Anaerobic treatment of wastewater of industrial belt of Baddi (solan) using Upflow Anaerobic Sludge Blanket Reactor (UASBR)
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ABSTRACT
Anaerobic treatment is widely used around the world as a biological stage in both domestic and industrial wastewater-treatment plants. The degradation process of organic matter is more effective compared to conventional aerobic processes and produces less sludge, hence reduces the cost associated with sludge disposal. Among anaerobic technologies, the most popular ones is the upflow anaerobic sludge blanket (UASB). This study reports applicability of UASB reactor to treat the wastewater from industrial belt of baddi, nalagarh, dist. Solan in H.P. The average COD of the wastewater varied between 13,000 – 20,000 mg/l over the study period. Waste water was diluted to achieve the desired organic load. The feed for the reactor was prepared using wastewater and cowdung extract with COD strength of 2000 mg/l. The removal efficiency of soluble COD and BOD ranged between 30-55% .The Volatile Fatty Acids (VFA) concentration ranged between 150 to 350 ppm in the reactor. Less concentration of VFA indicated proper methanogenesis within the reactor as most of VFA was converted into the methane and Co₂.

Keywords: Industrial wastewater treatment, UASB reactor

1. Introduction
The UASB process was developed by Lettinga and co-workers in the late 1970’s (Lettinga et al 1980). Initially the reactor was designed to treat concentrated industrial wastewater and its application was later extended to several type of wastewater treatment. Wastewater emerging from industries posing a threat for the environment and human health. Waste water is a water containing hazardous waste from various industries, institutes and residential areas with high concentration of organic matter, heavy matels, toxics and hazardous organic chemicals. Therefore it cannot be directly introduced to any disposal site or water body and its collection and treatment are necessary to avoid any possible future environment hazard.

The UASB process has several advantages over other anaerobic processes. It is simple to construct and operate and is able to tolerate high organic and hydraulic loading rates. The key feature of the UASB process that allows the use of high volumetric COD loadings compared to other anaerobic processes is the development of dense granulated sludge. This has made it possible for the UASB to enhance the quality and the development of sludge with high specific activity and superior settling properties (Lettinga et al., 1980, Li et al., 1995).

Wastewater treatment operations are basically divided into three categories primary, secondary and tertiary (Tchobanogloous and Burton, 1990).Primary treatment consists of physical separation of floating and settleable impurities through screening and sedimentation.
Secondary treatment employs chemical and biological methods of reducing the organic load in wastewater while tertiary treatment is a physicochemical process of removing inorganic nutrients especially phosphate and nitrate in the final effluent from secondary treatments through precipitation, filtration etc (Tchobanoglous and Burton, 1972). A UASB reactor is considered to be successful when anaerobic granules are formed (Hulshoff et al. 2004). Lettinga, in a full-scale study, concluded that the support medium was superfluous because microorganism can self-immobilise by forming granules (McHugh et al. 2003).

Granule-to-granule collision influences the agitation in a UASB reactor (Bhunia and Ghangrekar 2008). Collisions may be caused by a variation in particle density, a pushing of the granule due to the up-flow velocity, granules being dragged by biogas bubbles, biogas entrapped inside the granule or settling. All these factors may be grouped under the heading of granule buoyancy. Buoyant particles are defined as those whose density is almost the same as that of the carrier fluid, which usually corresponds to a solid–liquid two-phase flow system (Yang et al. 2007).

An anaerobic process involves the degradation of complex highmolecular-weight organic compounds to mainly methane (CH4) and carbon dioxide (CO2) (Bitton, 2005). Anaerobic digestion consists of several interdependent, complex sequential and parallel biological reactions, during which the products from one group of microorganisms serve as the substrates for the next, resulting in transformation of organic matter mainly into a mixture of methane and carbon dioxide (Noykova et al., 2002; Pavlostathis and Giraldo-Gomez, 1991; Gujer and Zehnder, 1983).

Anaerobic digestion takes place in four phases 1) hydrolysis/liquefaction 2) acidogenesis 3) acetogenesis and 4) methanogenesis. The present study focuses on the treatment of wastewater, by biological process, in particular by anaerobic process viz; UASB reactor.

2. Materials and methods

A 2.8 litre reactor (pilot plant) was constructed of plexi-glass and seeded with anaerobic sludge. Wastewater sample, collected from the industrial belt of baddi, Solan was treated during the study. Reactor was operated at an organic loading rate (OLR) of 4 kg/m3-d, chemical oxygen demand (COD) of strength 2000mg/l-d corresponding to a hydraulic retention time (HRT) of 48 h, upflow velocity of 0.25 m/d and flow rate of 1440 ml/d under continuous feeding of wastewater with cowdung extract (substrate) for 100 days. The reactor was monitored daily for temperature, pH, alkalinity, COD and flow rate. Analysis of COD, BOD, Alkalinity and VFA was done as per standard methods (APHA, 1998).

3. Results and discussion

The COD removal efficiency of the reactor is illustrated in figure 1. Initially, there was no COD removal in the reactor as it takes time for acclimatization. Gradually with continuous feeding of wastewater and cow dung extract reactor started the anaerobic digestion process, which leads to the COD removal in the effluent. Initially, the efficiency was 10 to 25% but with the time and continuous feeding in the reactor COD removal was increased from 30 to 50%.
Variation of COD with time

![COD removal efficiency with time](image1.png)

**Figure 1:** COD removal efficiency in % with time.

Variation of BOD with time

![BOD removal efficiency with time](image2.png)

**Figure 2:** BOD removal efficiency in % with time

The BOD removal efficiency of the reactor is illustrated in Figure 2. Initially, the reactor was showing very less removal of BOD as it takes time for acclimatization. With the continuous feeding of waste water with cow dung extract, the reactor started showing increase in the BOD removal efficiency. Initially removal was 10 to 25 % but with time it was increased from 30 to 55 %.

Variation of Alkalinity and pH with time

![Variation of Alkalinity and pH](image3.png)

**Figure 3:** Variation of influent and effluent Alkalinity with time
Variation in alkalinity in influent and effluent is shown in figure 3. In the beginning the influent alkalinity was 1000 mg/l and effluent alkalinity was 600 mg/l, with time, alkalinity started increasing and after sometime it was more than the influent. It shows that methanogens became very active during the process of methanogenesis and the production of methane gas along with the CO₂ was responsible for the increase in alkalinity. CO₂ in the system forms bicarbonate alkalinity to increase the total alkalinity in effluent.

![Figure 4: Variation of influent and effluent pH with time](image)

The variation of pH in combine influent and treated effluent is shown in figure 4. The pH of the treated effluent throughout the study varied most of the time between 7-8.4. Sometimes it was high due to higher pH of the industrial wastewater.

Graph of CONC. of VFA VS time

![Figure 5: Variation of concentration of VFA with time.](image)

The VFA concentration in the reactor was varied between 150 to 350 ppm, which was very less and with the time (as shown in figure 5) its concentration was decreasing gradually. This shows that proper methanogenesis was going inside the reactor and most of the VFA were converting into the methane and carbon dioxide.

4. Conclusion

In the present study, a pilot plant was set-up in the laboratory. This unit was set for 5 months. Following were the major findings of this study:

1. The upflow anaerobic sludge blanket reactor seems to be quite effective for treating industrial wastewater with respect to COD and BOD removal.
2. The efficiency of upflow anaerobic sludge blanket reactor seems to be optimum when it was operated with the influent COD concentration of 2000mg/l and BOD concentration of 1400 mg/l at 30 to 40 °C.

3. VFA concentration in UASBR reactor shows that the reactor was working properly as most of the VFA gets converted into methane and carbon dioxide during methanogenesis which can be used as energy sources.

The present study showed a positive approach for the industrial wastewater treatment. The treatment of wastewater in combine with cowdung extract is an attractive option of COD and BOD removal. It is economical as well as technically feasible. We also conclude that by maintaining some important parameters like HRT, OLR etc we can use this setup for large scale industrial wastewater treatment.

5. References


