CHAPTER 4

SUMMARY AND CONCLUSION

Excess waste activated sludge generated during biological treatment process from municipal and industrial waste water treatment is an unavoidable problem. The sludge have many negative impacts on the environment such as foul odor and generation of toxic compounds. In those consequences, the disposal of sludge has now become a major problem because of its excess volume and undesired characteristics. This research work was executed with the purpose to reduce the excess sludge and to improve the biodegradability, through the efficiency of immobilized bacterial pretreatment of WAS by deflocculation (removal of EPS). The effectiveness of pretreatment was assessed by comparing successive anaerobic biodegradability with that of immobilized bacterial pretreatment alone and control. As demonstrated in Chapter 3, all the three different chemicals (DOSS, MgSO₄ and STS) mediated immobilized bacterial pretreatments resulted in satisfactory achievement of biodegradability.

The following outcomes and conclusions are drawn from the research:

- *Bacillus cereus*, protease enzyme secreting bacterial strain was considered to be the effective bacterial strain for sludge solubilization.

- The optimum growth conditions of the bacteria were at a temperature of 35°C, pH 7 and an incubation time of 36 h.
The Chemicals such as DOSS, MgSO$_4$ and STS can be employed for the effective deflocculation and enhancement of extracellular enzyme activity to improve immobilized bacterial pretreatment.

0.009 g/g SS of DOSS, 0.1 g/g SS of MgSO$_4$ 0.08 g/g SS of STS are the optimized dosage for the deflocculation (floc disruption) with minimum cell lysis.

**Pretreatment improvement**

The consequence of various pretreatments on sludge solubilization and sludge reduction were explored. All the pretreatments provoked a perceptible enhancement in COD solubilization and biopolymer release.

COD solubilization obtained for three different pretreatment methods were established to be 20%, 21% and 22.8% respectively for DOSS, MgSO$_4$ and STS mediated immobilized bacterial pretreatment.

Kinetic study of pretreatment exposes that immobilized bacterial pretreatment increases the rate of the PCOD reduction reaction with rate constants – 0.008 h$^{-1}$, 0.006 h$^{-1}$, and 0.063 h$^{-1}$ for DOSS, MgSO$_4$ and STS.

**Biogas production improvement**

All the three pretreatment methods considerably increase the biogas production potential and biodegradability.

Pertaining to the Biochemical methane potential assay, the highest methane production potential has been achieved for STS mediated immobilized bacterial pretreatment 0.32 gCOD/gCOD added
comparatively higher than other pretreatments 0.26, 0.24 gCOD/gCOD (DOSS & MgSO₄).

- A conclusion can be drawn out based on the comparative effectiveness of the three different pretreatment methods in terms of substrate biodegradability and cost. The outcomes of the comparison revealed that the STS mediated immobilized bacterial pretreatment with a positive net profit of about 3801 INR/Ton of sludge was considered as promising and economically viable options for sludge pretreatment process.

- In future, a similar study to evaluate the significance of bacterial strain in anaerobic digestion of WAS is needed. In addition, compared with the extensive research about the EPS removal methods, the path of chemicals used for EPS removal were still not analytically studied. The chemicals that are employed for EPS removal such as cation binding agents (Sodium thiosulphate) Surfactant (DOSS), have many negative aspects. Some are micro pollutants, foam generators, non-biodegradable agents and inhibit biological treatment by coupling with metabolic reactions. In the view of lack of reliable means for investigating these negative aspects, a resolution for these drawbacks is essential. The challenge for future research on EPS removal should mainly focus on safety of using chemicals. In addition to more comprehensive and possible analysis, a method taking into account of all possible negative aspects must be investigated in order to obtain a valuable quantification procedure.