Chapter 6 Summary and Scope for Future Work

This chapter aimed to summarize the results discussed in previous chapters on the catalytic thermolysis and coagulation and flocculation of petroleum refinery effluent by using the metal-based catalysts/coagulants and the study of the physicochemical characteristic of oily petroleum sludge. This chapter has been divided into two parts: (1) summary of the thesis and (2) scope for future work.

6.1 Summary of the thesis

The work presented in this thesis has focused on the treatment of petroleum refinery wastewater through catalytic thermolysis, coagulation, and flocculation by using metal-based catalysts/coagulants like ferric chloride, copper sulphate, and the combination of both of these. These results were then used for deciding the strategy for further treatment using catalytic thermolysis, coagulation and flocculation. Knowledge of the physicochemical characteristics of oily petroleum sludge is helpful for deciding the treatment strategy; hence the sludge collected from petroleum refinery was analyzed to know its physicochemical characteristics. The results obtained through various experiments were analyzed and discussed and are presented in Chapters 3, 4, and 5 of this thesis. Based on these results following significant points have been drawn:

- The treatments of the petroleum refinery effluent (PRE) by thermolysis and coagulation and flocculation have been successful in making the treated effluent amenable for biological treatment. Sufficient reduction in chemical oxygen demand (COD), turbidity, total dissolved solids (TDS), and color has been observed that are helpful in biological treatment. In addition, the effluent final pH is also maintained in the disposal range.
- The $CuSO_4$+$FeCl_3$ showed better results with all the dependent variables compared to $CuSO_4$ and $FeCl_3$ alone coagulants/catalysts.
- Mixed catalyst ($CuSO_4$+$FeCl_3$) is well suited for the treatment of PRE by both thermolysis, and coagulation and flocculation process.
- Individually, copper-based catalyst performs better at basic pH and iron-based catalyst is effective at acidic pH.
- Higher COD and turbidity reduction are obtained with the copper-based catalyst.

- Temperature and pH had a significant effect on the reduction of turbidity, while time and dose had a minimal effect in case of the catalytic thermolysis treatment process.
- The formation of tri-basic copper chloride (TBCC) plays a key role in the case of $CuSO_4$+$FeCl_3$ as coagulants/catalysts.
- Optimization of the process parameters by RSM has helped in increasing the process efficiency.
- The physicochemical characterization of oily petroleum sludge before and after the solvent extraction by using a Soxhlet apparatus has been efficaciously analyzed.
- Thermochemical conversion techniques can be the possible route for the remediation of hazardous oily petroleum sludge.
- TGA/DTG analysis indicated that oily petroleum sludge can be pyrolyzed in the temperature range of 250 to 650℃.
- Accumulation of potassium, magnesium, cobalt, etc., on the surface of OPS after extraction, may favor its utility in thermochemical conversion processes by acting as a catalyst.
- GC-MS analysis showed that the most abundant class of compounds present in liquid is aromatic (52.84 %) followed by alkanes (39.35 %), acids (5.72 %), and alcohols (2.09 %).
- Thermochemical conversion techniques can be a possible route for remediation of OPS. Among the various thermochemical techniques, pyrolysis might be the most efficient process because of higher volatile matter, lower moisture, and activation energy of OPS.

6.2. Scope for future work

- This research focused on the treatment of petroleum refinery effluent collected from the effluent treatment plant, where, the mixed coagulant is more favorable than the individual coagulant. The mixed catalyst/coagulant is also recommended to conduct the test on wastewater generated in different kinds of industries.
- It has been shown that the presence of copper enhances the ability to reduce the COD, turbidity, TDS, color, basically suspended and colloidal particles due to the formation of TBCC. These results are based on the basis of results obtained with a 1:1 ratio of $CuSO_4$ and iron salts. It would be useful to investigate the efficacy of the system by varying the amount of copper salt to come out with the optimum ratio, particularly for other oily wastewaters.
- Physicochemical characterization suggests the pyrolysis of oily petroleum sludge is the better option for reusing the sludge.