ABSTRACT

During the last decades, the amount of sludge to be disposed has increased largely due to the higher number of municipal wastewater treatment plants. Surplus waste activated sludge (WAS) generated during biological treatment process from municipal and industrial waste water treatment is an unavoidable problem. Sludge minimization strategies have received more attention recently in research to solve the sludge-related problems, reduce the investment and operational costs, and enhance the performance of the subsequent treatment and final disposal processes. The volume of excess WAS generated in the sewage treatment process is about 0.15–1% of the treated water. A significant increase in WAS production is caused by an increase in the amount of wastewater and the treatment rate. The cost of WAS treatment is very high, accounting for up to 60% of the total operational costs of a plant.

Among the various sludge management methods practiced anaerobic digestion (AD) was proved to be effective in treating excess WAS. Minimization in sludge quantity, stabilization of sludge and production of a biogas are the advantages of AD. The pre-treatment of sludge prior to anaerobic digestion is required because of low biodegradability of the cell walls and extracellular polymers in sludge. Many researchers have suggested that in the sludge, extracellular polymeric substance (EPS) plays a major role in floc formation. In order to hasten the pretreatment process, removal of EPS is a necessary step. Therefore in the present study, it was planned to remove EPS (floc disruption) to increase the surface area for bacterial action and to enhance the solubilization.
The present study affords the consequences attained from laboratory scale experiments of different disintegration methods – Dioctyl sodium sulphasuccinate (DOSS), Magnesium sulfate (MgSO\textsubscript{4}), and Sodium thio sulphate (STS) induced immobilized bacterial pretreatment methods, evaluation of anaerobic biodegradability of disintegrated sludges. The WAS was collected from municipal waste water treatment plant (MWWTP) at Karakonam, Kerala. Protease secreting bacterial strain was isolated from WAS. The bacterial strain was identified as *Bacillus cereus* (Accession number- KX959688) through 16s rRNA sequencing.

At first phase, effective deflocculation (floc disruption) with negligible cell cleavage was achieved at 0.009 g/g SS DOSS dosage. The outcome of immobilized bacterial pretreatment of sludge biomass reveals that the achieved chemical oxygen demand (COD) solubilization for deflocculated (EPS removed – bacterially pretreated) sludge was observed to be 20% and was higher than that of flocculated (14%) and control (5%). The rate of disintegration was faster in deflocculated sludge with a rate constant of about 0.064 h\textsuperscript{-1}. The biochemical methane potential (BMP) assay resulted in a significant methane yield of about 0.24 (gCOD/gCOD) for deflocculated sludge. The economic assessment showed a net profit of about 1707.7 INR/Ton of sludge.

At second phase, effective deflocculation with negligible cell cleavage was achieved at 0.1 g/g SS MgSO\textsubscript{4} dosage. The outcome of immobilized bacterial pretreatment of sludge biomass reveals that the achieved COD solubilization for deflocculated (EPS removed – bacterially pretreated) sludge was observed to be 21% and was higher than that of flocculated (15.2%) and control (4.5%). The rate of disintegration was faster in deflocculated sludge with a rate constant of about 0.006 h\textsuperscript{-1}. The biochemical methane potential (BMP) assay resulted in a significant methane
yield of about 0.26 (gCOD/gCOD) for deflocculated sludge. The economic assessment showed a net profit of about 1802 INR/Ton of sludge.

At third phase, effective deflocculation with negligible cell cleavage was achieved at 0.08 g/g SS STS dosage. The outcome of immobilized bacterial pretreatment of sludge biomass reveals that the achieved chemical oxygen demand (COD) solubilization for deflocculated (EPS removed – bacterially pretreated) sludge was observed to be 22.8% and was higher than that of flocculated (14.2%) and control (4.3%). The rate of disintegration was faster in deflocculated sludge with a rate constant of about 0.0065 h\(^{-1}\). The biochemical methane potential (BMP) assay resulted in a significant methane yield of about 0.32 (gCOD/gCOD) for deflocculated sludge. The economic assessment showed a net profit of about 3801 INR/Ton of sludge.

At last, comparison of three different chemicals used for EPS removal of immobilized bacterial pretreatment was done on the basis of substrate biodegradability and cost analysis. It was concluded that STS mediated immobilized bacterial pretreatment showed enhanced biodegradability with greater net profit.