CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

This work demonstrates for the first time that the polyelectrolyte recovery from polyelectrolyte-enhanced ultrafiltration (PEUF) can be scaled up from batch experiments in a laboratory scale to batch and continuous operations in a pilot scale, steady state crystallizer. In batch experiments, the precipitation of barium chromate was carried out at equilibrium condition in a laboratory scale. It was found that an increase in barium to chromate concentration ratio and added electrolyte (NaCl) concentration could enhance the polymer recovery, whereas the polymer recovery decreases with increasing polyelectrolyte to chromate concentration ratio. At stoichiometric ratio of barium chromate, the percentage of polymer recovered are 93.1, 88.5, 84.5, and 81.5 % at QUAT to chromate ratios of 5, 10, 15, and 20, respectively.

The polymer regeneration unit was subsequently scaled up to operate in both batch and continuous crystallizers. In the continuous system, the polymer recovery decreases with increasing QUAT to chromate ratio, increasing drainage flow rate, and decreasing feed flow rate. The fraction of carry-over barium chromate solid increases as feed flow rate and QUAT to chromate ratio increase. It can be concluded that the dispersion of barium chromate particles in the presence of the cationic polyelectrolyte leads to poor separation efficiency in the continuous crystallizer. However, the longer residence time can enhance the solid settling in the batch system. The polymer recovery of the batch crystallizer is higher than that of the continuous crystallizer, while the batch crystallizer can provide lower amount of solid in the QUAT-recycled stream.

The dispersion of barium chromate particles in the presence of polymer is due to the polymer adsorption, which leads to a decrease in particle size, as well as an increase in solution viscosity. This phenomenon causes the sedimentation rate to decrease with increasing QUAT concentration. Above 0.05 M QUAT, polymer adsorption and particle size level off, so the reductions in sedimentation rate are primarily due to continuing viscosity increase with QUAT concentration.

This study shows the feasibility in substituting conventional processes with the PEUF process with a polymer regeneration unit in chromate wastewater treatment.

RECOMMENDATIONS

In order to improve the polyelectrolyte regeneration unit, a longer mixing zone and a lower supersaturation ratio might be required to produce larger particles, which can be settled at a higher rate. Therefore, a batch scale experiment to investigate the particle size distribution at the lower supersaturation ratio ($S < 135$) might be useful before operating in a settler.

It has been proved that a residence time is one of significant parameters affecting solid/polyelectrolyte separation. A batch settler seems to be the best choice, however, it is not applicable for industries. Thus, a semi-continuous operation might be an alternative way to integrate PEUF and recovery processes. The PEUF operation can be carried out continuously via a spiral wound ultrafiltration membrane, while the recovery step can be operated in multi-batch setters (swing-settler). Therefore, the entire operation would be continuous, which is suitable for industries.

It is interesting for further investigation to study other cationic polyelectrolytes (molecular weight < 240,000 Daltons), which have lower affinity to bind with barium chromate particles. With lower MW polyelectrolyte, poorer polymer adsorption and lower viscosity of the polyelectrolyte solution would be obtained, resulting in larger particle size and higher sedimentation rate.

The XRD, SEM, and EDX measurements might be useful to explain the barium chromate sedimentation and bimodal in particle size distribution.

In addition, the PEUF and regeneration processes should be applied to various types of contaminants and mixed-contaminant systems. For example, the mixture of chromate and sulfate, which present in groundwater.

Furthermore, the recovery of polyelectrolyte from a ligand-modified polyelectrolyte-enhanced ultrafiltration might be investigated based on this research work.