CHAPTER 4

Summary and Operational Issues

Foster Wheeler's On-site Laboratory and Job Trailer

4.1 Staffing Requirements and Cost Information

All staffing requirements and scale-up cost information were provided with assistance from ThermoEnergy Corporation and Foster Wheeler Environmental Corporation, i.e., these cost values were not verified by EvTEC or its evaluation process. Appendix C discusses this information.

4.2 Struvite Control

Magnesium ammonium phosphate ($Mg\ NH_4\ PO_{4\ (s)}$), more commonly referred to as struvite, is a recognized problem in anaerobic sludge centrate lines when the pH is basic and the concentrations of certain minerals are abnormally high. The Oakwood Beach WPCP has had struvite formation problems in the past, but the addition of Ferric Chloride ($FeCl_3$) which drops the pH to an acceptable level in the centrate, has eliminated struvite formation in the centrate lines. As a precautionary note, wastewater treatment plants (WWTPs) with a history of struvite formation should perform a complete centrate characterization. However, in general, as a result of the extreme pH depression and alkalinity uptake noted during the ARP pilot plant operations, struvite formation within the ARP adsorber vessels is not suspected to result in operational problems.

4.3 Operational pH

The pH of the ARP effluent was allowed to range from less than 2.0 to approximately 6.0. The characteristic pH of the ammonia adsorption columns effluent is about 2.0 due to the removal of both the ammonia and alkalinity and the resultant loss of centrate buffering capacity. The pH change was found to be rapid and sharp upon ammonia breakthrough. It was determined through operational experience that a sharp rise in effluent pH served as an excellent operational indicator of breakthrough in the ARP absorption columns. To maintain ammonia recovery efficiencies above 80%, the effluent pH should be below 3.0, and after the effluent rises above, or nears 3.0, the system column(s) should be regenerated. When the effluent pH was maintained below 2.5 the removal efficiencies were consistently higher. Due to the relatively small volumes of centrate treated during this program, no downstream pH adjustment was utilized for the ARP effluent. However, in a full-scale plant the pH should be adjusted as necessary to accommodate the processing needs of the wastewater treatment plant aqueous train. Conversely, it may be advantageous for a plant to use the low pH ARP effluent at locations within the plant for beneficial purposes, such as, struvite control.

4.4 Lessons Learned

Based on the day-to-day operating experience gained during the Oakwood Beach demonstration project, FWENC recommends that the following design enhancements be incorporated into full-scale facilities:

- Demineralizers should be provided upstream of the ARP adsorption columns to remove potential contaminants;

- Zinc adsorbers should be considered for installation downstream of the ARP process if zinc leaching to the main process stream is of concern;

- Duplex and triplex pumping systems should be provided for the pretreatment filters and sorption units;

- Redundant sorber, demineralization, and pretreatment filter trains should be provided;

- pH adjustment capability should be considered downstream of the ARP process if pH control in the main process stream is of concern;

- Reverse osmosis units should be considered for use in the evaporator/crystallizer unit stream to reduce any potential for fouling; and,

- Completely instrumented systems are recommended, with consideration being given to providing redundant instrumentation for critical system components.

4.5 Summary

The data obtained for this verification demonstrated that the ARP process was capable of removing ammonia with efficiencies ranging from 75 to 99+ % from a centrate wastewater stream. During the EvTEC evaluation, the ARP system treated 25,200 gallons (95,382 liters) of centrate and EvTEC's contracted laboratory, ACCUTEST®, sampled 16 of the forty-eight processing runs that totaled approximately 9,500 gallons (35,956 liters), or about 38%, of the total treated flow.

The average flow-weighted values for the centrate influent and effluent ammonia-nitrogen were 280 mg/L and 31mg/L, respectively. This equates to approximately 89% removal of the ammonia influent to the adsorption columns. For this project, ACCUTEST® measured the influent ammonia concentrations ranging from just over 100 ppm to a high of 500 ppm NH_3-N. To maintain ammonia recovery efficiencies above 80%, the effluent pH should be below 3.0, and after the effluent rises above, or nears 3.0 the system column(s) should be regenerated. EvTEC's off-site contract laboratory did not record values of influent ammonia concentrations in the 1,000 ppm range (see Table 3-1 Ammonia Concentrations and Section 3-1) and the off-site laboratory did not record an ammonia regeneration solution value approaching the theoretical value of 15,000 ppm (see Appendix A).

The system performed at high ammonia removal efficiencies even after several operational system disruptions occurred. Subsequent pilot plant laboratory testing on the resin used during the 3-month testing period was found to have less sorptive capacity than the unused virgin resin. The zinc loaded resin sites are believed to be exchanged with cationic ions and compounds having a higher affinity than zinc for ARP resin. Based on the data collected, iron, calcium, and magnesium are likely exchanged with the Zn^{2+} sites in the ARP resin.

The ammonium-zinc sulfate crystals used for yield calculations were produced during the pilot plant operations from November 1, 1998 and ending December 5, 1998, and these intermediate crystals did not exhibit any common biofouling characteristics such as slimy appearance and objectionable odors. Based on ThermoEnergy and FWENC field collected data, the ARP crystallization system was able to produce approximately 162.1 lb (73.5 kg) of ammonium-zinc sulfate, $(NH_4)_2SO_4 \bullet ZnSO_4$, crystals from 11,717 gallons (44,350 liters) of centrate flow processed in the ARP. The mass balance closure of the actual yield versus the expected yield is 46.9% (i.e., 162.1 lb/345.7 lb). The highest yield of 72.5% was achieved on the last of three mass balance production runs. The final step in producing the ammonium sulfate crystals was not instituted until the last week of operation and according to FWENC data, approximately 20 lb of ammonium sulfate crystals were produced from a combination of the intermediate crystals obtained in the last two mass balance processing runs.

FWENC estimates that the total cost to treat ammonia laden wastes at the concentrations found in centrate to be between 3 and 6 cents per gallon on a privatized basis. All scale-up cost information was provided by ThermoEnergy Corporation and Foster Wheeler Environmental Corporation(See Appendix C).