International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 05 |Aug-2015 www.irjet.net p-ISSN: 2395-0072

COMPARISON STUDIES ON BIODEGRADATION OF DISTILLERY SPENT WASH USING DIFFERENT PACKING MEDIA IN HUASB REACTORS

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Abstract –*There are nearly 300 distilleries in India that produce about 2.7 billion liters of alcohol and generating 40 billion liters of wastewaters annually. Distillery Industries require huge amount water for production and treatment process. Distillery spentwash is one of the wastewater generated during production of alcohol which contains high COD, BOD, TS and pH which is highly acidic in nature. anaerobic reactors are most advantages over the other technologies because of low sludge production, higher removal efficiency, methane production and low operating costs. Hybrid upflow anaerobic sludge blanket (HUASB) reactor with different packing materials which may be natural or artificial has proved to be highly efficient in treatment of high and low strength industrial wastewaters , but attempt has never been made to utilize Polypropylene pall rings and Fujino spirals as a packing materials in two hybrid reactors for treatment of distillery spentwash. In present study, a laboratory scale Hybrid Upflow Anaerobic Sludge Blanket Reactors (HUASB) were constructed for treating distillery spentwash. The reactors were operated at different Hydraulic Retention Time i.e. 48 hrs, 36 hrs, 24 hrs, 18 hrs, 12 hrs, 8 hrs and 6 hrs at COD feed concentration of 500 mg/L to obtain optimum hydraulic retention time (HRT) and it was found to be 8 hrs for both of the reactors. After finding optimum HRT, the reactors were studied to treat the distillery spentwash at various COD feed concentrations. Optimum COD feed concentration was found to be 2750 mg/L where COD removal efficiency was 87 % for P-Reactor (polypropylene pall rings as a packing media). And 76% COD removal efficiency for F-Reactor (Fujino spirals as a packing media) at an optimum COD feed concentration of 2500 mg/L.*

Key Words: *Hybrid Reactor, start up period, Packing Material, COD, HRT, TS*

1. INTRODUCTION

Over a period of years, continued population growth and rapid industrialization have resulted in the dilapidation of diverse ecosystems on which human existence relies on [1]. Water paucity and water contamination are critical issues in today's world. Water and wastewater treatment and utilization of treated water is one of the best manners to diminish the brunt of water dearth. The increasing lack of water on the planet alongside quick populace increment in urban regions offers ascend to worry about fitting water administration rehearses. In the setting of patterns in urban improvement, wastewater treatment merits more prominent accentuation. Presently, there is a developing familiarity with the effect of sewage tainting on waterways and lakes. As needs be, wastewater treatment is presently accepting more prominent consideration from the World Bank and government administrative bodies.[2]

Untreated crude dissipate fractions from industries, municipalities and agricultural sector putrefy in the environment ensuing in large scale pollution of land, water and air. The wastes from these sources not only signify the menace to the environmental eminence but also possess a latent energy value. This energy is not fully consumed although the fact that they are inexpensive and abundant over the world. In turn to defend the water resources from assault of these wastes, it is necessary to provide satisfactory treatment to reduce their pollution potential. For recyclable impurities, the natural alternative is biological treatment; there are two types of biological treatment which could either be aerobic or anaerobic. During anaerobic treatment small amount of sludge will be produced and also produces large amount of biogas as source of energy while the aerobic treatment desires exterior input of energy for aeration. [3]

2. BIOLOGICAL TREATMENT METHODS OF WASTEWATER

Biological treatment is a vital and basic piece of any wastewater treatment plant that treats wastewater from either region or industry having dissolvable natural pollutions or a blend of the two sorts of wastewater sources. The undeniable monetary point of interest, both regarding capital speculation and working expenses, of organic treatment over other treatment procedures like synthetic oxidation; warm oxidation and so forth has established its place in any coordinated wastewater treatment plant. [4]

2.1Aerobic & Anaerobic

The terms aerobic (oxygen consuming) and anaerobic. High-impact, as the title proposes, implies in the vicinity of air (oxygen); while anaerobic means without air (oxygen). These two terms are specifically identified with the sort of microscopic organisms or microorganisms that are included in the degradation of natural contaminations in a given wastewater and the working states of the bioreactor. Therefore, vigorous treatment procedures occur in the vicinity of air and use those microorganisms (likewise called aerobes), which utilize sub-atomic/free oxygen to acclimatize natural contaminations i.e. change over them into carbon dioxide, water and biomass. The anaerobic treatment forms, on other hand occur without air (and in this way sub-atomic/free oxygen) by those microorganisms (likewise called anaerobes) which don't oblige air (sub-atomic/free oxygen) to absorb natural polluting influences. The last results of natural osmosis in anaerobic treatment are methane and carbon dioxide gas and biomass. [4]

3. HYBRID UPFLOW ANAEROBIC SLUDGE BLANKET (UASB) REACTOR

The Hybrid UASB reactor is a blend of a UASB unit at the lower part and an anaerobic settled film unit at the upper. This reactor appreciates the benefits of both UASB (which guarantees great contact in the middle of biomass and substrate) and anaerobic channel (AFs can hold more biomass inside of the reactor). [5]
The standard HUASB reactor has a filter packing situated in the upper third of the reactor without Gas Liquid Solid (GLS) partition unit.

4. STATEMENT OF THE PROBLEM

Distillery spentwash is an industrial wastewater generated from molasses based distillery industry. The treatment of distillery industry wastewater is critical due to its genuine consequences for the water bodies which is need to be treated due to high characteristics strength like COD & BOD, TDS etc. In the event that untreated distillery spent wash is released into the water courses, especially in the little and non-enduring streams, fast consumption of oxygen because of biological oxidation takes place by anaerobic adjustment of waste causes an auxiliary contamination of bad odor, dark color, and fish mortality.
Industries require high capital investment for treating such wastewater and also maintaining treatment plants involves huge cost; hence economical methods need to be adopted. Anaerobic method is one of the best way to treat the distillery spentwash where reducing the sludge and energy can be recovered in the form of biogas. The use of hybrid upflow anaerobic sludge blanket reactors are popular now a days, these reactor's removal efficiencies can be enhanced by changing their design parameters and also introducing different packing materials which are non corrosive, withstand temperatures upto 60^0C.

5. OBJECTIVES OF THE STUDY

The study has been done to overview the treatment efficiency of distillery spentwash by Hybrid Upflow Anaerobic Sludge Blanket Reactor (HUASB) using different packing material. The specific objectives are as follows

- To analyze the initial characteristics of distillery spentwash.
- To determine the optimum Hydraulic Retention Time (HRT) of the reactor.
- To determine the maximum COD feed concentration for both the reactors.
- To determine bio-gas production in each reactors at optimum HRT

6. MATERIALS AND METHODOLOGY

A laboratory scale hybrid reactors were fabricated The overall height of both the reactors are 1220 mm and the effective volume of the reactors are 16.9 liters .The effective height is 1070 mm about 25 % seed sludge were feed into the reactors before feeding. The sludge was passed into 1 mm sieve in order to eliminate the solid particles. Acrylic sheets were placed in both the reactors. They were placed at 100 mm from top as well as 50 mm distance from bottom to arrest the packing material and reduce the choking problems at inlet as well as outlet. Sampling ports were given to both the reactors as shown in the figure. The sampling ports were fixed at various levels 25 %, 50 % and 75 % of overall height of the reactor.

6.1 Packing Materials

According to previous studies and literature review use of plastic materials are having more advantages in removal efficiencies when compared to others materials. Hence we have selected two packing materials for the present study. They are Polypropylene pall rings and Fujino spirals.

Table 1: Design details of HUASB reactors

Total height	1220mm
Effective height	1070mm
Inner diameter	142 mm
Outer diameter	150mm
Thickness	4 mm

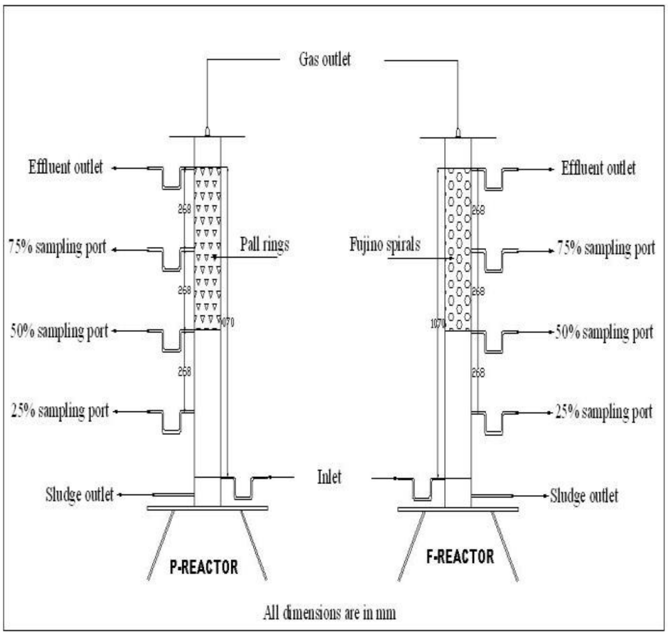

Figure-1: Design of HUASB reactors

7. RESULTS AND DISCUSSIONS

7.1 Characteristics of Raw Spentwash

Table 1: Characteristics of distillery spentwash

Characteristics	Average value
pH	3.6 – 4
Color	Dark Brown
BOD(mg/L)	36000 – 45000
COD(mg/L)	70000 – 90000
Total Solids(mg/L)	85000 – 88000
Dissolved Solids (mg/L)	75000 – 78000
Suspended Solids (mg/L)	10000 – 11000

7.2 Optimum HRT for Both the Reactors

At first the reactor was loaded with diluted spentwash of 500 mg/L COD concentration. At first the HRT for both the reactors was set to 48 hours and HRT was gradually reduced to 36 hours, 24 hours, 18 hours, 12 hours, 8 hours and 6 hours. COD removal efficiency was examined for both the reactors at different HRTs. The results were obtained for both of the reactors at different HRTs and are given in chart.

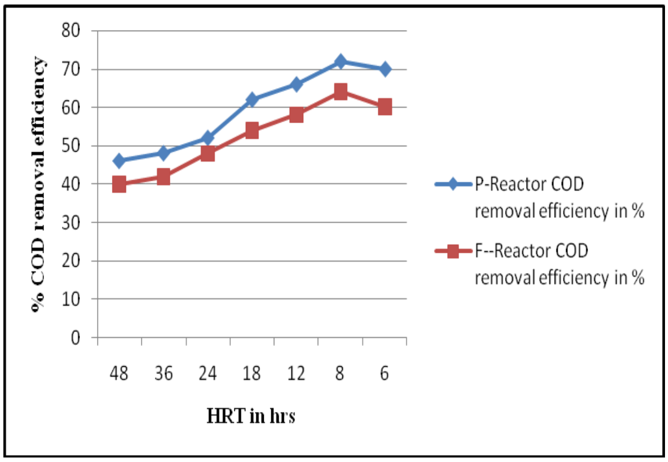

Chart -1: COD removal efficiencies at varying HRTs for influent COD feed concentration of 500 mg/L

From the experimental data it can be clearly inferred that the optimum HRT for both the reactors were found to be 8 hours at COD feed concentration of 500 mg/L.

7.3 Overall Performance of both P-Reactor and F-Reactor at Different COD Feed Concentrations at Optimum HRT

Initial COD feed concentration of 500 mg/L was fed into both the reactor treatment of 500 mg/L. The feed concentration was then gradually increased at an increment of 500 mg/L till the feed concentration reached 3000 mg/L. In order to find maximum COD feed concentration of both of the reactors, the reactors were fed again in increment of 250 mg/L from 2000 to 3250 mg/L and maximum feed concentrations were found out.

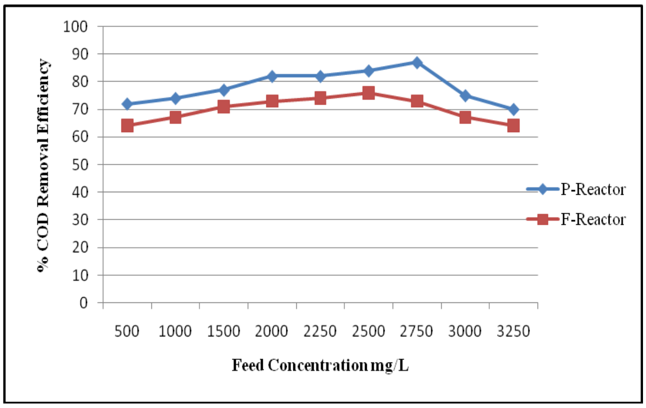

Chart-2: Percentage COD removal efficiency at various COD concentration at 8 hrs HRT

From the experimental data it can be observed that the maximum COD removal efficiency was found to be 87% in P-Reactor at COD feed concentration of 2750 mg/L and

76% in F-Reactor at COD feed concentration of 2500 mg/L at optimum HRT of 8 hours .

7.4 BIO-GAS GENERATION IN P-REACTOR AND F-REACTOR

The bio-gas generation rate throughout the study at diverse COD feed concentration at optimum HRT of 8 hours for both reactors given below.

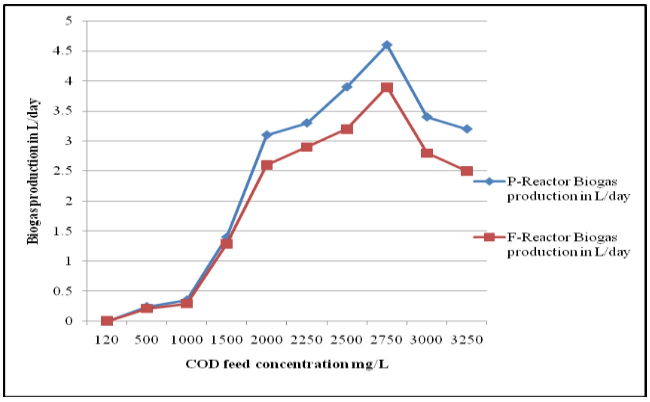

Chart-3: Bio-gas production of P-Reactor and F-Reactor at different COD feed concentration

At first the bio-gas generation was negligible at 120 mg/L COD feed concentration. Biogas generation rate gradually increased in both of the reactors with increase in the COD feed concentration as the days passed by. It was noticed that, there was a sudden decline in biogas production at feed concentration of 3000 mg/L and 3250 mg/L as shown in graph. The biogas generation was greater at feed concentration of 2750 mg/L.

8. CONCLUSIONS

- Successful startups of both the reactors were observed to be 46th day for P-Reactor and 51st day for F-Reactor.
- The optimum HRTs for both the reactors were found to be 8 hours where P-Reactor COD removal efficiency was found to be 72% and F-Reactor shows 64% for initial COD feed concentration of 500 mg/L.
- The pH range of spent wash was maintained between 6 to 7.5 by adding NaOH solution for better methanogenic activity.
- Maximum COD removal efficiency was found to be 87 % in P-Reactor at influent COD concentration of 2750 mg/L and 76 % in P-Reactor at influent COD concentration of 2500 mg/L.
- Maximum bio-gas production was found to be 4.6 L/day in P-Reactor and 3.9 L/day in F-Reactor at influent COD feed concentration of 2750 mg/L.
- Though surface area of Fujino spirals was greater than pall rings its efficiency in treating wastewater was less due to often settling of Fujino spirals and clogging problem. Hence pall rings more efficient in treating distillery spentwash.

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