

Treatment and Reuse of Distillery Wastewater

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Abstract

Distillery industries in India pose a very serious threat to the environment because of the large volume of wastewater they generate which contains significant amount of recalcitrant compounds. Distillery spent wash has very high COD and BOD with low pH and dark brown color. The treatment of spent wash using various treatment technologies and reactor configurations has been widely explored. However, none of the work reports about the performance of most advanced hybrid configuration of reactors at various operating conditions for the treatment of spent wash. Therefore, the study has been undertaken to assess the performance of Hybrid Anaerobic Baffle Reactor (HABR) for the treatment of distillery wastewater (spent wash). The main objective of the paper is to explore the use of anaerobic digestion as complete solution to treat BOD and COD in the same reactor in conjunction with suitable oxidation technique. The above proposed methodology will be used for treating raw effluent from the distilleries which can be further reused for agriculture or other purposes. The availability of enhanced amount of biogas from reactors shall make proposed technology attractive to the industry.

Keywords: Distillery spentwash, Chemical Oxygen Demand (COD), Hybrid Anaerobic Baffle reactor (HABR), Biogas.

1. Introduction

Molasses Spent Wash (MSW) is a dark browned color effluent, conventionally treated by anaerobic digestion for generation of methane and then aerobically using trickling filter or by activated sludge system prior to disposal. But the disposal of these conventionally treated MSW is quite hazardous as they contain many dark brown

colored recalcitrant compounds which have antioxidant properties and are toxic to many micro organisms.

Apart from the color, distillery spent wash has also high COD, BOD, suspended solids, inorganic solids and low pH (Saha et al., 2005). The biochemical oxygen demand (BOD) and chemical oxygen demand (COD), the index of its polluting character, typically range between 35,000–50,000 and 100,000–150,000 mg/l, respectively (Nandy et al., 2002). Different environmental regulatory bodies worldwide have already set norms for the waste discharge from industries. In India for instance, distillery industry had been told to achieve zero discharge of spent wash by December 2005 according to the charter of Central Pollution Control Board, the apex pollution control authority (CPCB, 2003).

It has been observed that almost all distilleries have adopted anaerobic digestion as industry standard practice for the first stage treatment of raw spent wash. However, further treatment is not properly done in most of the distilleries as most of them are not willing to spend the money on treatment plants as its costs will be equal to or more than capital cost of running parent industry. This review paper will explore a methodology which will not only remove COD with over 90% efficiency and thereby making it fit for irrigation purpose but also produce biogas and thereby generate revenue for the industry.

2. Methods

2.1 Experimental Protocol

The objective of the project is complete removal of BOD-COD and color of distillery spent wash by using combined Anaerobic Digestion and Advanced Oxidation. The proposed three step methodology is shown in Figure 1.

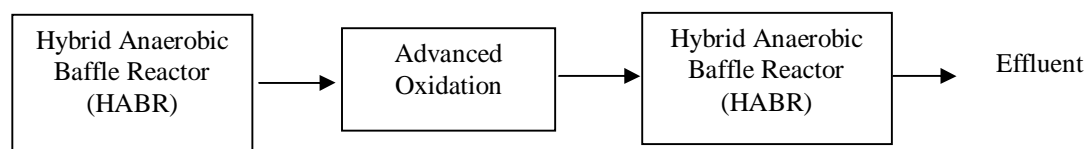


Fig 1: Schematic Diagram for the treatment of wastewater.

Here in the first step it is proposed to use Hybrid Anaerobic Baffled Reactor (HABR) with mixed anaerobic consortia to reduce BOD to almost zero level. The recalcitrant COD remaining after the first step will be cracked to BOD with help of suitable post oxidation treatment such that resulting biodegradability is maximum. The treated effluent will be fed to another Hybrid Anaerobic Baffled Reactor (HABR) with mixed anaerobic consortia to achieve maximum anaerobic BOD and COD reduction. This scheme is proposed to produce COD free and thereby colorless effluent which can be used for irrigation or recycled to conserve the water needs.

2.2 Reactor configuration

Here the reactor is made of acrylic sheet and it consists of 3 chambers and a final settling chamber. The volume of each chamber is about 3 liters, settling chamber is about 1 liter and the reactor including settling chamber is about 10 liters. The first two chambers had close to the surface level 5cm of plastic media while the third chamber was half filled with plastic media. The gas phase from each chamber was collected to a common rectangular gas collection chamber.

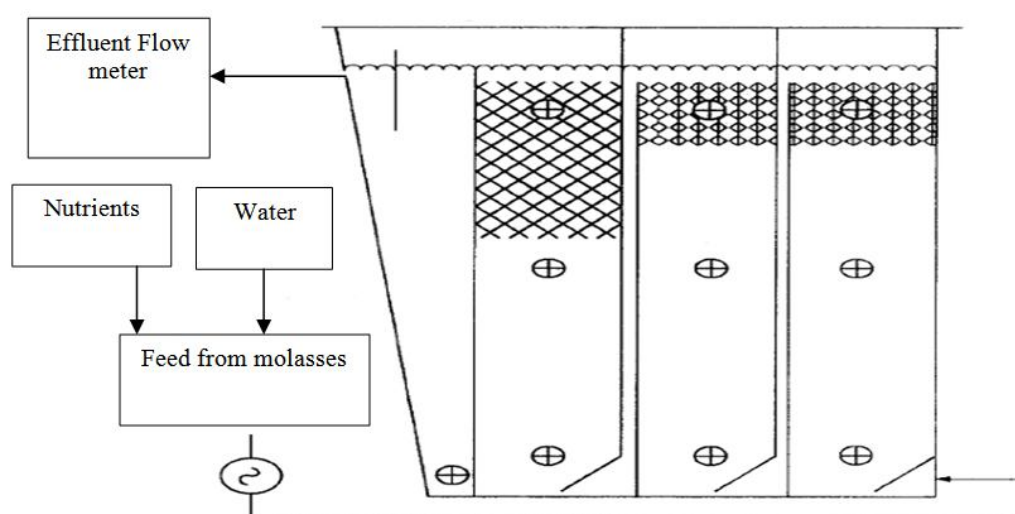


Fig. 2: Schematic Diagram of Hybrid Anaerobic Baffled Reactor (HABR).

2.3 Experimental Setup

Two bench scale model of HABR reactor was fabricated with acrylic sheet having thickness 6 mm. The reactors were operated at ambient temperature without any temperature control. Both the reactors had empty bed volume of 10 liters and were provided with gas outlet at the top of the reactor. The volume of gas collected was measured using water displacement method. To maintain constant inflow rate for each reactor peristaltic pump (Masterflex, model no. 77202-60, Cole-Parmer Instrument Company) with two channels were used for feeding the reactor. The open end of the suction tubes of the pump were immersed in the feed tank keeping it always below the liquid level of the tank. To avoid gas escaping from the inlet portion the inlet steel pipe is bent 90° by about 2mm towards the water.

3. Results and Discussion

3.1 Characteristic of raw spentwash

Raw spent wash was characterized (Table 1) for various parameters which are generally used for monitoring distillery spentwash.

Table 1: Characteristics of raw distillery waste water.

Parameter	Value
pH	3.67
Total Solids	66,980 mg/l
Total Dissolved Solids (TDS)	14,660 mg/l
Chemical Oxygen Demand (COD)	82,000 mg/l
Biochemical Oxygen Demand (BOD)	35,000 mg/l

3.2 Start up of the reactor

The reactor was inoculated with granular sludge from a UASB reactor that is treating distillery waste water and initially it was fed with low concentrations of distillery waste which is ten times diluted. This sludge water mixture is mixed thoroughly and this mixture is used for fully filling the reactor. It is then slowly fed with distillery wastewater which is diluted in 1:2 ratio. The organic loading rate of the diluted distillery spent wash is found to be 1.68 kg COD/m³day and it is made to work at an HRT of 30 days and flowrate of 0.23 ml/min.

3.3 Reactor operation

Over the first 30 days of operation the organic loading rate is 1.68 kg COD/m³ day, a rate at which is maintained until day 30. The objective of this low loading rate was to develop a suitable mass of flocculent and granular organisms in the reactor before the elevated loading rates typical of commercial operation were obtained. The organic loading rate is then increased from 1.68- 3.36 kg COD/m³ day at a relatively uniform rate in the next 30 days. This period represented by the transition from the establishment of granular and flocculent biomass to commercially acceptable loading rate. Finally after 60 days of operation the reactor is made to work on the real raw spentwash thus increasing its organic loading rate to 5.04 kg COD/m³ day.

3.4 Data interpretation

COD of the influent and effluents both at first and second stages of reactors were monitored once in every week. When run at 33% spentwash COD of effluent was found to be reaching 11,000 mg/l at the end of 30 days. At 66% spentwash it reached 20,000 mg/l. When run at raw spent wash it reaches a steady condition where effluent COD values are 17,000 mg/l with COD removal efficiency of 79%.

Table 2: Overall Performance of First stage Reactor.

Parameters	Two Third Dilution	One Third Dilution	Raw Spentwash
Influent COD, mg/l	30800	62000	82000
Effluent COD, mg/l	11400	17600	17300
pH	8.18	8.54	8.45

During the oxidation stage using Hydrogen Peroxide the COD was reduced to 10,000 mg/l. At second stage of operation it was found that COD value further reduces to 6,000 mg/ with an overall COD removal efficiency of 92%.

Table 3: Overall Performance of Second stage Reactor.

Parameters	HABR
Influent COD, mg/l	11500
Effluent COD, mg/l	6000
pH	8.7

3.3 Biogas produced

The amount of biogas generated was monitored both at first and second stages on daily basis. Here it was observed that when working at raw spentwash a biogas production of 2.5l/d and in the second stage of reactors since COD removal was less and biogas production was not prominent, it was recorded to be less than 0.15l/d.

4. Conclusion

The main objective of the study was to use anaerobic digestion along with advanced oxidation to reduce COD from the distillery spentwash. The COD of the raw spent wash was found to be around 82,000 mg/l which was reduced to 17,000 mg/l in the first stage. The remaining COD's biodegradability was increased by using by hydrogen peroxide oxidation. Further it was again passed to another plug flow anaerobic reactor where the biodegradable COD is further reduced. Here the COD of HABR was further reduced to 6000 mg/l thus giving an overall COD removal efficiency of 92% at the end of the whole cycle of process. Thus the objective of COD reduction of distillery spent wash was achieved by the stated methodology along with biogas production. But still it is recommended to conduct a pilot scale study to see if the lab scale efficiencies are achieved there.

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