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A STUDY ON BEHAVIOUR OF HUASB REACTOR FOR SULPHATE FREE DISTILLERY WASTEWATER

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Abstract - *Presently in India there are nearly around 300 distillery units producing alcohol using molasses a raw material which is by-product of sugarcane industry. Distillery industry requires huge amount of water for the alcohol production. In distillery industry the main wastewater which is generating in the production of alcohol and spent wash is the major wastewater in distillery industry, which contains high COD, BOD, Total solids and is acetic in nature. In this study, a laboratory scale Hybrid Up-flow Anaerobic Sludge Blanket Reactors(HUASB) were constructed for treating distillery spent wash using Polypropylene pall rings as a packing materials. The reactors were operated at different Hydraulic Retention Period (HRT) i.e. 48hrs, 24hrs, 18hrs, 12hrs, 8hrs and 6hrs at COD feed concentration of 1000mg/L to obtain optimum Hydraulic Retention Period (HRT) and it was found to be 8hrs for both the reactors. After finding optimum HRT, the reactors were studied to treat the distillery spent wash at various COD feed concentration. Optimum COD feed concentration was found to be 3000mg/L and 89.66% COD removal efficiency for A-Reactor and 88.33% for B-Reactor. Later on Reactor-B was loaded with sulphate free distillery spent wash of 3000mg/L influent feed concentration and the maximum COD removal efficiency was observed to be 92%. The maximum removal efficiency of TS and TDS was found to be 90.90% for A-reactor and 89.09% for B-Reactor of Feed Concentration of 1000ppm and 92.23% for A-Reactor and 90.29 % B-Reactor respectively and maximum removal efficiency of TSS was found to be 83.33 and 75% for A and B-Reactor respectively at a Feed Concentration of 1500ppm.*

***Key Words*: Anaerobic Reactor, Polypropylene pall rings, Hydraulic Retention Time, Spent wash, Fermentation**

1.INTRODUCTION

Population growth and rapid industrialization are effected in the contamination of several species on which circumstances depend on [1]. Many industries, agricultural wastewater is directly discharge to the natural streams, these directly discharged wastewater is comes and contacts with natural streams and its contaminating the water bodies, also it effects the aquatic life. Degradation and water scarcity are most censorious matter in now a day's. Treatment and usage of that decreases the scarcity of water [2]. Most of the sources like industries, municipal and agricultural sectors produces huge amount of wastewaters. The wastewater generated from these above mentioned sectors are directly discharged into the environment means it leads to pollute the environment in large scale and it includes soil, air, water will get degrade. These pollutants not only pollute the environment, they are also having the potential to produce some amount of energy. Wastewater treatment methods are those which reduce the waste contaminants from the waste water coming from household as well as industries. There are three types of wastewater treatments namely physical, chemical and biological treatment. These treatments produce treated wastewater that is free from contaminants and provides safe environment. Sedimentation is one of the physical treatment processes which are used to achieve treatment and the aeration is used to provide oxygen to the wastewater. Chemicals are used during the chemical treatment to treat the wastewater. Biological treatment methods are best way to treat these wastewaters for extraction of energy and reutilization of wastewater. There are two types of secondary treatment methods they are namely aerobic and anaerobic treatment. Anaerobic method is the better method to treat waste water it also generates the energy in the form of biogas, where as aerobic method requires some amount of energy [3].

2. DISTILLERY INDUSTRY

The distillery industry is the part of the beverage and food industries busy in clarifying, blending, flavouring and aging alcohol to make potable spirits like grain spirits, brandies, rum etc and which manufacture ethyl alcohol, whether they are or are not used in potable spirits. The first distillery was started in India from "Carew and Co. Ltd" in 1805 at Cawnpore now a day's it is changed to Kanpur the liquor was produced for the sake of armed forces. In olden days instead of using beverage they were use Alcohol and it is called as samaras in Vedic times and it was utilized for its stimulating impacts as well as in love and restorative employments [20]. Due to increase in population the alcohol consumption rate is also increasing at a greater rate. Presently in India there are nearly around 300 distillery units producing alcohol using molasses a raw material which is by-product of sugarcane industry. There are mainly two types of distillery industries which are namely grain based distillery and molasses based distillery industry. Distillery industries requires large quantity of water

for the production of alcohol and it also produces the huge amount of wastewater which is highly contaminated and highly toxic in nature, due to its high toxicity it pollutes the nature and harm to the environment as well as human beings. Hence distillery industries are listed in the list of "Red category" industry. In distillery industry the main wastewater which is generating in the production of alcohol and spent wash is the major wastewater in distillery industry, which has high BOD, COD, Total solids and very low pH [5].

3. SPENT WASH GENERATION DEPENDS ON:

a. Type of fermentation process (batch or continuous).
b. Type of distillation process (atmospheric or multi-pressure).
c. Distillation of re-boiler or without re-boiler.
d. Distillation with or without integrated evaporation system.
e. Stand alone evaporation system.
f. Alcohol concentration is fermented wash depends on molasses quality.
g. Selection of yeast culture.
h. Spent wash recycle % (depends on final alcohol quality).

4. EFFECTS OF DISTILLERY WASTEWATER

Distillery industries are important to the global resources. It is one of the highly important sources of pollution for the environment because of its dark colour, very low pH high COD, BOD, Phosphates, Total Solids and huge amount of toxic substances. Also it includes melanoidins, di-butyl phthalate, benzenepropanoic acid and toxic substances of organic and inorganic pollutants, which are carcinogenic and genotoxicin nature. It leads to the serious environmental problem by decreasing photosynthetic activitiesdue to this the aquatic resources will get difficulty for their survival. Similarly in agricultural land due to the discharge of untreated distillery wastewater, it causes the depletion of vegetation and inhibition of seed germination by decreasing the manganese availability and soil alkalinity [4].

5. STATEMENT OF THE PROBLEM

This part of state has seen rapid industrialisation and especially in the field of Sugar production. The waste molasses from sugar industries has encouraged for setting up of new distilleries in the region due to easy availability of raw material. Distillery wastewater mainly contains the high concentration of parameters like pH, colour, temperature, BOD, COD, Total solids, nitrates, phosphates etc. This contaminated wastewater is discharged into the natural water bodies. This discharged contaminated wastewater causes an auxiliary contamination of brunette colour, foul odour and fish kill.
In the recent times anaerobic treatment has gained popularity because of aesthetics and recovery of energy in the form of Biogas. The anaerobic treatment behaviour has always been linked to characteristics of feed wastewater. In this study an attempt has been made to check the behaviour of Hybrid UASBR for sulphate free wastewater.

6. OBJECTIVES

The main objectives of this experimental work are as listed below.
• To analyze the characteristics of distillery spent wash.
• Fabrication and design of laboratory scale HUASBR.
• To find optimum Hydraulic Residence Time of the reactors and to compare the efficiencies of both the reactors for COD removal for different feed concentrations.
• To compare the efficiencies of both the reactors for COD removal efficiencies for different feed concentrations of sulphate free spent wash and normal spent wash.

7. MATERIALS AND METHODOLOGY

The design of hybrid UASB reactor were designed and fabricated based on the laboratory scale the research done by many researchers on design of UASB reactor and its process for treating industrial wastewater, according to different design studies the fabrication of the reactor were done. In the present study the reactor were designed as a circular shaped based on the laboratory scale having design features and packing media [16]. The overall height of the hybrid UASB reactor is 1220 mm and the reactor effective volume is 16.9 L. The effective height of the reactor is 1070 mm and the seed sludge was feed into the reactor before feeding. The passed sludge was sieved into 1 mm sieve in order to eliminate the beats. The sampling port was fixed at various levels 25%, 50% and 75% of overall height of the reactor to collect the sample.
The working volumes of two hybrid UASB reactors are 13 litres. In order to maintain anaerobic condition both the reactors were thoroughly checked for leakage test. Cow dung is used as seed culture. Both the reactors were filled cow dung for about 25% "working volume" of reactors. Initially spent wash having "COD feed concentration of 500 mg/L was loaded" to both of the reactors. In this study "start up periods" were found out to be 53 days for A-Reactor and 55 days for B-Reactor.

8. POLYPROPYLENE PALL RINGS

Polypropylene pall ring is a thermoplastic used for different applications in the commercial ventures. Up to 50% of the polypropylene pall rings was filled to the overall volume of the reactor. The polypropylene pall rings have the various characteristics such as low pressure drop, high free volume, low mass exchange productivity, small specific gravity and high flooding point [19, 20].

9. RESULTS AND DISCUSSION

Table -1: characteristics of distillery spent wash.

Characteristics	Values
pH	4.40
Colour	Dark brown
Conductivity (µs/cm)	98.64
BOD_3@27^{0}C (mg/L)	53,040
COD (mg/L)	1,30,000
Total Solids (mg/L)	4,50,000
Dissolved Solids (mg/L)	3,50,000
Suspended Solids (mg/L)	1,00,000
Sulfate(mg/L)	8750

9.1 COD removal efficiency at different Hydraulic Retention Time (HRT):

Initially, the reactors were filled with COD feed concentration of 1000mg/l. The HRT which had bee was set to 48 hrs initially and was reduced step by step to find efficiency of COD removal at various HRT's. Further the experiment was continued for the optimum HRT.

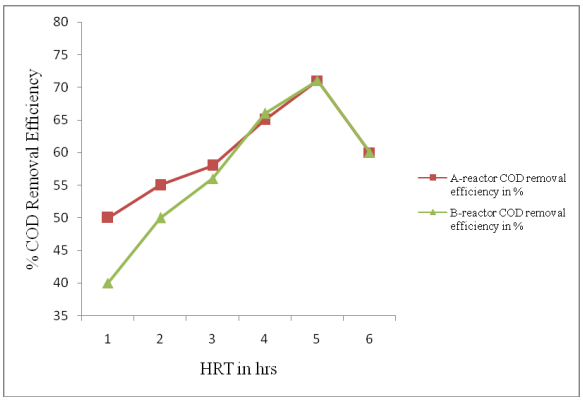

Chart -1: Reduction of COD at decreasing HRTs for the influent COD feed concentration of 1000 mg/L

From the above graph it is evident that, the COD removal efficiency increased as the HRT was reduced. The maximum efficiency for both the reactors was 71% at HRT of 8 hrs. However, the efficiency decreased at 6 hrs HRT and may be due to insufficient time for anaerobic process to be completed. Hence 8 hrs of HRT was considered as optimum HRT for further experiments

9.2 Overall performance of both the reactors for different COD feed concentration at optimum HRT

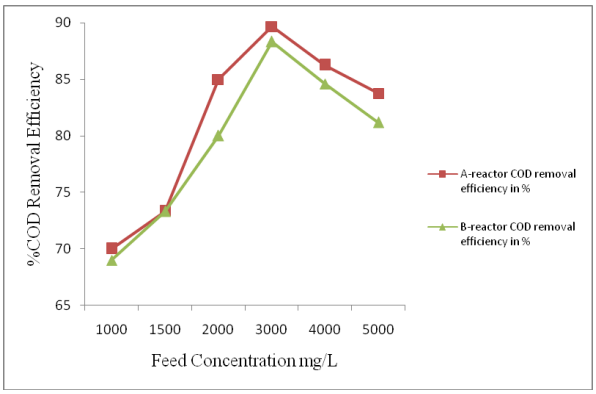

Chart -2: Percentage COD removal efficiency at various COD concentration at 8 hrsHRT

The experimental results clearly shows that the A-Reactor works with maximum removal efficiency (89.66%) at feed concentration of 3000 mg/L where as the maximum efficiency (88.33%) was achieved for B-Reactor at feed concentration of 3000 mg/L of COD respectively. The results obtained from the study are in-line with the outcomes of the literature on hybrid reactors. However the efficiency decreased at the feed concentration of 4000 mg/L, may be at higher concentration, the HRT of the anaerobic process is inadequate or the existing microbial species. Hence 3000mg/L feed concentration was considered as an optimum concentration for further experiments.

9.3 Total solids

It was observed from the analyzed results that the reduction of total solids decreased with increasing the feed concentration of both the reactors.

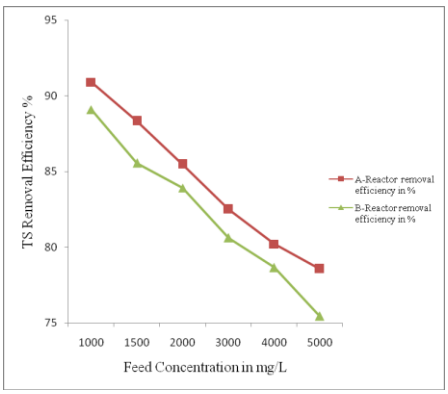

Chart -3: Percentage Total solids removal efficiency at various COD concentration at 8 hrsHRT

Maximum reduction in total solids was reduced from 1100 mg/L to 100 and 120 mg/L for A- Reactor and B-

Reactor respectively. The solid removal efficiencies were 90.90 % and 89.09% for A-Reactor and B-Reactor respectively at COD feed concentration of 1000 mg/L.

9.4 Total dissolved solids

The overall trend from the above results showed that the reduction in dissolved solidsdecreased with increase the feed concentration of both the reactors.

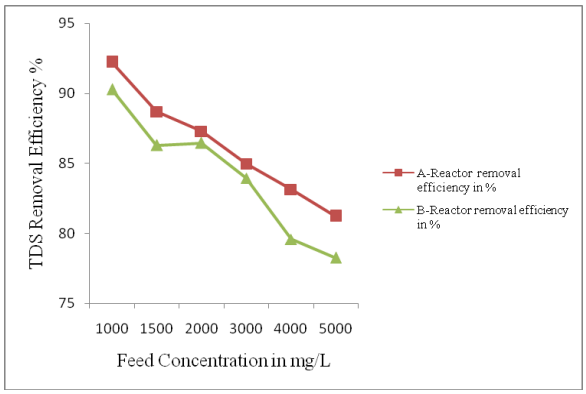

Chart -4: Percentage Total dissolved solids removal efficiency at various COD concentration at 8 hrsHRT

Maximum reduction in total dissolved solids was reduced from 1030 mg/L to 80 and 100 mg/L for A-Reactor and B-Reactor respectively. The total dissolved solids removal efficiencies were 92.23 % and 90.29% for A-Reactor and B-Reactor respectively at COD feed concentration of 1000 mg/L.

9.5 Total suspended solids

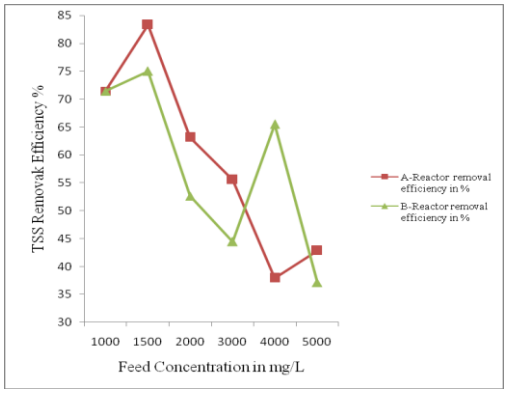

Chart -5: Percentage Total suspended solids removal efficiency at various COD concentration at 8 hrsHRT

9.6 Performance of reactor in COD reduction for sulphate free distillery spent wash at optimum HRT

The experiment was further conducted to find out the performance of reactor for treatment of sulphate free spent wash. Due to time constraints the experiments were conducted from feed concentration of 3000 mg/l based on the earlier finding.

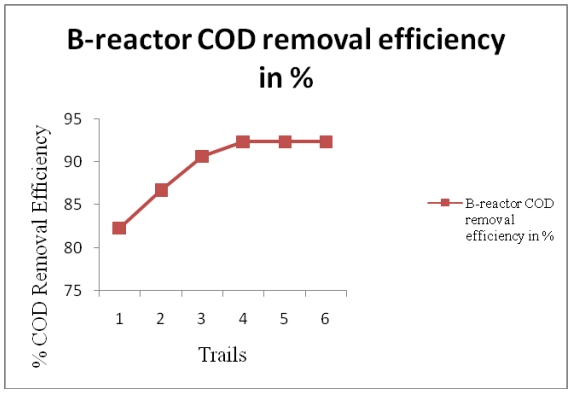

Chart -6: COD removal efficiencies of B-Reactor at 3000 mg/L of COD feedconcentration at optimum HRT

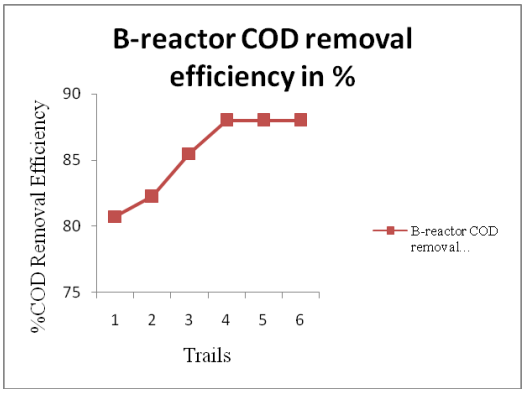

Chart -7: COD removal efficiencies of B-Reactor at 4000 mg/L of COD feedconcentration at optimum HRT

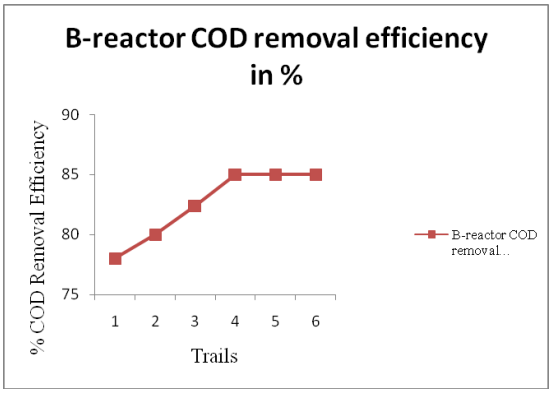

Chart -8: COD removal efficiencies of B-Reactor at 5000 mg/L of COD feedconcentration at optimum HRT

9.7Discussion

The reactors used for the experiments required a start up period of around 55 days. The startup period was short when compared to literature may be the process got expedited due to addition of mineral salts and micronutrients in right proportions.

The feed concentration was slowly raised stage wise from 500mg/l to 5000 mg/l. The reactors worked efficiently throughout the experimental period. The highest efficiency was achieved for 3000mg/l and efficiencies reduced slightly as the feed concentration was increased further. However the efficiencies at 4000mg/l and 5000 mg/l were better compared to the literature referred.

The experimental results for COD removal for feed without sulphate have shown promising results. The efficiencies of reactor fed with sulphate free spent wash have shown better results compared to the rector which was fed with spent wash having sulphate.

10. CONCLUSIONS

From the above experimental study the conclusions are as follows

- The distillery spent wash was analyzed results for pH, Colour, BOD, COD. TS, TDS, Sulphate were 4, Dark Brown, 98.64 µs/cm, 53,040 ppm, 1,30,000 ppm, 4,50,000 ppm, 3,50,000ppm, 1,00,000 ppm and 8,750 ppm. The obtained results clearly shows that they are exceeded their permissible limits to discharge on land and water directly according to CPCB standards hence treatment is required.
- The reactor-A showed a successful start up at 53rd days and reactor-B showed start up at 55th days.
- The optimum HRT of A and B-Reactors were found to be 8 hours. For reactor-A the optimum COD removal efficiency was observed 89.66 % at influent organic loading rate of 3000mg/L and reactor-B the COD reduction of 88.33 % was detected at a influent feed concentration of 3000mg/L.
- From results it was concluded that TS, TDS and TSS solid removal efficiencies were decreased with increase in feed concentration in both the reactors. The maximum removal efficiency of TS and TDS was found to be 90.90 % for A-reactor and 89.09% for B-Reactor of Feed Concentration of 1000 ppm and 92.23 % for A-Reactor and 90.29% B-Reactor respectively. And maximum removal efficiency of TSS was foundto be 83.33 and 75 % for A and B-Reactor respectively at a Feed Concentration of 1500 ppm.
- The maximum COD removal efficiency was 92% for a sulphate free influent feed concentration of 3000mg/L. From the experimental outcomes it is clear that A-Reactor with sulphate is less efficient in treating distillery spent wash when compare to B-Reactor without sulphate feed concentration.

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