**Abstract**

Effective solids-liquid separation is the basic concept of any wastewater treatment system. Biological treatment methods involve microorganisms for the treatment of wastewater. Conventional activated sludge process (ASP) poses the problem of poor settleability and hence require a large footprint. Biogranulation is an effective biotechnological process which can overcome the drawbacks of conventional ASP to a great extent. Aerobic granulation represents an innovative cell immobilization strategy in biological wastewater treatment. Aerobic granules are self-immobilized microbial aggregates that are cultivated in sequencing batch reactors (SBRs). Aerobic granules have several advantages over conventional activated sludge flocs such as a dense and compact microbial structure, good settleability and high biomass retention.

For cells in a culture to aggregate, a number of conditions have to be satisfied. Hence aerobic granulation is affected by many operating parameters. The organic loading rate (OLR) helps to enrich different bacterial species and to influence the size and settling ability of granules. Hence, OLR was argued as an influencing parameter by helping to enrich different bacterial species and to influence the size and settling ability of granules. Hydrodynamic shear force, caused by aeration and measured as superficial upflow air velocity (SUAV), has a strong influence and hence it is used to control the granulation process. Settling time (ST) and volume exchange ratio (VER) are also two key influencing factors, which can be considered as selection pressures responsible for aerobic granulation based on the concept of minimal settling velocity. Hence, these four parameters - OLR, SUAV, ST and VER- were selected as major influencing parameters
for the present study. Influence of these four parameters on aerobic granulation was investigated in this work.

A laboratory scale column type SBR with a capacity of 2 litres was designed and fabricated. Three values for each parameter (OLR - 3, 6 and 9 kg COD m\(^{-3}\) d\(^{-1}\), SUAV - 2, 3 and 4 cm s\(^{-1}\), ST - 3, 5 and 10 min and VER - 25, 50 and 75%) were attempted in nine trials. All the other operating conditions except the studied parameters were kept constant throughout the study. Performance of the reactor was observed in terms of formation and development of aerobic granules, settleability of the sludge and COD removal.

The influence of the studied parameters (compared parameters) on important performance characteristics (reference parameters) of aerobic granulation was analyzed using grey system theory (GST). Sludge volume index (SVI), time taken for the appearance of aerobic granules, size and specific gravity of granules and COD removal efficiency were taken as the reference parameters. Using grey relational coefficients (GRCs) and grey entropy relational grade (GERG), the impact of the compared parameters on reference parameters was estimated. A ranking based on the order of importance was also made. The optimal values of the compared parameters were estimated as 6 kg COD m\(^{-3}\) d\(^{-1}\) for OLR, 3 to 4 cm s\(^{-1}\) for SUAV, 5 min for settling time, and 50% for VER.

Rubber is one of the main agro-based industrial sectors that play an important role in Kerala’s economy. The rubber latex processing units generate wastewater with high organic content during the various stages of processing. The treatment and disposal of this wastewater is a major problem. Where availability of land is a constraint, treatment of latex
processing wastewater by aerobic granulation is thought to be a viable option. Hence wastewater from the rubber latex coagulating units was selected as a real wastewater for the present study. Latex effluent was subjected to treatment by aerobic granulation using the optimized values of the operational parameters studied. Excellent performance was observed in the study in terms of aerobic granule formation, settleability of sludge, COD removal (97%), and nitrogen removal (90.9%).

This study has established the suitability of aerobic granulation technology for the treatment of high strength wastewater under controlled operating conditions. Prioritization of major influencing factors is necessary for the design of pilot plants and for scaling-up of SBRs. GST was found to be an effective tool for arriving the order of importance. The optimized values of operational parameters were proved successfully for the treatment of a real wastewater.

**Key words:** Aerobic granulation; sequencing batch reactor; organic loading rate; hydrodynamic shear force; superficial upflow air velocity; settling time; volume exchange ratio; grey system theory; latex processing effluent.