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# A Study on Comparison of Inverted Anaerobic Sludge Blanket Reactor and Up Flow Anaerobic Sludge Blanket Reactor for Dairy Wastewater

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***Abstract*—Dairy industry is one of the biggest contributors to Indian economy and also the most of polluting industries. The industry uses water from initial stage of receiving to the final stage of storage, so the amount of wastewater generated is more. The wastewater generated from dairy industry has high concentration of nutrients, organic and inorganic solvents. It also contains milk solids, detergents, pathogenic virus and bacteria. The untreated wastewater from dairy industry damages the water quality and pollutes the environment by high COD and BOD level. To reduce the effect of dairy effluent on environment anaerobic treatment is followed. Treatment of wastewater aims at reduction of Fat Oil and Grease (FOG), COD, BOD levels and produces biogas. So, the nature of released wastewater from the dairy industry is improved to achieve the permissible limit of wastewater and can be released into water bodies or for agricultural land. In our country lots of researcher are developed the anaerobic sludge blanket reactor for the dairy wastewater treatment..The present study was operated at different HRTs of 24, 18 and 12 h with OLRs 3.1, 4.3 and 6.2 kg COD/ $m^3$d, respectively. A maximum COD removal of 90.1 % and corresponding fat removal of 90 % was achieved. The biogas production at an optimized condition was found to be 2.8 l/d. This study aims to analyze and compare the treatment of UASB and IASB reactor for dairy wastewater.**

***Keywords: Inverted; Anaerobic; Fat; Oil and Grease, Biogas*.**

## I. INTRODUCTION

Wastewater created in a dairy contains exceedingly putrescible natural constituents. This requires instant and sufficient treatment of the wastewater before its transfer to the earth. Practically all the natural constituents of dairy squander are effectively biodegradable. Henceforth the wastewater is amiable to organic treatment-either high-impact or anaerobic. The quick development of enterprises has upgraded the efficiency, yet additionally brought about the generation and arrival of dangerous substances into nature, making wellbeing risks and influenced ordinary activities, widely varied vegetation. These squanders are potential contaminations when they produce unsafe consequences for the earth and for the most part discharged as solids, fluid effluents and slurries containing a range of natural and inorganic synthetics. To battle the plenty of natural wrongs of present day society, effective and earth safe natural waste treatment innovations are required.

India is the most ideal milk maker in the total globe. India is appropriately viewed as the 'Shellfish' of the worldwide dairy industry, with circumstances aplenty for the business visionaries universally. It would potentially be dream for any state on the planet to exploit the greatest and fastest developing milk and milk items advertise. The Indian Dairy Industry has accomplished this quality of a maker claimed and expertly overseen agreeable framework, notwithstanding the actualities that a dominant part of dairy ranchers are uneducated and run little, negligible tasks and for some, ranchers, selling milk is their sole wellspring of salary. In excess of 10 million dairy ranchers have a place with 96,000 nearby dairy cooperatives, who pitch their items to one of 170 milk makers' agreeable associations who thusly are upheld by 15 state helpful milk advertising alliances.

The dairy business includes handling crude drain into the items, for example, purchaser drain, margarine, cheddar, dense drain and drain powder utilizing procedures, for example, sanitization, freshening up and pressing, and so on. These shifts from little getting stations to expansive plants where the vast majority of the items produced using milk are made. Composite stream chart demonstrates the significant tasks for the handling of the more typical drain items. Dairies are focuses where crude drain is handled, either for quick utilization or changed over into dairy items, for example, whey, cheddar, margarine and so forth. Drain is gotten at the plant or getting station in standard 80-lb jars. Drain is pumped to a capacity tank or, if the plant is a getting station. The drain is cooled and pumped to a tank truck for pulling to a packaging or handling plant. Around half of the drain delivered in this nation is utilized as entire drain. Pasteurization is accomplished by heating either to 143º F for thirty minutes or 160º F for fifteen minutes. The milk might then be bottled for distribution, condensed to supply milk, or milk powder.

A little measure of entire milk is utilized in the make of frozen yogurt blends and in some sort of cheese. Around 41% of the milk supply is isolated into cream and skim milk. A portion of the cream is packaged for appropriation or is utilized for frozen yogurt blend. An extensive portion anyway is utilized, in the production of butter.

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## II INVERTED ANAEROBIC SLUDGE BLANKET REACTOR

The effective volume is 12 liter and the height of the reactor is 550mm and diameter is 180mm. The length of the submerged wall is 350mm. To arrest sludge washout, a detachment step is situated at the base of the reactor before profluent leave focuses. One lamella separator comprising of two parallel plates is situated at the base to keep the ooze inside the reactor. It is put so that the gas can't enter them and exasperate the partition procedure. The slanted parallel plates are put at a point of 70° with the reactor base. Blending is accomplished in two different ways.

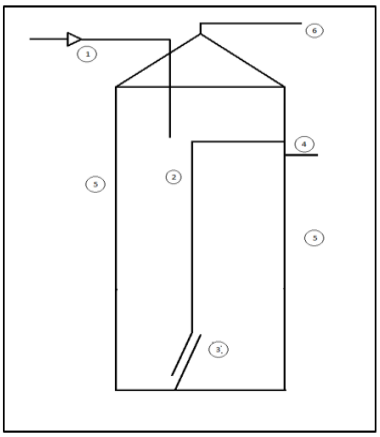

Figure 2.1: Typical diagram of IASB reactor

1. Inlet
2. Sample port
3. Inclined plates
4. Outlet
5. Separation port
6. Biogas

*COD Removal Vshydraulic retention time (HRT)*

The removal of COD for 12, 18, 24 h HRTs fluctuates between 86.5 and 91.7%. The COD removal efficiency was reduced with HRT in the order of 24, 18 and 12 h, respectively. The maximum COD removal efficiency is 91.7%. Figure 2.2 shows the percentage of COD removal drastically dropped at 12 h HRT. Priyanka*et al.,* (2013) revealed a COD evacuation effectiveness of 89 % with the greatest natural stacking rate (OLR) of 1.052 kg COD/$m^3$d for the treatment of dairy wastewater utilizing UASB reactor at 24 h HRT. Javed et al., (2011) revealed a COD expulsion productivity of 96 % at 10 h HRT with the most extreme natural stacking rate (OLR) of 6.2 kgCOD/$m^3$d for treatment of dairy wastewater with COD of 2050 mg/L by utilizing 10.7 $m^3$ UASB reactor. The aftereffects of this examination demonstrate that the variety in HRTs for the treatment of dairy wastewater depicts a considerable variation in the removal of COD and fat as well as gas production. i.e. whenever the increase in HRT, COD reduction is high, more fat removal was observed.

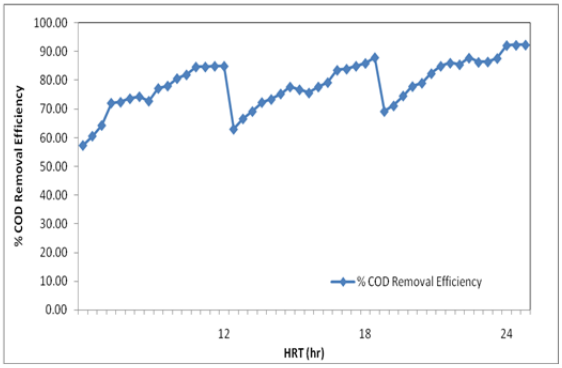


Figure 2.2: COD removal efficiency at various hydraulic retention times

This was consistent with previous results recorded by Rajeshwari*et al.*, (2000) on the effect of HRT on mesophilicacidogenesis of dairy wastewater. The COD expulsion proficiency for different HRTs areshown in Figure 2.2.

*COD removal Vs organic loading rate (OLR)*

The COD expulsion effectiveness diminished somewhat with an expansion in natural stacking rate (OLR) from 3.15 to 4.91 kg COD/$m^3$d with the level of 93.7 to 91.5. Though the expulsion effectiveness of COD at the OLR of 6.23 kg COD/$m^3$d diminished to 89%, as appeared in Figure 2.3. *Abdulsalam et al.*, (2011) accomplished the greatest COD evacuation proficiency 54.16% at lower natural stacking rate of 1.0 kg COD/$m^3$d in 72h HRT while treating dairy wastewater with a successful volume of 10L anaerobic reactor. Notwithstanding, a base COD evacuation productivity of 41.33% was seen at higher natural stacking of 3.0 kgCOD/$m^3$d in 72h HRT. The reason might be because of more acclimatization period taken by anaerobic microorganisms at a higher natural burden rate. (*Venkatesh et al.*, 2013). Potentially, if the pressure driven maintenance time expanded, the COD decrease gets expanded. Moreover, the rate COD decrease diminishes with increment in natural loadings monotonically for various time. *Rajeshwari et al.*, (2000), announced that COD decrease of 90% dropped to 70-80% with the expansion in natural stacking rate from 6.5 to 45 kg COD/$m^3$d for treatment of dairy wastewater with COD of 2.05 g/l by utilizing 10.7$m^3$ UASB reactor.

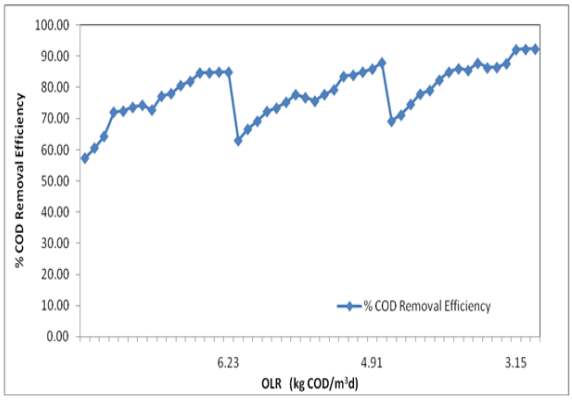


Figure 2.3: COD removal efficiency for each organic loading rate (OLR)

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Fang *et al.*, (1995) indicated that COD removal efficiency of an anaerobic reactor is dependent on the organic loading rate. Panesar*et al.*, (1999) reported that increased OLR for a UASB reactor treating dairy wastewater, lower performance was observed. Thus, the removal efficiency of COD observed by various researchers as mentioned above was not different from this study. This is a common problem encountered with cheese, whey or dairy wastewater, that when the substrate loading is increased, the acidogenic region extends into the methanogenic, (kraichat, 2003). This indicates that the COD removal is related to OLR.

### A. *FOG removal efficiency Vs hydraulic retention time (HRT)*

The present examination was done in an Inverted Anaerobic Sludge Blanket Reactor (IASBR). The impact of expansion of fat and oil alongside substrate was concentrated amid start-up period. Its stun stacking execution was additionally cautiously checked. By thinking about the issue during the operational period, fat and oil was bit by bit added from 45 to 136 mg/l at 12, 18, 24 h HRTs. Fat and oil expulsion proficiency at 24 h HRT was marginally higher than 18 h HRT and 18 h HRT was higher than 12 h HRT. From the figure 2.4, it was seen that the level of fat and oil evacuation dropped at 12 h HRT. Most extreme fat and oil evacuation productivity at 24, 18 and 12 h HRT were 90, 81 and 75%, separately.

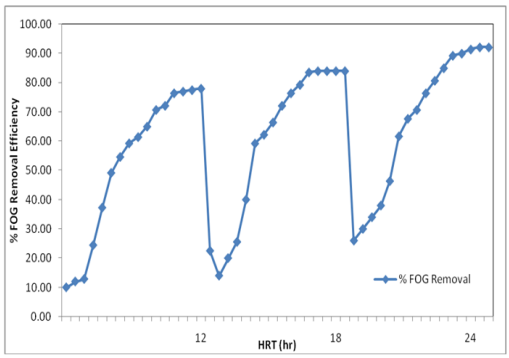


Figure 2.4: Removal efficiency of FOG at various hydraulic retention times

This result indicates that HRT would affect the removal efficiency of fat for 12, 18 and 24 h HRT. However fat and oil content in the treated effluent ranges from 15 mg/l and to 78 mg/l. The maximum permissible limit for fat and oil in the treated effluent prescribed by authorities is 10 mg/l. *Mohamed et al.*, (2004) reported that 95.9 % of FOG removal efficiency was achieved by different bacterial strains secluded from vegetable oil and oil-polluted wastewater shows that anaerobic bio-film reactor system reduce oily wastewater. FOG content in the treated effluent was 16 mg/l.

### B. *Biogas production Vs HRT's*

The daily biogas production was estimated by the water displacement method, analyzed. The highest biogas production was 2.8 l/d at 24 h HRT corresponding to an OLR of 3.2 kg COD/$m^3$d. The biogas production at 12, 18 and 24 h HRT were 9.1, 9.8 and 10.4 l/d, respectively.

## III COMPARISON WITH UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR

### A. *COD Removal Vs hydraulic retention time (HRT)*

*Nadais et al .,(2005)* observed that by raising the HRT from 6 to 12 h the execution of the framework is improved concerning the most extreme appropriate burden, the COD expulsion proficiency and methane creation, however by raising the HRT from 12 to 16 h the distinctions are not significant .UASB reactors treating dairy wastewater the change to methane of the expelled COD diminished step by step from about 80% to about 65% for HRTs of somewhere in the range of 0.5 and 1.5 d and for COD evacuation efficiencies of 93.4% to 95.4%. *Elangovan et al* .,(2014) Chemical oxygen request expulsion for 12 hr to 24 hr HRT ran from 78.40 to 94.33%. The COD evacuation effectiveness of 20 hr HRT was somewhat higher than 24 hr HRT, and marginally diminished at 16 hrHRT.It was observed that COD removal clearly dropped at 12 hr HRT. *FarhikhtehSamadi et al., (2017)* concluded that the maximum COD removal efficiency was 80% with retention time of 9.6 h.

### B. *COD removal Vs organic loading rate (OLR)*

*Nadais et al.*,(2005) observed thatthe reactors must be worked at burdens under 2.5 g COD/ℓ•d so as to accomplish a change to methane of the evacuated COD above 70%.*Elangovan et al* .,(2014) ),observed that a treatment efficiency of 90% was achieved with maximum OLR of 6.5 kg COD $m^{-3}$ d for treatment of dairy wastewater with COD of 2.05 g $l^{-1}$, using 10.7 $m^3$ UASB reactor. *Farhikhteh Samadi et al., (2017)*reported that thereactor reached its maxi-mum efficiency at the flow rate equal to 10000 *l*/d and COD removal efficiency was 80% with OLR 7.67 kg⁄(m.d)

### C. *FOG removal efficiency Vs hydraulic retention time (HRT)*

*Nadais et al.,(2005)*observedthat VFA evacuations and protein mineralisation, the most huge impact of a raise in the HRT was seen somewhere in the range of 6 and 8 h, however for the fats expulsion, the most elevated improvement was identified for the raise from 8 to 12 h. VFA evacuations and protein mineralisation close 80% and fat expulsions above 60% it is necessary to work the UASB reactors at a HRT of somewhere around 12h.*Elangovan et al.,(2014),*reported that the anaerobic digester performance was considered satisfactory, since COD reduction was greater than 90%. The concentration of VFA for 12 hr to 24 hr HRT was 332 mg/l,336 mg/l,330 mg/l and 329 mg/l, respectively

### D. *Biogas production Vs HRT's*

*Nadais et al.,(2005)*observedthe low level of change to methane of the evacuated COD demonstrates a huge amassing of natural issue in the slime bed for all the HRT tried, proposing the need of an option working mode, since the raise in HRT over 12 h does not improve the framework conduct.*Elangovan et al., (2014),*observed that the biogas composition, that of methane ranged from 60 - 80% with average value of 68%. OLR of 4.85 kg COD $m^{-3}$ day, obtaining 73% of methane.Biogas and methane production rate at various OLRs during treatment phase of

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20 hr HRT.*FarhikhtehSamadi et al.,(2017)*observed that the Biogasproduction as 1gCOD/d removal is 0.3144 and as 1 gBOD/d removal is 0.4315 which was less than previous studies.

## IV RESULTS AND DISCUSSION

- The study was carried out to optimize the fat removal efficiency in an anaerobic condition using Inverted Anaerobic Sludge Blanket Reactor. The COD removal efficiency and biogas production are the other two parameters observed along with fat removal in this study.
- The reactor was operated at different HRTs of 24, 18 and 12 h with OLRs 3.1, 4.3 and 6.2 kg COD/ $m^3$d, respectively. A maximum COD removal of 90.1 % and corresponding fat removal of 90 % was achieved.
- Comparing to the other researcher, this reactor was achieved high removal efficiency of COD and Fat.
- The biogas production at an optimized condition was found to be 2.8 L/d.

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