THERMOPHILIC ANAEROBIC DIGESTION OF WASTEWATER IN UASB REACTOR

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ABSTRACT

Anaerobic treatment of wastewater has been severe problem due to its toxicity and poor biodegradability, using a thermophilic reactor (55±2^{o}C) of wastewater was investigated in a UASB reactor. After start up period 120 days of operation, the removal of chemical oxygen demand by thermophilic reactor could reach 50-55%, at an organic loading rate of 2.5 kg COD/m^{3}.d and hydraulic retention time (HRT) of 24 hours. The results suggested that thermophilic anaerobic digestion improved significantly both anaerobic and aerobic biodegradation of wastewater.

Keywords: COD, granular sludge, Hydraulic retention time, Thermophilic, UASB reactor

I. INTRODUCTION

In the last two decades, the anaerobic wastewater treatment process has gained a wide popularity as an established technology for the treatment of a variety of industrial wastewaters, with more than 1160 full-scale plants installed in 2001 [1]. The presence of sulphate in some wastewaters restricts the application of the anaerobic treatment technology, due to the production of the toxic, corrosive and odorous hydrogen sulphide (H2S) [2]. Due to the present increase in the consumption of natural gas, India faces the challenge of a rising gas demand, which is paving the way for the development of the country's coal gasification industry [3]. Among the major coal gasification technologies available, which include Shell and GSP the latter is used to a significant extent in India because of its technological maturity and its capability to produce large amounts of methane as a by product [4]. However, the wastewater discharged from a Lurgi gasifier contains a large number of toxic and refractory compounds, such as phenolic compounds, cyanide, pyridine, and long-chain alkanes, posing a major challenge to environmental safety [5].

The treatment of coal gasification wastewater commonly includes physico-chemical treatment and biological treatment. Although Lurgi coal gasification wastewater is pre-treated using the processes of ammonia stripping and phenol solvent extraction to remove the majority of toxic compounds, the effluent is still refractory and toxic to microorganisms [6]. The conventional anoxic–oxic process provides an efficient and cost- effective method for coal gasification wastewater treatment, but the reduction of effluent COD concentrations to less than 200 mg/L using it is difficult [7]. Recently, much attention has been directed to the anaerobic digestion method due to its capability to improve the biodegradability of coal gasification wastewater [5-6, 8-9].

Thermophilic anaerobic digestion offers several merits, such as increased degradation rate for refractory organics, high methane production rate, improved wastewater biodegradability, and in- creased detoxification effect of anaerobic bacteria [10]. After thermophilic anaerobic treatment, hazardous compounds like phenol, l,2-

methoxyphenol, 2,4,6-trichlorophenol, dibutylphthalate, 1-bromo naphthalene, and antipyrine in bulk drug pharmaceutical wastewater degraded almost completely [11]. Several thermophilic anaerobic phenol degrading bacteria have been found so far, such as Desulfotomaculum [12, 13] and six major populations accounting for 64.8% of the total population in the thermophilic sludge which consisted of OTU TPD-1, TPD-2, TPD-3, TPD-45, TPD-60, TPD-85 [14]. So far, little is known about the competition, microbial population dynamics and treatment efficiency of thermophilic methanol-fed reactors seeded with sludge previously not exposed to sulfate. Therefore, a thermophilic (55°C) methanol-fed methanogenic reactor seeded with such as sludge was operated at decreasing COD/sulfate ratios (10, 5 and 0.5) to evaluate metabolic shifts, effects on conversion rates and process disturbances induced by the presence of sulfate in the influent. The effect of increased levels of sulfate on the activity of methanol-degrading microbial groups present in the upflow anaerobic sludge bed (UASB) sludge was also investigated.

II. DATA COLLECTION AND METHODOLOGY

In the analysis of anaerobic digestion in UASB reactor, the experimental results of [15, 16] have been used. These experimental data were read either from the figures or taken directly from the tables provided in [15, 16]. In [15] influent substrate concentration (S_0) was maintained at 5.36-5.77 g COD/L in all the four periods and OLR was varied in the range of 17.69-18.96 g COD/L. d. In [16], influent substrate concentration was varied in range of 1 g/L to 3 g/L throughout the study of 300 days. Start up period for the thermophilic reactor is 120 days.

III. RESULTS AND DISCUSSION

3.1 Start Up of Thermophilic Reactor

In [16] the start-up period is120 days for the thermophilic reactors treating the wastewater. During the start up period, the reactors were operated without effluent recirculation at a constant hydraulic retention time (HRT)of 24 h and upflow liquid velocity of 0.021m/h. In [15] four different operational period was considered 0-75, 76-103, 104-124 and 125-155 days continuously. COD concentrations in all four operational period lies between 5.0-5.8 g/L. In IInd operation period COD concentration, pH is highest 5.7 g/L and 7.2 respectively.

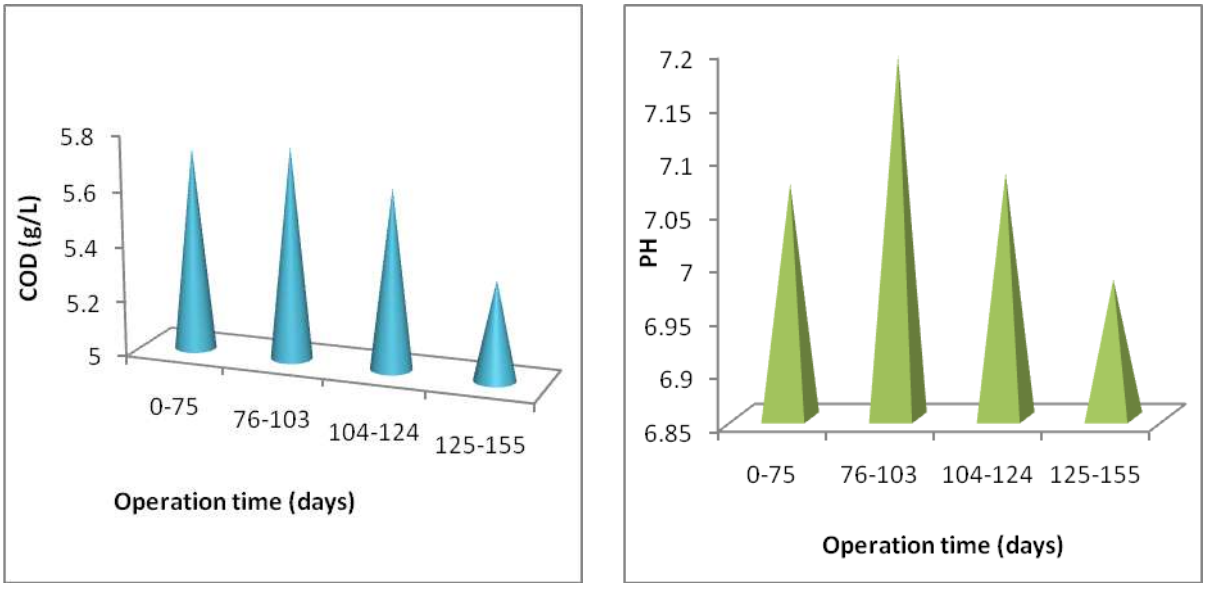

Fig. 1 applied (a) COD concentration (b) PH in UASB reactor

3.2 Effect of COD and HRT on Performance of the Reactor

Thermophilic anaerobic digestion was prior to mesophilic anaerobic digestion in treatment of wastewater in term of chemical oxygen demand. In [6] after the start up period of thermophilic reactor (1-120 days), an HRT study was carried out to determine the effect of a longer HRT on the removal of COD. COD influent in first 60 days is constant and equal to 1.5 g/L and after 60 days COD concentration increases rapidly and equal to 2.5 g/L. COD effluent concentration in first 60 days continuously decreases then rapidly increases and equal to 2.5g/L then concentration decreases but in fluctuating manner.

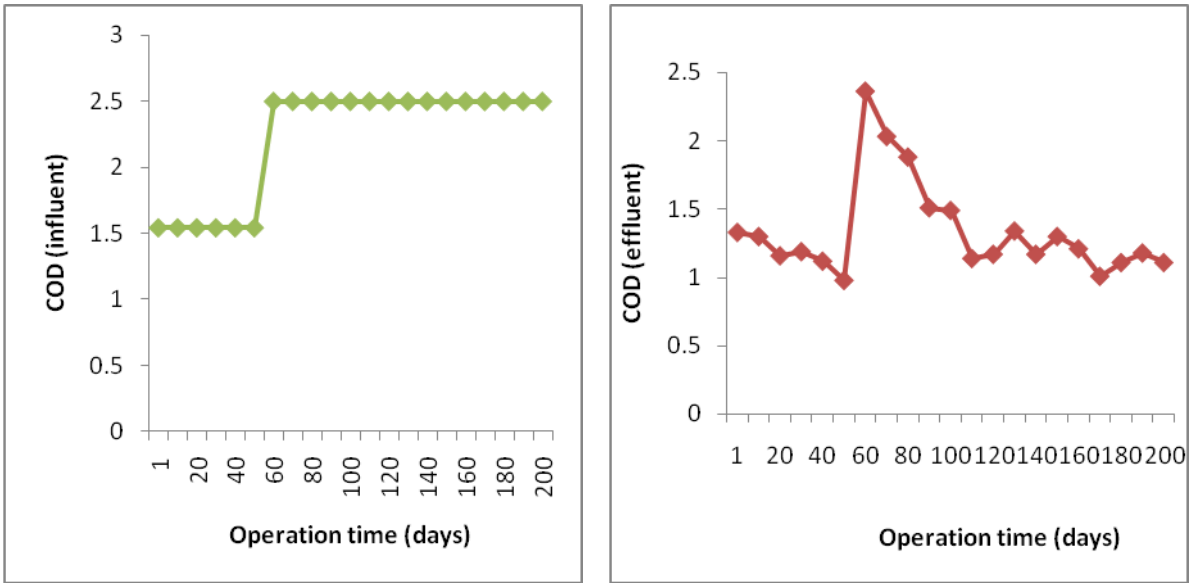

Fig. 2 Variation of (a) COD Influent Concentration (b) COD Effluent Concentration with Time in the UASB Reactor

During start up period % COD removal increases continuously but in fluctuating manner up to 200 days. COD effluent concentration shows variation after 120 days, so % COD removal also shows fluctuating behaviour after 120 days.

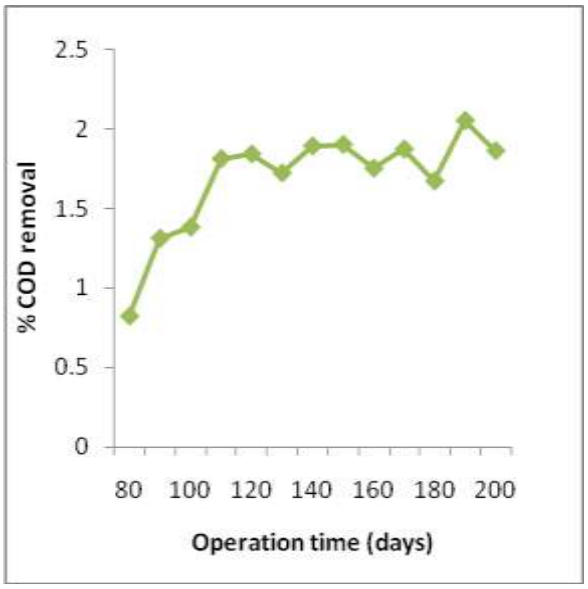

Fig. 3 Variation of % COD Removal with Time in UASB Reactor

The results indicated that the longer HRTs of 36 and 48h with respective efficiencies stabilized at 50-60% did not cause a significant improvement of chemical oxygen demand. Considering its complex composition it

contained, the wastewater could be purified to a higher level with difficulty only by extending the contract time between the pollutants and the anaerobic microorganisms.

IV. CONCLUSION

In thermophilic anaerobic digestion longer HRTs did not significantly improve the COD concentration and % COD removal efficiency in the thermophilic reactor. After thermophilic digestion, the wastewater concentrations of the aerobic effluent COD could not reach below 200mg/L and if sole aerobic pre-treatment was done the concentration is 375 mg/L. The result suggested that thermophilic anaerobic digestion improved both anaerobic and aerobic biodegradation of wastewater.

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