISCUSSIONS:-

From the laboratory tests we came to know the value of PH of the sample is more or less to neutral. If the treatment of the waste is done immediately after washing without storing for a long time the neutralization could be avoided. On the other hand if it is stored and tested. It could be found that the PH value will be less.

The total solids in waste are in high range hencee sedimentation, classification has to given to the work before it is subjected to any biological treatment process. BOD, COD values are high indicating the presence of large amount of organic loading matter. As more nutrients are available in the waste for micro organic to thrive (which are responsible for biodegladation) any biological process treatment can be employed which best suits to the condition of the milk plant.

COMPOSITION OF THE DAIRY WASTE WATER:

S. No	Particulars	Value
1.	PH	7.2
2.	Alkalinity	600 mg/lit
3.	Total dissolved solids	1060 mg/lit
4.	Suspended solids	760mg/lit
5.	BOD	240mg/lit
6.	COD	84mg/lit
7.	Oil and grease	290mg/lit
8.	Chlorides	105mg/lit
9.	Phosphorous	11.7 mg/lit
10.	Total Nitrogen	84.mg/lit

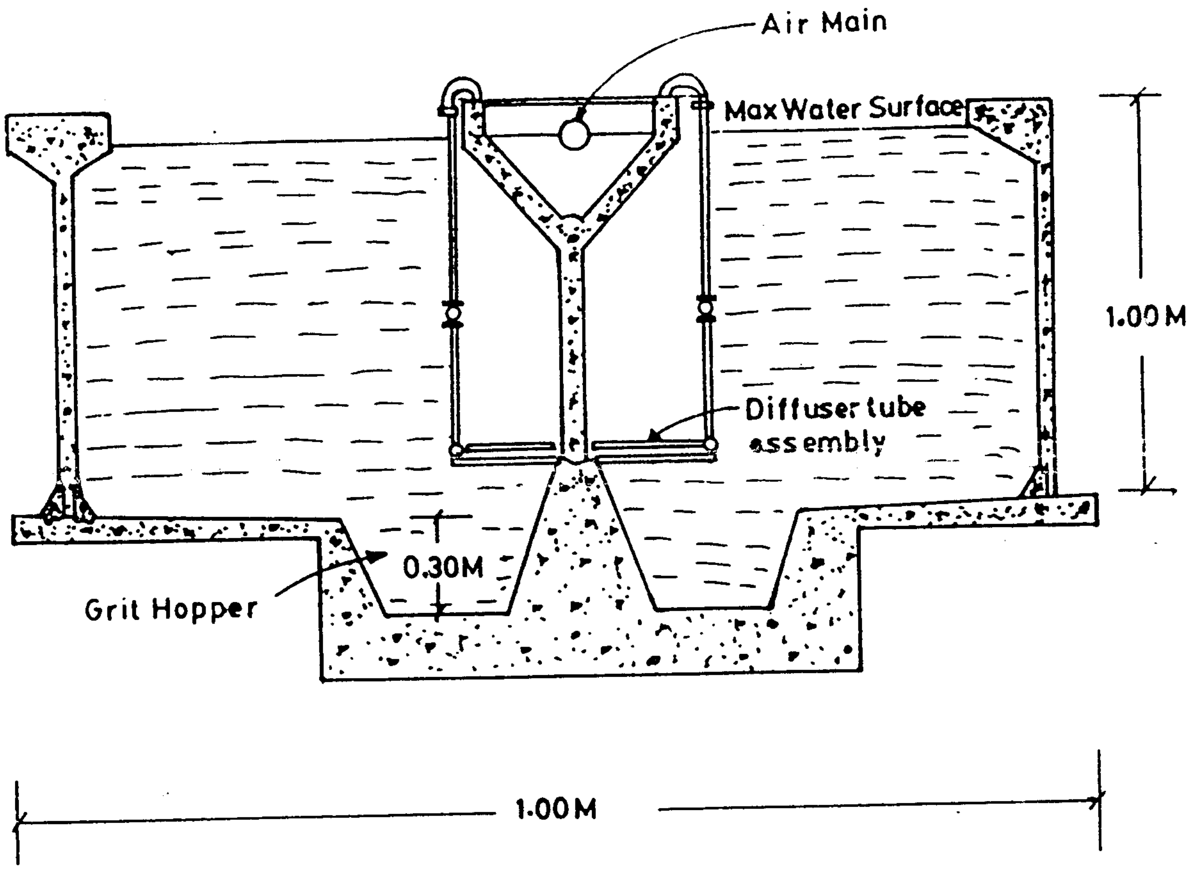
STANDARDS FOR SEWAGE AND TRADE EFFLUENT DISCHARGE INTO STREAMS AND ON LAND

S.No	Characteristic	Stream	Onland
1.	Total Suspended solids mg/l max	-	2100
2.	Particle size of total suspended solids	Stall pass 850 micron IS sieve	-
3.	PH	5.5to9.0	5.5 - 9.0
4.	B.O.D for 5 days at 20°cmg/l.max	30	200
5.	Oil and grease Mg/l max	10	20
6.	Colour and odour	absent	ABsent
7.	Chemical oxygen demand mg/lit mix	250	-
8.	Chlorides(ascl) mg/lit max	1000	600

COMPARISION OF THE TWO METHOD OF DISPOSAL

S. No	Disposal on land	By Dilusion
1.	For land disposal, large areas with preferably s andy type of soils are required.	Large volume of clean water with high D.O contents are necessary
2.	All the land required may not be available at one place and more number of disposal Points may be required	Similarly large volumes of water may not be available throughout the year summer being the most critical season when the volume of water and the available D.O both are less
3.	The cost of land might be prohibitive but by adopting sewage farming seme return can be obtained for which good management is also required.	Low cost operation and no return is possible.
4.	It requires either preliminary (or) Primary treatment of sewage.	Dilusion may usually need either full or at least portional treatment. This involves entra cm and operational troubles.

5.	It sewes the inland streams from getting polluted by the sewage and returns to the land the feri-lising element present ir the sewage	It causes stream pollution and unavoidable health hazards. Town situated down stream therefore, cannot use the water in the stream for their water supply purpose without adequate treatment.
6.	It requires high lead pumping the operational cort of which is is therefore, high	It usually requires no (or) low head pumping because streams pass through the lowest contouss and valleys



.CROSS SECTION THROUGH AERATED GRIT CHAMBER

Fig 3.1

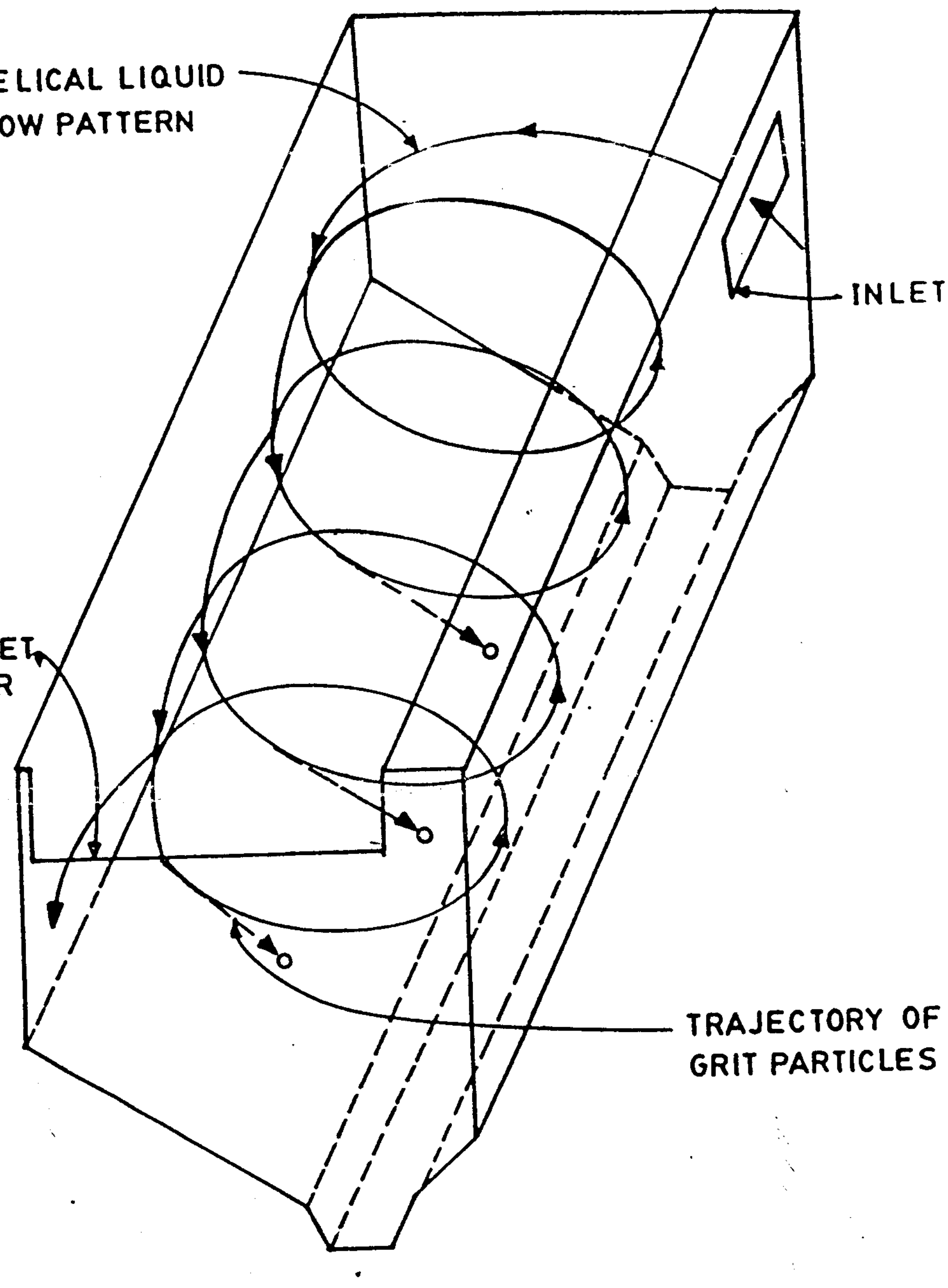
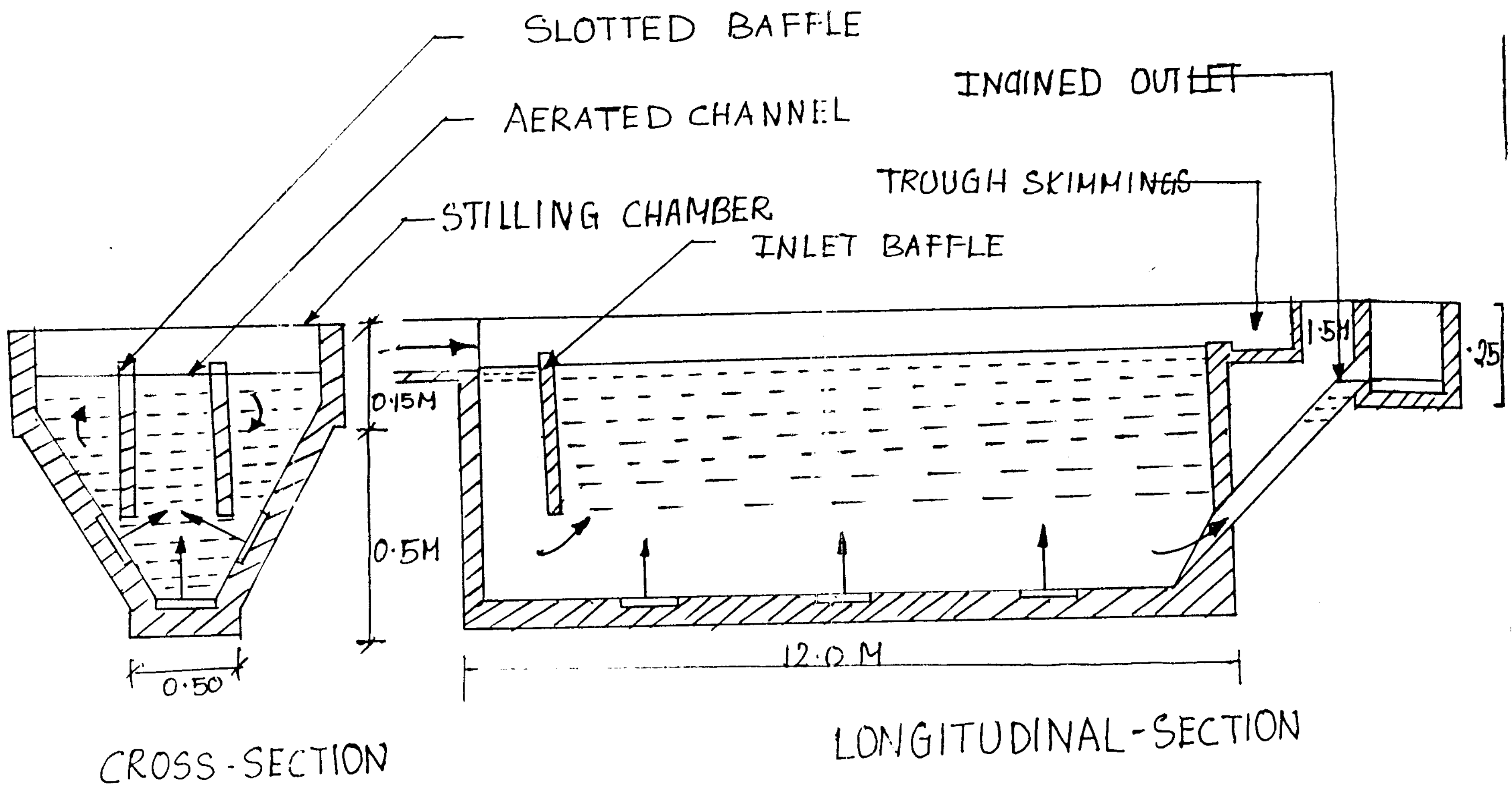


FIG 3.2

HELICAL FLOW PATTERN IN AERATED GRIT CHAMBER



SKIMMING TANK Fig 3.3

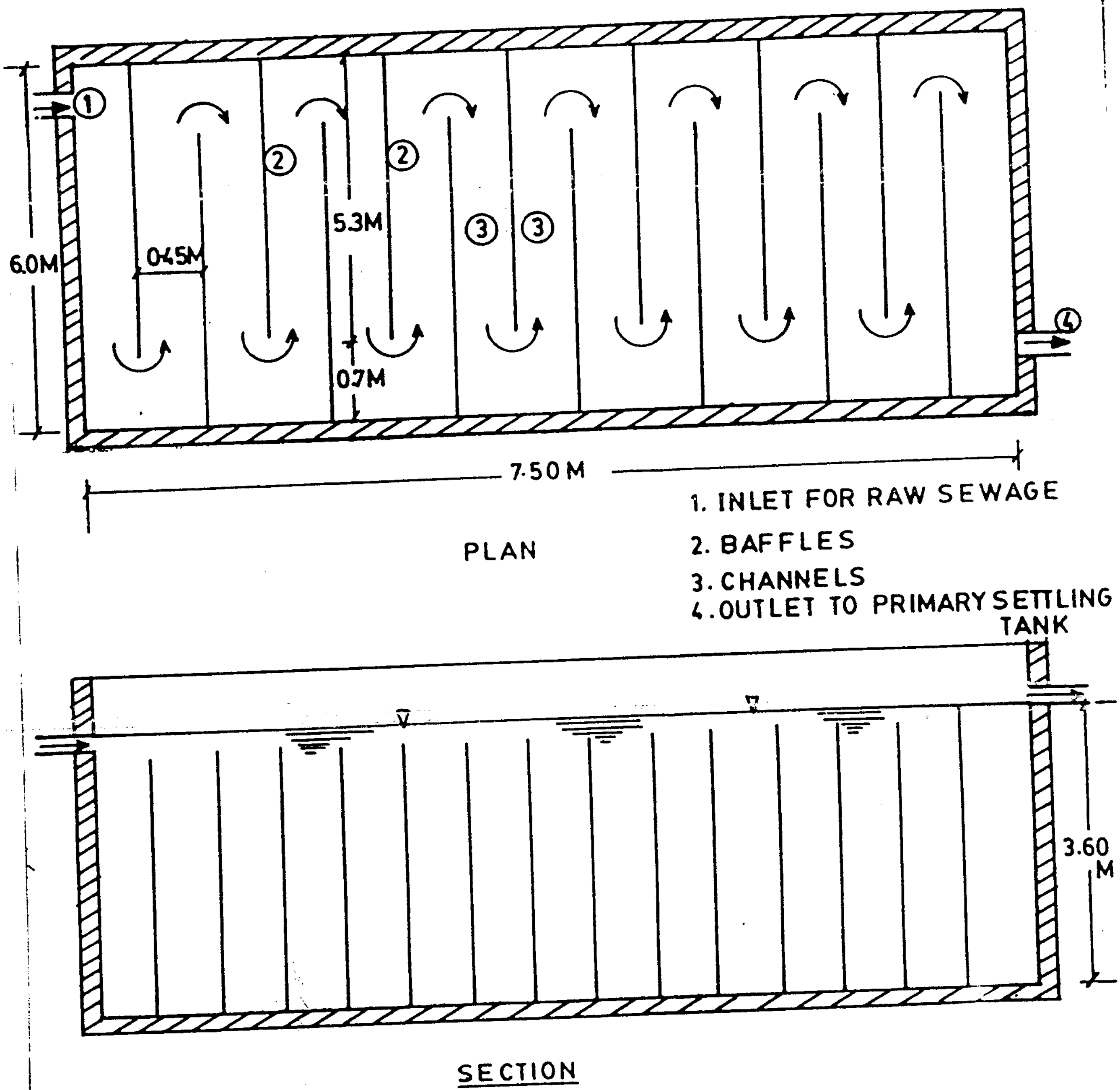
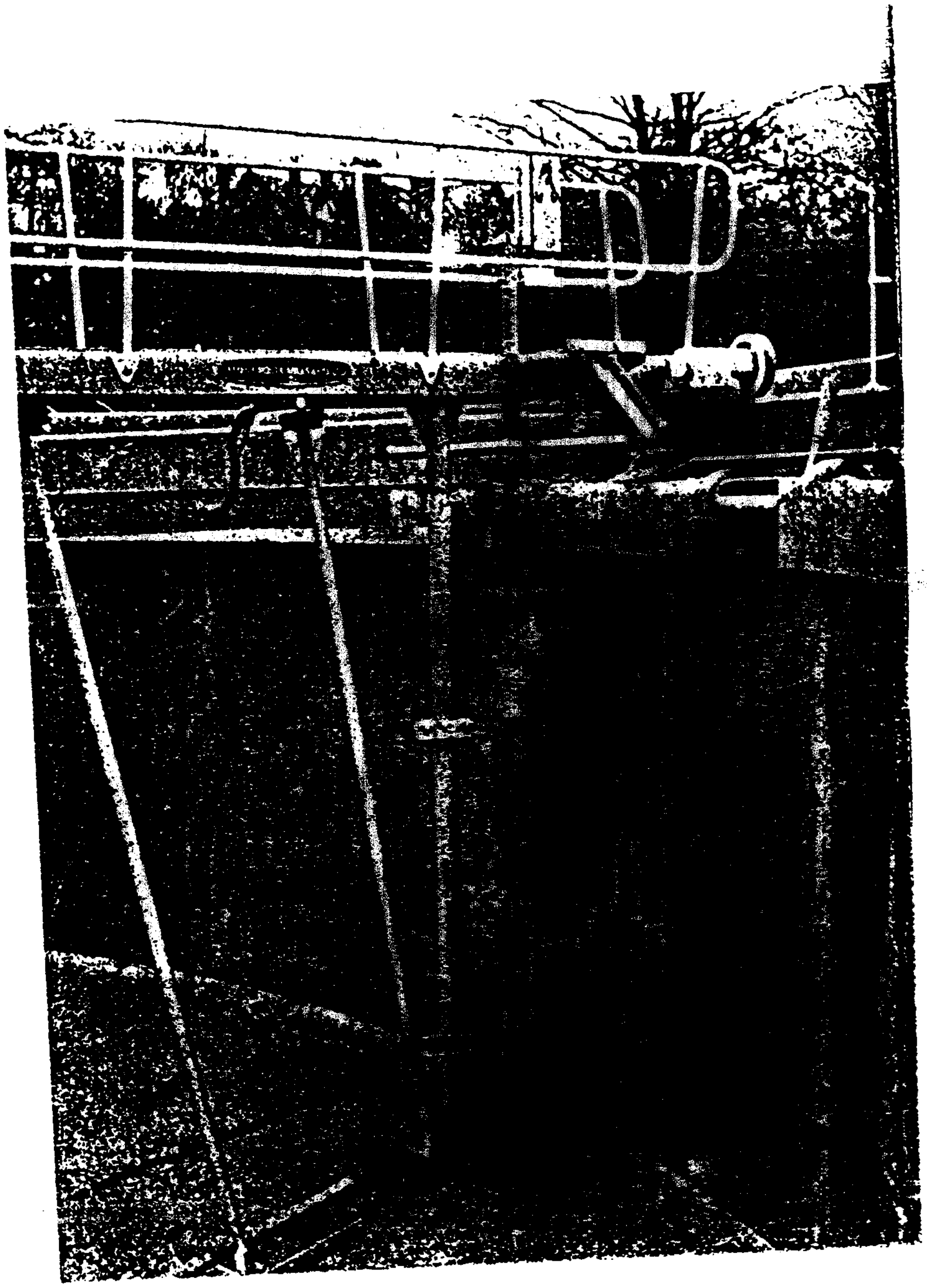
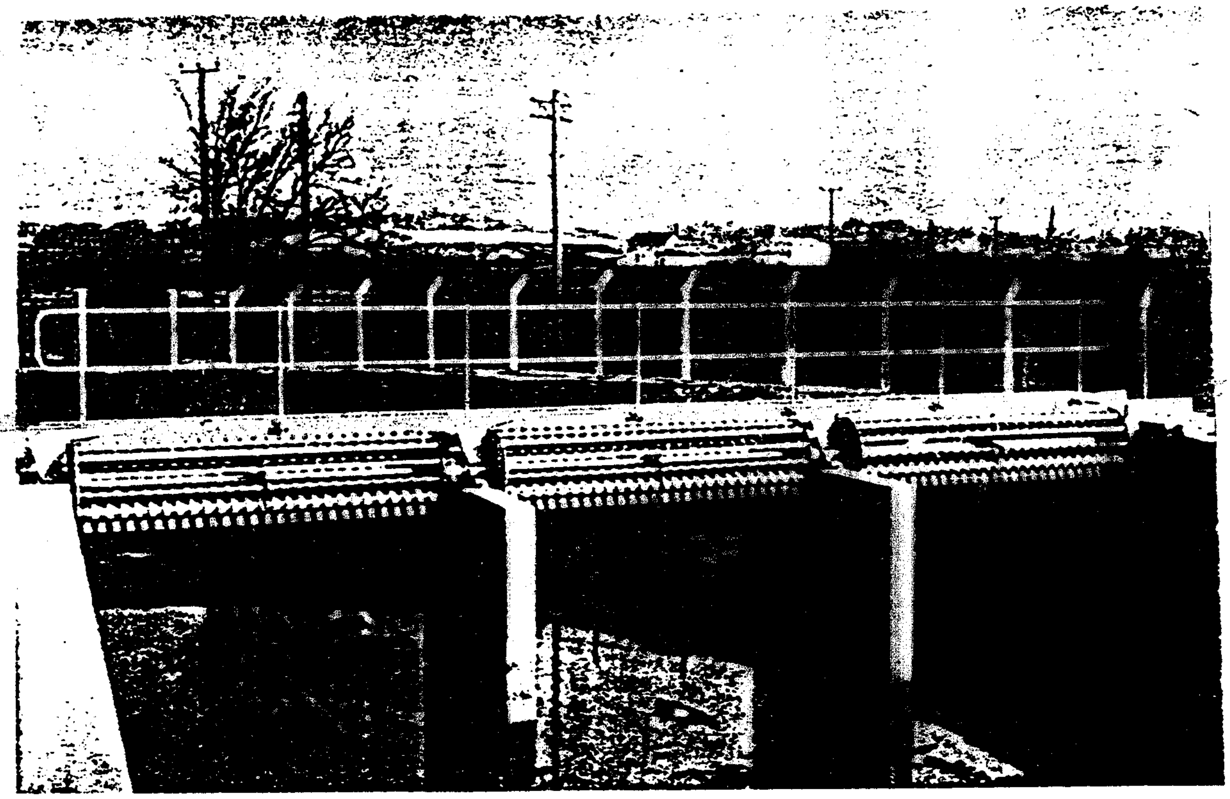


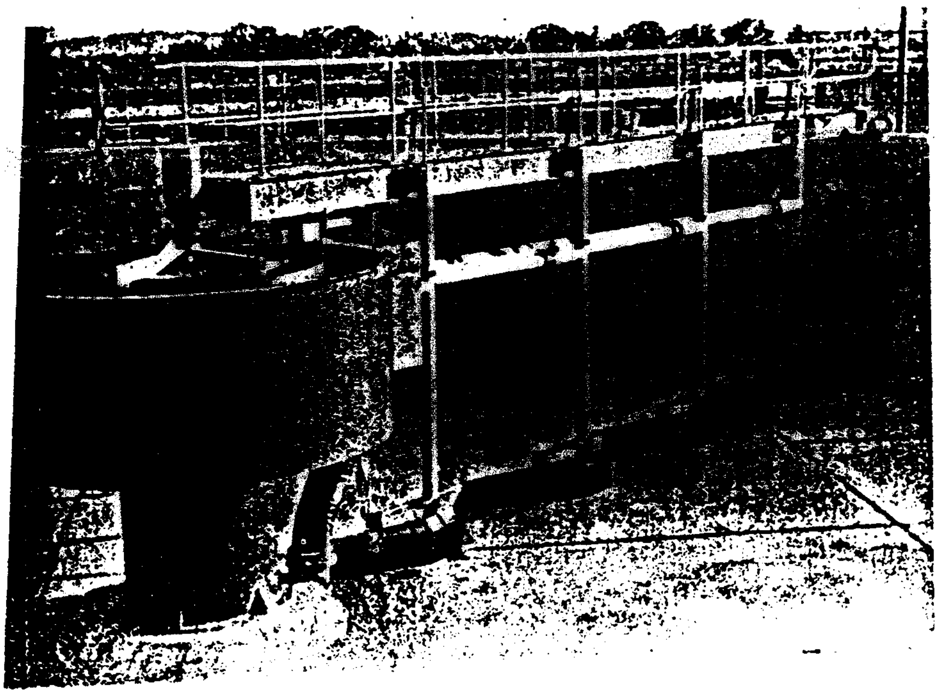
FIG. 3.4 EQUILIZATION TANK



SEDIMENTATION TANK Fig 3.7



SEDIMENTATION TANK FIG 3.8



FINAL SETTLING TANK FIG 3.9

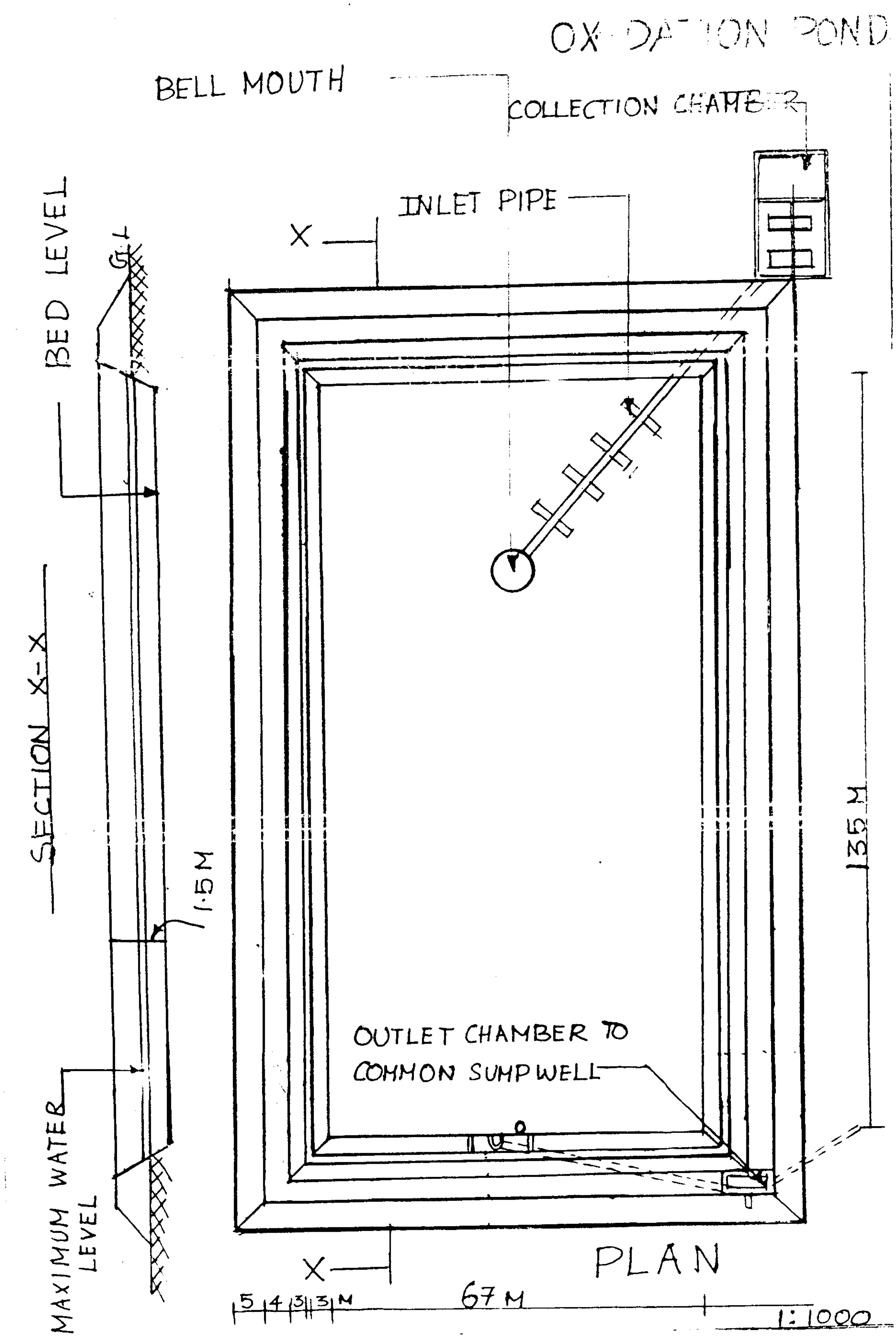
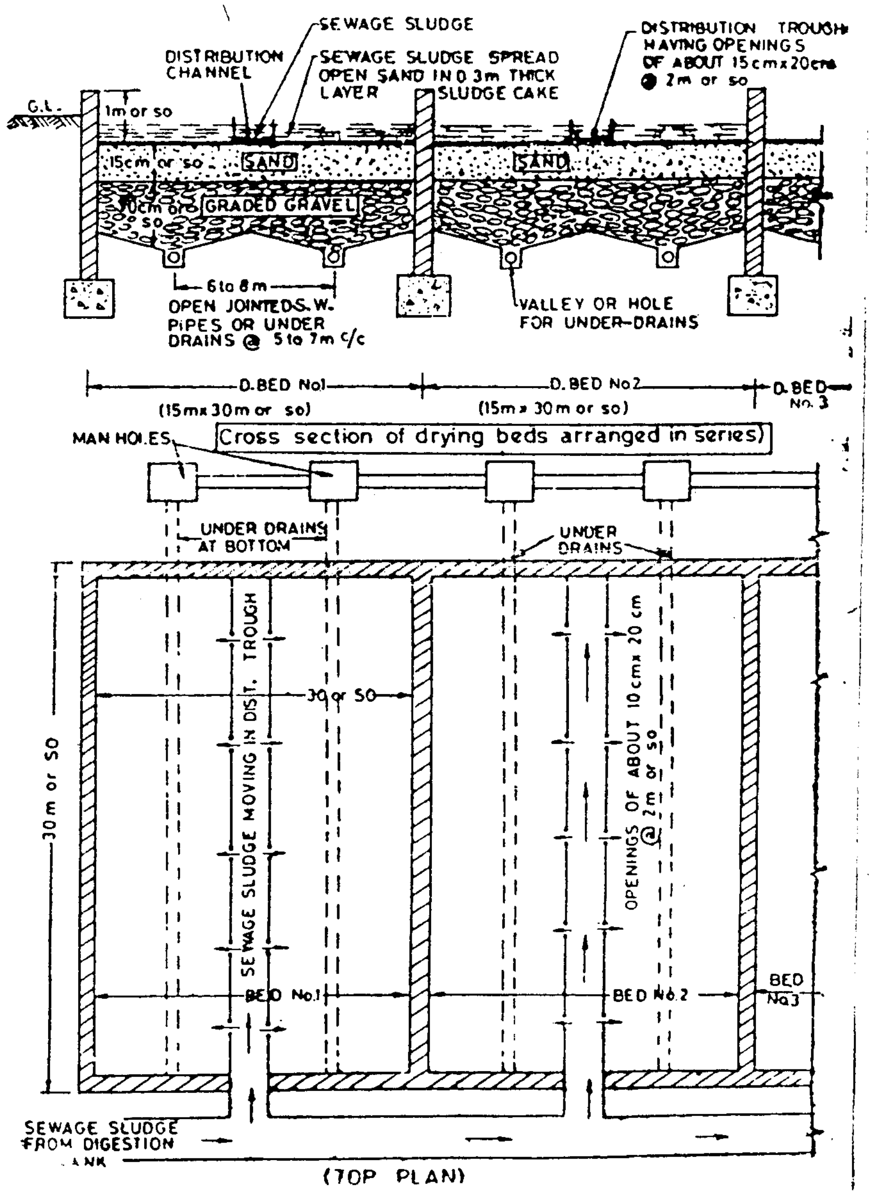
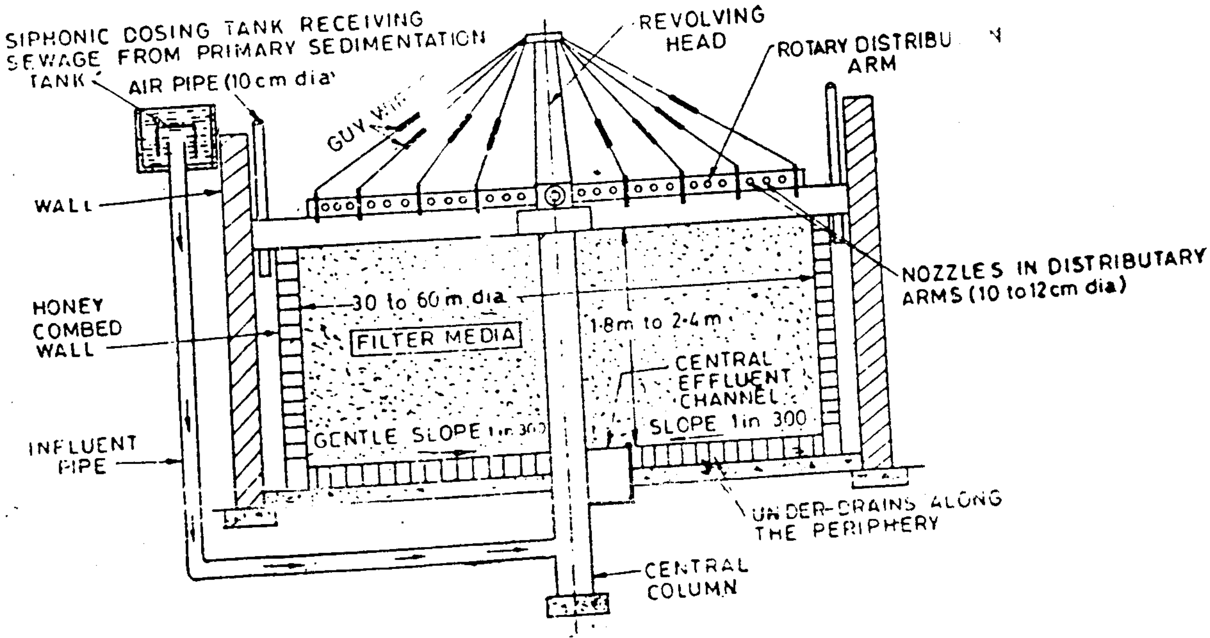

OX DATION POND
BELL MOUTH
COLLECTION CHAMBER
INLET PIPE
X
BED LEVEL
G.L
SECTION X-X
1.5M
MAXIMUM WATER LEVEL
135 M
OUTLET CHAMBER TO COMMON SUMPWELL
X
PLAN
5 4 3 3 M
67 M
1:1000

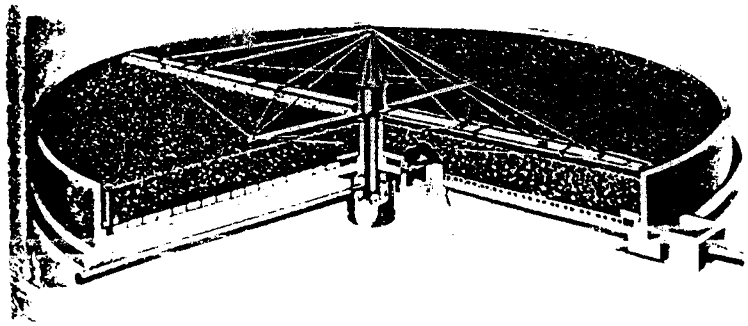
FIG 3.10



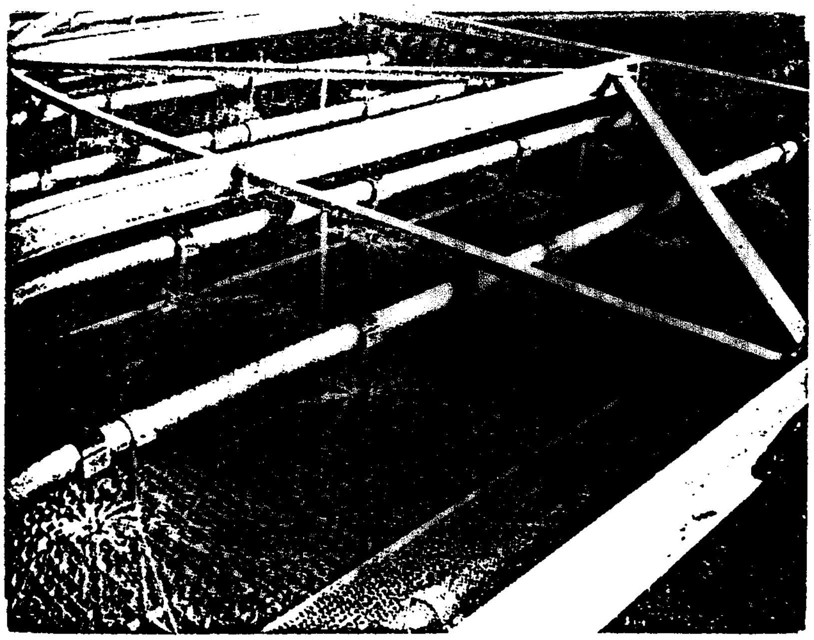
SLUDGE DRYING BEDS FIG 3.11



TYPICAL SECTION OF A CONVENTIONAL CIRCULAR TRICKLING FILTER WITH ROTARY DISTRIBUTORS FIG 3.12

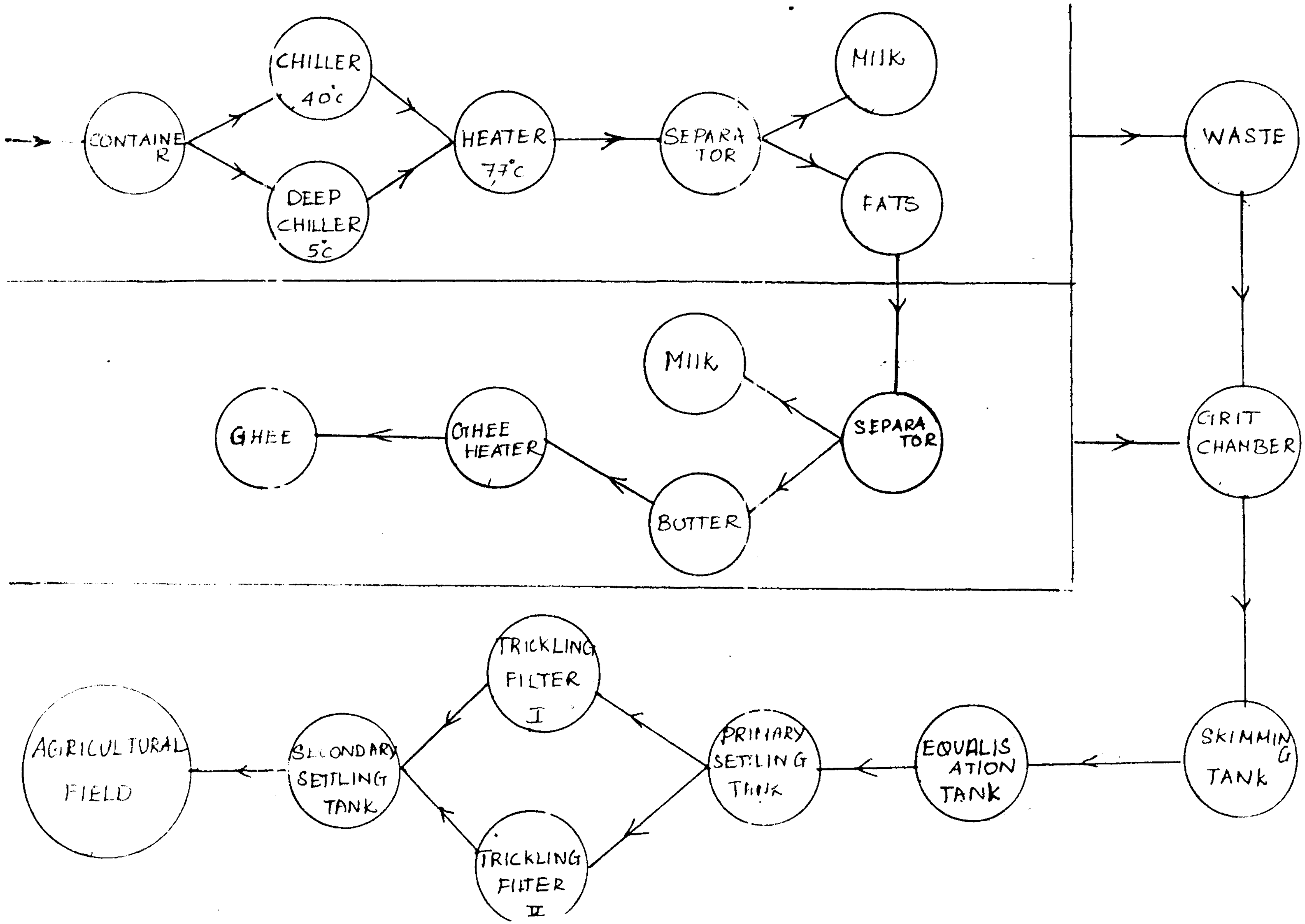


dd TRICKLING FILTER FIG 3.13



SHEETPLASTICTRICKLING FILTER MEDIUM

FIG 3.14



FLOW DIAGRAM FOR PROCESSING IN DAIRY FIG 3.15