MIXING

For minimizing channeling and short-circuiting in order to ensure sufficient contact between sludge and wastewater, a certain level of agitation is necessary [Viera, 1992]. This will enhances granulation and treatment efficiency. Probably, under conditions of moderate mixing, cells growing on aggregates experiences a certain shear rate with respect to fluid. This might improve mass transfer of nutrients and metabolites, to the extent that these cells grow more rapidly than their single suspended counterparts [Vanderhaegan *et al*., 1992]. However, vigorous mixing is detrimental for granule formation, causing the disintegration of sludge granules under the influence of friction forces to which the sludge flocks are exposed [Lettinga *et al*., 1980a, Brunetti *et al*., 1983].

Mixing in the reactor depends upon upflow velocity caused by feed influent and biogas flux rates (m^3 biogas/ m^2 reactor cross section per hour). Under mesophilic and thermophilic temperature conditions, the biogas produced in the reactor has a greater role in ensuring adequate mixing than upflow velocity. At lower temperature mixing can be improved by gentle mechanical mixer, effluent recycle or by gas recirculation. Mechanical mixing at a minimum i.e., less than 10 - 30 rpm for 1 minute at every 10 minutes interval may be beneficial at the beginning of the process, where agitation by rising gases may not be sufficient [Lettinga *et al*., 1980a]. Gentle or intermittent agitation preserves the microstructure of the flocks and promotes the formation of granules. Mixing performance can also be improved by using a pulse feed rather than continuous feed for the UASB reactors operating at mesophilic and ambient conditions [Hickey and Goodwin, 1991a]. However, once the gas production reaches 1 m^3/m^3 reactor volume per day, external mixing is not required [Brummeler *et al*., 1985] as the natural mixing of the system appeared to be sufficient. During the start-up of UASB reactor for loading less than 1.5 kg COD/ m^3.d and if gas production is less than 0.7m^3/m^3.d external mechanical mixing may be beneficial for proper mixing inside the reactor [Ghangrekar 1997]. The gas production greater than 0.7 m^3/m^3.d and less than 2.17 m^3/m^3.d provides sufficient mixing to ensure proper contact between wastewater and sludge in UASB reactor.