**Task 2.0 - Air Quality Assessment, Control, and Analytical
Methods**
**Subtask 2.11 - Lactic Acid FGD Additives From Sugar Beet
Wastewater**

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**TASK 2.0 – AIR QUALITY ASSESSMENT, CONTROL, AND ANALYTICAL
METHODS
SUBTASK 2.11 – LACTIC ACID FGD ADDITIVES FROM SUGAR BEET
WASTEWATER**

1.0 INTRODUCTION

Organic buffers maintain the pH of the scrubber slurry in flue gas desulfurization (FGD) as the SO_2 dissolves at the air-liquid interface. Inexpensive acids with an appropriate pKa are required for this application. The pKa of lactic acid (3.86) is between that of the interface and the recirculating slurry and will make soluble calcium ion available in large amounts. Currently lactic acid is somewhat expensive for this use, but this project will develop a new source of inexpensive lactate.

Microbial action during the storage and processing of sugar beets forms lactic acid in concentrations as high 14 g/L in the processing water. The concentrations are lower than those occurring in conventional fermentation production of lactic acids, but since a considerable amount of water is involved in the processing of sugar beets in the Red River Valley (1 million gallons/day), a substantial amount of lactic acid or calcium lactate could be recovered as a by-product for use in FGD and other applications.

2.0 OBJECTIVES

The project objective is to evaluate two novel methods for recovering and processing the lactic and other volatile acid by-products produced during the processing of sugar beets. These methods are 1) freeze crystallization concentration of lactic acid and 2) ion exchange of lactate with recovery as the ester. In the first quarter, bench-scale testing of the freeze crystallization concept will be performed at B.C. Technologies using its freeze-thaw simulation method, and analysis of the recovered fractions will be performed at the Energy & Environmental Research Center (EERC). In the second semiannual period, ion exchange methods will be investigated for concentrating lactic acid. These methods employ novel inorganic ion exchangers that have the potential for eliminating fouling by the large amount of the other organic materials present in the water. These include carbohydrate, betaine, and proteins that bind irreversibly to organic ion exchange resins and significantly reduce the capacity and regeneration capability.

3.0 RESULTS AND DISCUSSION

Work in the previous six months established the feasibility of concentrating the lactic acid by freeze-thaw crystallization (Task 2.0 – Semiannual Report, January 1 through June 30, 1997). A simulation was performed with sugar beet wastewater in a bench-scale freeze-thaw unit at B.C. Technologies. This experiment used a temperature sequence corresponding to typical midwestern winter conditions. Two brine fractions from the experiment were high in lactate (2.6

times the feed concentration of 7.82 g/L). Thus the goal of 10 times concentration was not achieved in the simulation. However, the two brine samples represent 55% of the lactate recovered. Other carboxylic acids were similarly concentrated in the brine fractions. The lactic acid in two intermediate fractions was also concentrated (12.2 and 9.1 g/L) with respect to the feed. Two of the "treated water" samples were very low in lactic acid and represent 35% of the feed water. Thus a substantial part of the product fractions could possibly be discharged without further treatment.

In the exchange technology, a novel inorganic ion-exchange material was utilized to remove and concentrate lactic and volatile acids from the process water. Previous work with the inorganic exchanger showed that the acids were removed along with other organic materials, leaving the water with only 500 ppm chemical oxygen demand and suitable for discharge without further anaerobic treatment. The inorganic ion exchanger is a form of magnesium aluminum hydrotalcite, prepared in such a way as to have a very high exchange rate for organic anions. This material was synthesized at Universal Fuel Development Associates and was demonstrated to be very effective for removal of humates from surface waters draining peat basins in northern Minnesota. The advantage of the inorganic exchanger is that it can be regenerated thermally. Thus calcining at 400°C completely removes all organic matter by catalytic conversion to carbon dioxide and water.

Work in this period demonstrated that the hydrotalcite ion exchanger removed 90% to 95% of the lactic acid, along with most of the other organic material in the wastewater. Several methods were attempted for desorption of the lactic acid from the hydrotalcite. Exchange of the used hydrotalcite with sodium carbonate solution removed very little of the lactate. Sodium hydroxide was also ineffective.

Thermal treatment of the lactate-sorbed hydrotalcite was performed at various temperatures. Unfortunately, the major thermal decomposition products were carbon dioxide and water, rather than acrylic acid or other useful product.

Treatment of the lactate-sorbed hydrotalcite with refluxing ethanol was also investigated. If the hydrotalcite, which contains both basic and acidic sites, could catalyze the esterification of the lactate, a useful ester (ethyl lactate) could be obtained, and the remaining organic materials could be thermally decomposed. Gas chromatographic analysis of the ethanol separated at the end of the refluxing period (8 hr) showed that no ethyl lactate had formed. Addition of acid (sulfuric acid or boron trichloride) to the lactate-sorbed hydrotalcite suspension in refluxing ethanol gave no ethyl lactate. Similar experiments performed with an anion-exchange resin with lactate demonstrated that ethyl lactate does form with the addition of acid to the system. This method could be further explored, however, rapid fouling of the resin by the carbohydrate and protein material present may not make this approach commercially viable.

4.0 CONCLUSIONS

Sugar beet wastewater can be purified by treatment with hydrotalcites or other inorganic anion exchangers, and the exchangers can be easily regenerated; but recovery of lactate from the exchangers as lactate or ester is extremely difficult. Other methods such as freeze-thaw crystallization are better for lactate recovery.

Future work should investigate freeze crystallization of the salt forms of lactate acid. Other methods, such as electrodialysis, are feasible for isolation of lactic acid, but not necessarily economically viable for this application.