ORGANIC LOADING RATE

Effect of Organic Concentration and Loading

Successful start-up of UASB reactor is possible for low strength wastewater like domestic sewage, effluent from fruit and vegetable factory etc. [Maaskant and Zeevalkiak, 1983], and also for medium and high strength wastewater. Wentzel *et al*., [1994] stated that for the COD concentration in the range 2000 to 5000 mg COD/ L, the performance of the reactor depends upon the loading rate and is independent of influent substrate concentration.

Increase in granules size with increase in substrate concentration and decrease in size with decreasing concentration was observed in a UASB lab-scale reactor fed with propionate and acetate as substrate [Grotenhuis *et al*., 1991b]. Increasing the influent concentration also led to an increase of menthanogenic activity of the granules. This may be attributed to an increased fraction of viable organisms in the more heavily loaded granules.

Granular sludge was reported to form when a high organic loading above 0.6 kg COD/ kg VSS.d was applied [Hulshoff *et al*., 1983b, Brunetti *et al*., 1983]. Organic underloading may be detrimental to sludge settleability. At low loading, less than 0.3 kg COD/ kg VSS.d, extremely voluminous (bulking sludge formation was reported which can washed out of the reactor easily [Hulshoff *et al*., 1983b]. The loading above 1 - 2 kg COD/ m^3.d is essential for proper functioning of the reactor [Lettinga *et al*., 1993b]. The guidelines for volumetric loading rate at different temperatures are given by Bhatti *et al*., [1995]. However, very high organic loading is also detrimental to the granule formation. At very high organic loadings, large quantity of biogas is produced, creating a vigorous mixing condition at the top of the reactor. As a result, a large amount of sludge may get disintegrated or washed out of the reactor [Fang and Chui, 1993].

It is reported that, for OLR & SLR values below 4 kg COD/m^3.d and 0.267 kg COD/kgVSS.d, respectively during start-up, the reactor took three weeks to achieve steady state. Beyond this loading start-up time increases drastically. For OLR<4.6kgCOD/m^3.d and SLR<0.267 kgCOD/kgVSS.d. The reactor can give the maximum COD removal efficiency about 95% and the efficiency drops rapidly for OLR>4.6kgCOD/m^3.d and SLR>0.3kgCOD/kgVSS.d and start-up time also increased up to around seven weeks [Ghangrekar, 1997].

It is suggested not to start the reactor with OLR>4.6kgCOD/m^3.d and SLR>0.3kgCOD/VSS.d, because, higher loading results in high VFA concentration in the reactor which is unfavorable for cultivation of good sludge. The reactors started with OLR less than 1.5 kgCOD/m^3.d and upflow velocity 0.015m/hr resulted in very low gas production rate of 0.55 m^3/m^3.d. Because of low gas production improper mixing of the reactor content took place due to which reactor performance was not stable and high fluctuations in COD removal efficiency from 5.16 to 97.37% were observed [Ghangrekar, 1997]. During start-up, mechanical mixing would be beneficial for the reactor having loading less than 1.5kgCOD/m^3.d.

The OLR between 2 and 3.5 kg COD/m^3.d and SLR between 0.15 and 0.25 kg COD/kgVSS.d are reported to be favorable loading conditions for the reactor start-up. For this loading the efficiency of the reactor was reported to be about 90%.