Chapter I

INTRODUCTION:

The characterisation of an Industrial waste is essential before selecting a proper method of treatment for its disposal. Broadly, the liquid industrial wastes may be classified based on the following parameters : dissolved solids, suspended solids, pH, BOD, COD, inorganic solids, toxic metals, cations etc. The liquid wastes containing high inorganic solids can be treated by Physico-Chemical methods. However, liquid wastes containing high organic solids, BOD can be treated economically by biological methods. A biological process can be classified as (i) aerobic, and (ii) anaerobic. The choice of this particular method depends on the concentration of dissolved solids and organic matter. Anaerobic method is cheap and economical when liquid wastes containing high organic matter is to be treated. It is also found advantageous to use anaerobic process for a particular Industrial waste which is deficient in nutrients such as Nitrogen and Phosphorous. It is proved that in an anaerobic system the nutrient requirements are almost half as compared to aerobic system.

Gehm and Morgan[1] have pointed out that the wastes to be treated by anaerobic digestion should preferably have the following characteristics : (i) BOD greater than 500 p.p.m., (ii) Nitrogen:Carbon ratio of at least 1:20. Buswell[2][3] considers that anaerobic digestion is best carried out on wastes containing 1-3 percent digestible solids. The cost of the waste treatment decreases as the waste concentration increases. In general, it was reported that concentrated organic wastes can be treated successfully by anaerobic digestion.(4)(5)(6)

1.A Nature and Importance of the Distillery Waste Problem in India

In India there are about 77 distilleries with an installed capacity of about 450 million litres of rectified spirit annually. It is estimated that about 15 litres of spent wash or effluent is discharged for each litre of rectified spirit produced. The waste water resulting from Distilleries in India is, therefore, about 6750 million litres daily. All the Distilleries in India are based on the utilisation of cane sugar molasses as raw material. It is estimated that the industry will be almost doubled in its production in the next decade.

The Distillery waste resulting from alcohol manufacturing industry in India uses cane sugar molasses as raw material. The characteristics of cane sugar molasses are summarised in Table I.

The cane sugar molasses which is also called as mother liquor is diluted about five times and admitted to prefermenter where yeast culture is added. It is then admitted to Fermentation vat where CO_2 evolved is either collected or allowed to escape into atmosphere. The detention time in prefermenter and Fermentation vats are adjusted to approximately 24 hours. It is also a practice to bubble air in the prefermenter for a short period of time (3 to 5 minutes) in order to mix thoroughly yeast culture with molasses. The prefermenter vat temperature is maintained nearabout 35°C by circulating cold water. The vats are washed daily once and settled yeast sludge is let into drain. The prefermented liquor is taken to a distillation column where rectified spirit is continuously taken into a storage tank and the residue of the ~~xx~~ distill which is called as spent wash is discharged into a drain.

In this process, there are two types of wastes resulting from the Industry, i.e. (1) Yeast sludge, and (2) Spent wash.

(1) The yeast sludge is drained only once in a day and the quantity of waste is about 10,000 litres/day when 45,000 litres of rectified spirit is produced per day. It is stored in open pits and allowed to dry and then used in fields as manure. (2) The spent wash is discharged continuously as effluent and it is estimated each litre of rectified spirit produced per day results in a spent wash quantity of 15 litres. The characteristics of spent wash are summarised in Table II.

It is seen from Table II that this waste is characterised by high dissolved solids, high BOD and low pH.

1.B <u>Methods of Treatment</u>

Distillery waste treatment by anaerobic digestion was studied by Neave and Buswell as early as in 1928[7]. Boruff and Buswell[8] studied the commercial solvent beer slop and found that the gas yield is about 18 volumes per volume of distillery slop. The percent volatile matter reduction was 88 to 72 percent at a detention time of 6 to 8 days. Stander and Hide[9] reported anaerobic digestion studies on distillery wastes in South Africa and found that it is the cheapest method of treatment. Sen and Bhaskaran[10] carried out laboratory investigations to treat distillery waste on anaerobic digestion principles at 37°C. The loading used was 3.01 kg BOD/cum/day at a detention time of 10 days. The gas yield was 20 times per each volume of the waste water. During the digestion process more than 90 percent of BOD was removed. Parthasarathy et al[11] carried out detailed laboratory studies to determine the optimum conditions of operation under which anaerobic digestion of distillery waste could be done. Experiments have shown that an optimum BOD loading 0.688 lb/cft/day gave a BOD reduction of 90-95 percent. The Distillery waste is treated in Japan[12] based on the principles of anaerobic digestion both at thermophilic and mesophilic temperature ranges. It was reported that 85 to 90 percent BOD removal was obtained. The economics of the project has been also worked out to Indian conditions. It was found that the effluent resulting from a distillery having a capacity of 20,000 litres of alcohol per day would involve a capital expenditure of forty lakhs of rupees. The setting up of a distillery itself would almost cost the same amount. Besides, the high sulphates concentration present in molasses and in turn in effluent would cause severe corrosion problems unless the gas is scrubbed which was found to be a huge recurring expenditure on the operation of the digester plants.

Spent wash contains about 0.6 to 1.2 percent of Potassium. Potassium is at present imported by India from other countries. Efforts were also made by various investigators in India[13][14] to recover potassium from spent wash. The method adopted is to concentrate the effluent in multiple effect evaporators and spray drying. Since the initial pH of raw spent wash is about 4.0, it has to be neutralised or stainless steel evaporators are to be used. The economics of this process has also been proved to be impracticable for any distillery in India to exploit the process even on a pilot plant scale.

Sharma et al[15] obtained encouraging results on laboratory scale in growing yeast Saccharomyces Cerevisia on distillery waste. Under optimum conditions of pH and inoculum, aeration periods ranged from 90 to 120 hours. Total sugar and BOD reductions at 60 percent and 57.5 percent respectively were obtained under optimum set of conditions.

At present, many distilleries in India follow the practice of solar evaporation. Spent wash is spread over on land in shallow trenches and allowed to evaporate with the help of solar energy. Eventhough this method results in ground water pollution and also cause lot of smell nuisance, this practice is being continued in the absence of any economical method. About 35 to 40 hectares of area is normally used to treat 3 lakh litres of spent wash per day.

Some of the Factories store spent wash in holding tanks and discharge into nearby streams and nallas in high floods.

Both the above methods are now being discouraged with the recent legislation formed by Central and State Governments in India to control water pollution in streams and natural water resources.

A few industries have the facilities of diluting the effluent. It is observed in certain places the effluent is put in the lift irrigation schemes where the dilution is more than 500 times xxxxx and applied on land for irrigation.

A review of the available methods indicated a definite study to be undertaken to find out a suitable method of treatment for distillery waste.

1.C Purpose of the study

It has to be realised that water pollution control has to be considered in relation to environmental pollution and not in isolation. It is a multi-disciplined science and as such requires multiple approach. The possibilities of solutions can be as many as varied as the industries themselves, and again, for the same industry solutions may be different in different situations of environment. The availability of technology within the country at reasonable costs is also an important consideration.

It is therefore attempted to find a simple and economical method of disposing the distillery waste without creating any health hazards to the community. The water pollution control has gained a considerable impact on the socio-economic life of the community. In a developing country like India, economy plays a major role while deciding the method of treatment to be given to a particular industrial waste. Bearing this fact in view and also the degradability of the waste, "anaerobic lagooning method" was used to treat distillery waste. This method was found to be suitable for this particular waste because of high organic matter content and low BOD:N:P ratio. It is pertinent to mention that climatic conditions in India are extremely favourable for this method of treatment. The temperature variations are marginal in most of the parts of India and even in winter season an average temperature of 18°C is recorded in many parts of India. Besides, the simplicity of the process is one of the major criteria as the Industrial growth may be severly hampered if sizeable amounts are spent on waste water treatment projects. The other important consideration to select this process is to return waste water to soil after some pre-treatment as India is a highly agro-based nation.

Based on the above guide lines, "anaerobic lagooning" method has been selected to treat distillery wastes. Eventhough anaerobic lagooning is not a new innovation and it is applied widely to treat variety of Industrial wastes, it is proposed to study certain aspects more in detail such as optimum detention time, organic loading, solids retention time, effect of cations, use of this waste after treatment on land. It was also felt necessary to treat anaerobic lagoon effluent further by aerobic treatment to see the possibility of letting this waste into streams. The implications of such treatment are also explored.

In order to simulate the field conditions, laboratory experiments were being conducted under uncontrolled conditions to obtain the design criteria. Based on the experience gained in laboratory models, pilot plant and full scale treatment plants are designed and operated. The data obtained was processed to put limitation, if any, under the laboratory, pilot plant and full scale conditions.

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Table - I

CHARACTERISTICS OF CANE SUGAR MOLASSES

Sr.No.	Parameter	
1	Sp.gravity	1.42
2	pH (2:1) dilution	5.50
3	Moisture (percentage)	20.0
4	Dry Matter	80.0
5	Total Inverted Sugar as glucose (percentage)	56.0
6	Ash percentage	9.0
7	Phosphorous (percentage)	0.9
8	Calcium (percentage)	0.5
9	Magnesium (percentage)	0.07
10	Potassium (Percentage)	3.60
11	Nitrogen (percentage)	0.80

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Table - II

CHARACTERISTICS OF SPENT WASH FROM A CANE SUGAR MOLASSES INDUSTRY.

Parameter	Concentration
Colour	Dark Brown
Odour	Sugar Smell
Temperature	90° - 95°C
BOD	35,000 - 45,000 mg/l
COD	65,000 - 95,000 mg/l
pH	4.0 - 5.4
Total Solids	52,000 - 86,000 mg/l
Total Volatile Solids	40,000 - 60,000 mg/l
Total Volatile acids as acetic	5,000 - 5,500 mg/l
Total Alkalinity	
Sulphates	2,000 - 5,000 mg/l
Potassium as K	0.8 to 1.0 percent
Total Nitrogen	1,000 - 1,200 mg/l
Free Ammonia (as N)	20 - 40 mg/l
Chlorides	5,000 - 6,000 mg/l
Phosphorous (as PO_4)	800 - 1200 mg/l
Sodium	150 - 200 mg/l
Calcium	500 - 600 mg/l
Iron (Fe)	50 - 80 mg/l

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