CHAPTER FIVE: SUMMARY AND CONCLUSIONS

The study on chemical characteristics of the rubber thread manufacturing industry wastewater revealed that the wastewater is acidic in nature (pH ranged from 3.8 to 4.4) and contained high levels of carbonaceous organics and zinc which originated from residual latex and chemicals used in the latex compounding stage of the manufacturing process. The concentrations of COD; BOD; total nitrogen, phosphorus and zinc in the combined wastewater from the rubber thread manufacturing industry ranged from about 4,690 to 6,560 mg/L; 3,990 to 5,790 mg/L; 170 to 290 mg/L, 21 to 24 mg/L and 250 to 310 mg/L respectively. The average COD:N:P ratio of the same wastewater was 100:3.8:0.4 which indicated that the wastewater has sufficient amount of carbon, nitrogen and phosphorus for treatment by an anaerobic process.

The high BOD to COD ratio of the wastewater also suggests that the wastewater can be easily degraded by the anaerobic digestion process. However the high concentration of zinc in the wastewater requires that the pretreatment step has to be carried out first before the effluent could be treated in an anaerobic reactor such as upflow anaerobic filter. The chemical precipitation/flocculation was the

pretreatment steps used to remove zinc from the wastewater. The combination of 800 mg/L of sodium sulphide and 5 mg/L of LT 27 was found to be the most effective chemical precipitation/ flocculation for the removal of zinc from the rubber thread manufacturing industry wastewater. The chemical cost of this system works out to RM1.04/m^3 of wastewater treated.

Studies on the use of upflow anaerobic filter for treatment of the rubber thread manufacturing industry wastewater have indicated that the upflow anaerobic filter which contained polyurethane foams as the packing media can be started-up quite rapidly by first digesting the synthetic wastewater containing acetate and other nutrients for the anaerobic bacteria after the reactor was seeded with well digested anaerobic sludge. Acetate was chosen as the substrate for the anaerobic bacteria because the rubber thread manufacturing industry wastewater contains mainly acetate which originated from acetic acid used as a coagulant in the manufacturing process. In all, the start-up period required was about 54 days before the upflow anerobic filter achieved steady state and is ready for carrying out other experiments for studying the influence of varying organic loading rate, hydraulic retention time, temperature, pH etc. of the wastewater.

Results of the study on the influence of organic loading rates have indicated that the percentages of COD and BOD removal efficiencies, the percentage of methane in biogas and the biogas yield had decreased while the biogas production rate increased with increase in the organic loading rates applied. The optimum loading rate for treatment of rubber thread manufacturing industry wastewater was about 8.0 g COD/L/d or 8 kg COD/m^3/d. At this loading rate, more than 80% of COD was removed and the biogas yield was about 342 mL CH_4/g COD removed or 342 L CH_4/kg COD removed.

Similar observations were also noted when the hydraulic retention time of the system was decreased from 3.0 d to 0.5 d. The optimum hydraulic retention time for treatment of rubber thread manufacturing industry wastewater by the upflow anaerobic filter was found to be about 1.5 days.

The study on influence of temperature on the anaerobic treatment of the rubber thread manufacturing industry wastewater by an upflow anaerobic filter revealed that in view of cost the treatment is best carried out at the mesophilic temperature of 35 °C although the highest biogas production rate was recorded at the thermophilic temperature of 50 °C.

By increasing the pH of the wastewater from 4.0 to 10.0 before feeding into the upflow anaerobic filter, the percentages of COD and BOD removed and the rate of biogas production were found to be more in a pH range of 6.0 to 8.0. These results suggest that pH of the rubber thread manufacturing industry wastewater should be adjusted to 6.0 - 8.0 before feeding into the upflow anaerobic filter. However cost considerations need to be evaluated.

In the study on the effect of micronutrients on the anaerobic treatment of rubber thread manufacturing industry wastewater in an upflow anaerobic filter, it was found that the addition of 100 mM Ni and 50 mM Co as chloride salt had increased the COD and BOD removal efficiencies and the rate of biogas production of the process.

With regard to specific biogas yields, it was observed from the present study that by increasing the organic loading rate from 2 to 14 g COD/L/d, the specific biogas yield decreased from 0.250 to 0.069 L CH_4/g COD added while the biogas yield rate increased from 0.97 to 1.50 L CH_4/L/d.

On the nutrients requirement, the present study has indicated that by increasing the organic loading rate from 2 to 14 g COD/L/d, the amount of nitrogen and phosphorus utilized by anaerobic

microorganisms decreased from 1.53 to 1.20 and from 0.30 to 0.26 mg for each 100 mg of COD consumed respectively.

The study on the importance of attached versus suspended biomass in the upflow anaerobic filter has confirmed that the attached biomass had contributed by more than 70% to the COD removals in the treatment of rubber thread manufacturing industry wastewater by the upflow anaerobic filter containing polyurethane foams as the packing media.