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Treatability Study of Composite Effluent With Stripping, Settling, Coagulation and Upflow Anaerobic Sludge Blanket Digestion

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ABSTRACT:

The composite industrial wastewater of various industries from an industrial area was treated by using upflow anaerobic sludge blanket reactor (UASB) combined with conventional treatments. The treatability of the sample effluent was investigated. The effluent had COD to BOD ratio 2.5. Aerobic treatments have disadvantage of space requirement, high power requirement and treatment cost. Compared to this, anaerobic treatment attracts with advantage such as biogas and power generation, volume reduction. Anaerobic treatment can be effective alternative combined with some other treatment steps.The effluent with initial COD of 3800 -4000 mg/l can be treated effectively by using UASB reactor along with conventional air stripping, coagulation, alum-lime treatment. The cumulative percent COD removal was 26.3 percent after aeration, 37 percent after settling, 50.3 percent after alum treatment and 74 percent after lime alum treatment. The effluent with COD 3802 mg/l effluent was reduced below 1000 mg/l. In the UASB treatment 81.2 percent COD removal and 91.3 percent COD removal occurred.

KEYWORDS: Aerobic, anaerobic treatment, parameters, COD, BOD, suspended solids, effluent.

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INTRODUCTION

Industrial wastewater treatment has become a challenge to the investigators because of the stringent norms and cost of treatment. For effective and economical treatment of the wastewater from industries, many industries in India have adopted common effluent treatment (CETP) plant model. Various physico-chemical treatment methods like adsorption, ion exchange, coagulation and biological treatment methods like activated sludge and rotating contactors are being investigated for more and efficient treatments by optimizing affecting parameters(Saleh et al.,2004; Amale et al., 2014; Girap et al., 2015;Mohan et al., 2008; Amale et al., 2014; Dey and Mukherjee, 2010). Methods like membrane separation, electro-dialysis, coagulation, flotation are studied for efficient use of the chemicals and the membranes (Son et al., 2014;Kulkarni and Goswami, 2014; Jain et al., 2013). Also optimization of various factors affecting the treatments is essential part of these investigation.

REVIEW OF PAST WORK

Biological methods are highly efficient for wastewater, especially domestic wastewater because of its high BOD to COD ratio. Activated sludge process and trickling filters are commonly used treatment methods(Gasparikova et al., 2005). According to Jereb(2004), it is important to achieve an optimal system for processing organic waste. Speeding up natural biological processes can result in optimum processing. According to him, all kind of organic fraction of municipal solid waste can be treated by composting. Saveyn and Eder (2013) explored possibilities for recovering biodegradable waste through composting and/or digestion. Asnani(2006)observed that many times, the system applied is unscientific, outdated and inefficient.He expressed need toimprove soil texture and augmenting of micronutrient deficiencies are main advantages of composting. According to studies carried out by Hamer(2003), safety and acceptability isone of the main concerns from public health point of view regarding waste management practices.

Changes in parameters like pH, temperature, moisture content, organic carbon, volatile solids during aerobic composting were studied by Narkhede et.al.(2010). They used a box model composter made up of wood. In their investigation, they found that there was increase in temperature from the first day itself. The temperature reached 60 degree Celsius on day 25. At the end of process, it dropped down to 28 degree Celsius. 35 days were required to reach the constant temperature conditions. In their studies, Buyukgungor and Gurel(2009) discussed the aerobic treatment methods such as activated sludge process, trickling filters and rotating biological contactors. Cosicetal.(2011) carried out the workto characterize the biodegradability of leachate from composting tobacco waste.

They used batch reactor with different initial concentrations of leachate. They observed that the use of activated sludge is an effective way of treating leachate with high concentrations of organics.

An investigation on municipal wastewater treatment with kinetic studies using immobilized fixed bed anaerobic digester was carried out by Dwaraka and JayaRaju(2010). They obtained 85 percentage COD removal. Appels et al.(2008) observed that hydrolysis was a rate determining step in the complex digestion process. Factors such as pH, alkalinity, and concentration of free ammonia, hydrogen, sodium, potassium, heavy metals, and volatile fatty acids influenced the anaerobic process.

VisvanathanandAbeynayaka(2012) reviewed the anaerobic wastewater treatment process. According to them, the AnMBR (anaerobic membrane biological reactor) performances have achieved comparable status to other high rate anaerobic reactors. The stability of Hybrid up flow anaerobic sludge blanket (HUASB) reactor for various parameters like pH, total suspended solids and COD removal was assessed by Hemlata et al.(2014).In their work, they used a specific packing media of polypropylene polyhedral spherical balls. Predominantly, the biomass attachment and accumulation was over the surface of the polypropylene polyhedral spherical balls.

An UASB reactor was used for wastewater treatment and its reuse in small agglomerations by Davila etal.(2009). In their investigation they employed, UASB system followed by rotating biological contactor. They found that denitrification started immediately after feeding the UASB with nitrate. Also the methanogenesis was negatively affected for two days after starting nitrate addition to the feed and cached up to normal later. High nitrite and COD removal rates (nitrate 97.5% and COD 91%) were obtained by them. Studies on industrial wastewater treatment integrated a UASB reactor with UV and AOPs (advanced oxidation processes) (Ozone, H_2O_2/UV, Fenton, and photo-Fenton) were carried out by Yasar and Tabinda(2010). They observed that highly effective treatment can be achieved with proper control over the parameters like temperature, sludge age, pH, and hydraulic retention time. AOP Pathogen elimination is done with advanced oxidation process. In similar work, COD removal efficiency of 71 percent and denitrification efficiency of 90 percent was obtained by Sousa et al. (2008). Ganesh et al. (2007) treated low-strength dairy industry wash waters with chemical oxygen demand of (COD) 1200-2000 mg/l by the successful operation of UASB. COD removal efficiency of 75-85 percent was reported by them.

Many investigators have reported use of UASB for dairy wastewater and domestic wastewater (Shirule et al., 2013; Lew et al., 2004; Hampannavar and Shivayogimath, 2010; Aiyukab et al., 2010; Bhatti et al., 2014). Also distillery effluent was treated successfully by incorporating UASB treatment by many investigators (Moe and Aung, 2014; Mirsepasi, etal., 2006;

Powaret.al.,2015). In many of these investigationsadvanced oxidation process was used after the UASB treatment.

BACKGROUND

Common effluent treatment plants in the industrial area are being preferred over the separate treatment plants for each industry. It results in savings in terms of time, land and money. The composite effluent was prepared from effluents of many industries from the industrial area near Mumbai in Maharashtra. The proportion of the effluent from industry was decided based on the effluent generated. This treatability study is presented in this paper.

The composite industrial wastewater from an industrial area from various industries viz. bulk drugs, dye, dye intermediates, drug intermediates, specialty chemicals and textile process was studied. The treatability of the composite effluent was investigated. The composite effluent has COD to BOD ratio 2.5. Biological treatment after initial primary treatment steps can be appropriate treatment method. Aerobic digestion is good alternative and various studies have shown that the COD can be brought down to 200 mg/l from 4000 mg/l by physicochemical treatment followed by biological treatment and then activated carbon filter. The space requirement and cost of treatment are high due to aeration. Compared to this, anaerobic treatment attracts with advantage such as biogas and power generation.

METHODOLOGY

The mixing was carried out in a tank (500 liter) with pipe grid at the bottom to ensure air stripping. Then the wastewater was allowed to plain settle for 2 hours. It was then treated with lime alum and ferrous sulphate in different proportions. Fresh coagulant solutions were prepared and mixed for about 4 minutes in 100 literHDPE tank(high density polyethylene). For chemical dosing 5 liter HDPE tanks were used.After settling for 3 hours in this step, the effluent was send to upflow aerobic sludge blanket reactor(100 liter). The gas out let is connected to flexible tube. To ensure uniform flow velocity, an arrangement for recycle is also provided. Finally the effluent is send to aeration tank.

RESULTS AND DISCUSSION

During the study it was observed that the pH varied between 7 to 9. The COD values of the sample effluents from various industries were measured. These value varied from 1500 to 4000 mg/l. The effluents from various units were mixed and initial COD value was maintained according to the requirement of the experiment. The COD to BOD ratio was 2.5. The BOD of the mixed composite effluent was measured after proper dilution. The suspended solids at various stages were also measured.

Air stripping

The solvents present in the wastewater are removed in this step. To study the effect of initial COD, three effluent samples were prepared by appropriate dilution. The percentage COD removal was maximum(26.3 percent) for maximum initial concentration(3802 mg/l).Final COD of this sample was 2801 mg/l after air stripping (Fig.1, Fig.2).

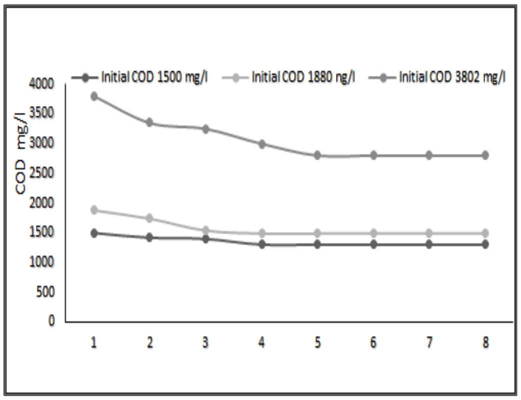

Fig.1: Air stripping at various initial COD values

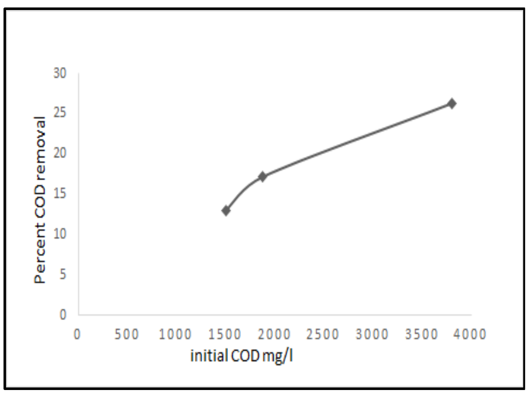

Fig.2: Air stripping-percent removal at various initial COD values

Plain settling

Plain settling was carried out for the samples with initial COD concentrations of 1500 mg/l, 1880 mg/l and 3802 mg/l (Fig.3). The COD removals obtained were 8, 10 and 7.5 percent and suspended solid removal was 72,75 and 80 percent respectively.

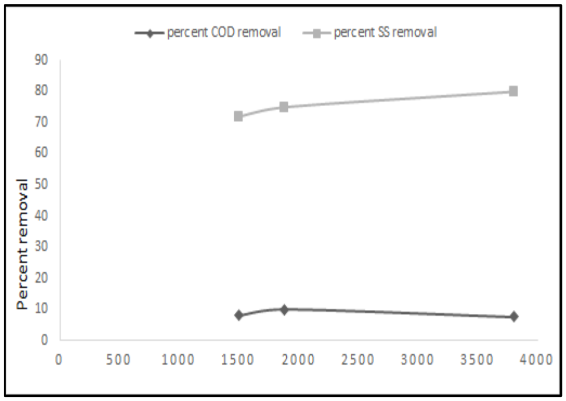

Fig.3: Plain settling

Coagulation-Alum treatment

Lime dosage of 10, 20, 30, 40 ppm were used. The percent removal was observed to be 7 to 13.3 percent in the experiments (Fig.4). There was marginal increase in the percent removal with initial COD. The percent increased by 1 to 2 percent for each 10 ppm increase in the alum dose.

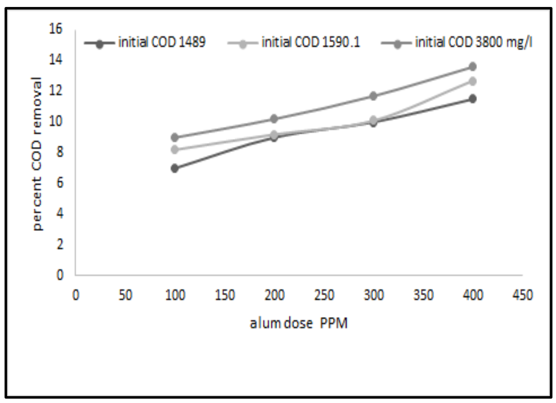

Fig.4:Alum treatment

Lime alum treatment

Experiment were carried out at constant lime dosage (225, 250,270,450,500,600,760 ppm) and$FeSO_4$ dosage of 100, 200, 300,400ppm(Fig.5). Maximum removal obtained for lime dose of 250 ppm and 270 ppm. It was 23.7 and 23.9 percent.The initial COD was 3010 mg/l. The final minimum COD for 300 ppm alum and 270 ppm lime was 2287.2 mg/l.

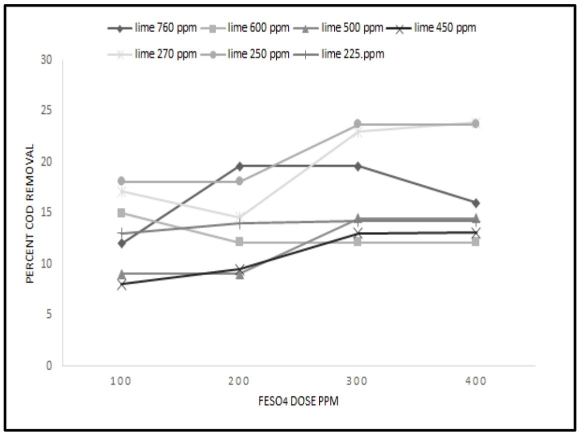

Fig.5: Lime-alum treatment

UASB treatment

The effluent with initial concentration 2200, 1400, 901 and 704 mg/l was treated in UASB reactor(Fig.6). Maximum COD removal was obtained 81.2 percent and BOD removal of 91.3 percent. Final COD values were 700, 392, 169.38 and 479.5 mg/l for these samples respectively.Final BOD values were 200, 110.2, 40 and 140 mg/l. For initial COD of 740 mg/l, the process yielded poor result. Insufficient population of the microorganisms can be the reason for this. Also high value of initial organic matter content (2200 mg/l) resulted in comparatively less COD and BOD removal. For intermediate initial concentrations, best results were obtained.

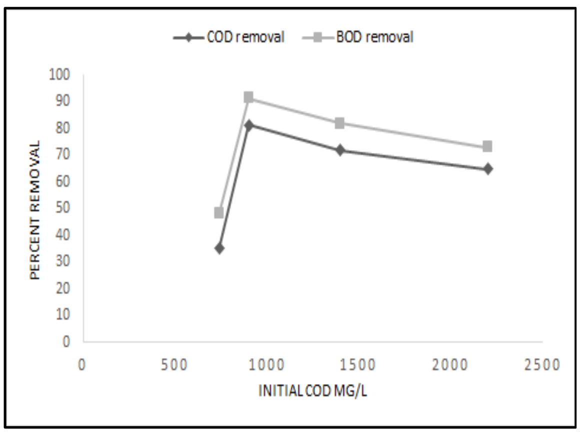

Fig.6: UASB treatment

Biogas

Methane content of the biogas was 71 percent. Hydrogen sulphide in biogas was in traces.

Aeration

The samples were again aerated in the aeration tanks to remove residual colour and odour. The COD reduction of 20- 25 percent was achieved in this stage. The final CODs of the 1400 mg/l and 901 mg/l initial COD samples were brought down to 292 mg/l and 112.5 mg/l respectively after this step. For the 2200 mg/l sample, further treatment was necessary. Ozone treatment can be the option for further treatment. For the third sample of 740 mg/l initial COD, aerobic treatment can be considered as an alternative.

CONCLUSION

The effluent with initial COD of 3800 -4000 mg/l can be treated effectively by using UASB reactor along with conventional air stripping, coagulation, alum-lime treatment. The cumulative percent COD removal was 26.3 percent after aeration, 37 percent after settling, 50.3 percent after alum treatment and 74 percent after lime alum treatment. For the effluent with COD 3802 mg/l, CODwas reduced below 1000 mg/l. In the UASB treatment 81.2 percent COD removal and 91.3 percent COD removal occurred. The sample can be passed through second aeration tank to remove residual colour and odour.

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