FINAL TECHNICAL REPORT
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Project Title: **VALUE-ADDED PRODUCTS FROM FGD SULFITE-RICH SCRUBBER MATERIAL**

ICCI Project Number: 04-1/US-1
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ABSTRACT

Massive quantities of sulfite-rich flue gas desulfurization (FGD) scrubber materials are produced every year. In fact, at present, the production of sulfite-rich scrubber cake outstrips the production of sulfate-rich scrubber cake by about 6 million tons per year, yet most of the utilization focus has centered on FGD gypsum. Therefore, we have recently initiated research on developing new strategies for the economical but environmentally sound utilization of sulfite-rich scrubber material.

In 2004-2005, we undertook an exploratory project, supported by the Department of Energy and Illinois Clean Coal Institute, in which we attempted to ascertain whether it is feasible to develop reconstituted wood replacement products from sulfite-rich scrubber material. The preliminary results indicate that not only significant amounts of sulfite-rich scrubber material could be used to produce wood substitute products without any binders but the products are also considerably stronger than the wood products on the market.

Pages 1 to 11 contain proprietary information

EXECUTIVE SUMMARY

OBJECTIVES

The long term objective of our research is to develop technology which mitigates the liability of sulfite-rich FGD scrubber sludge disposal by converting it into value-added products that can commercially compete. More specifically, for this one year proposal, the objectives were to:

(a) obtain sulfite-rich FGD scrubber sludge from two different power plants and to characterize the sludges for toxic metals,
(b) map the fate of mercury under typical composite formulation conditions,
(c) optimize the co-blending of scrubber material and agricultural byproducts and composite formulation, and
(d) evaluate the composite mechanical properties.

We proposed that we will explore whether it is feasible to enhance the utilization of sulfite-rich scrubber material by developing functional wood substitute structural materials from this type of sludge. This was to be accomplished by exploiting the physical and chemical properties of sulfite-rich scrubber materials, natural byproducts, and agricultural byproducts. To establish the preliminary viability of developing structural materials, we proposed five tasks, i.e.,

Task 1: To collect sulfite-rich scrubber material from two different power plants.

Task 2: To monitor the mercury, arsenic, selenium, and boron concentration in the scrubber material.

Task 3: To develop requisite mixes of scrubber material and renewable agricultural byproducts for the formulation of structural composites.

Task 4**:** To fabricate composite materials using compressive molding and/or injection molding technology.

Task 5**:** To subject the composites formulated under Task 4 to various mechanical tests to evaluate their performance.

BACKGROUND

According to the American Coal Ash Association, about 29,250,000 tons of FGD by-products were produced in the USA in the year 2003. Out of 29.25 million tons of FGD byproducts, 11.9 million tons were FGD gypsum byproduct. On the other hand, sulfite-rich scrubber byproduct's production was 17,350,000 tons in 2003. It is believed that 70% of the total FGD gypsum produced is consumed in wallboard, Portland cement, and agricultural application. The rest of the FGD gypsum, i.e., about 3.60 million tons is landfilled. However, the economical and environmentally conducive management of sulfite-rich scrubber byproduct is much bleaker. Out of 17,350,000 tons of sulfite-rich scrubber material produced in 2003, only about 224,100 tons were used as structural fills/structural embankments and 259,608 tons for mining applications. The rest, i.e., 16,865,588 tons, was landfilled. Unlike FGD gypsum, which when sold can garner resources for the electric utilities, most power plants have to pay to dispose of sulfite-rich scrubber material. In fact, electric utilities paid to dispose of 2.08 million tons in 2000. Clearly, environmentally friendly and economically conducive utilization of sulfite-rich scrubber material is of utmost importance for coal burning electric utilities.

SUMMARY OF RESULTS

To achieve our objectives, we undertook characterization, fabrication, and mechanical property measurements on both raw materials and the composites formulated from sulfite-rich scrubber materials. The following is a summary of our outcomes:

1. In our pursuit to develop value-added wood substitute products from sulfite-rich FGD scrubber material, we collected samples of scrubber material from two power plants, which burn Midwestern coal. The scrubber materials had not undergone stabilization with fly ash and were in a wet cake form.
2. The wet cake samples were air dried and then subjected to arsenic (As), boron (B), cadmium (Cd), mercury (Hg), and selenium (Se) analyses. The analyses of these elements were undertaken at a commercial laboratory. The concentration of As, B, Cd, Hg, and Se were < 4.8 mg/kg, 61 mg/kg, < 0.95 mg/kg, 0.28 mg/kg, and 6 mg/kg, respectively.
3. In another set of experiments, we explored how various fibrous materials would affect the strength of wood substitute composites formed from sulfite-rich scrubber material. Four natural fibrous materials were chosen for this purpose. The composites tested for their flexural strength provide strong evidence that the type of fibrous material chosen has a critical effect on the strength. The strength of the composites formulated from scrubber material and natural fibers ranged from 12.5 MPa (1813 psi) to 30 MPa (4350 psi).
4. We also explored whether byproducts derived from annual crops can alter the strength of the wood-substitute composites developed from sulfite-rich scrubber material. Two natural protein concentrates derived from two different crops were obtained and were tested. It appeared that 5 wt% natural proteins improved the strength of the composites from 2 MPa (290 psi) to 43 MPa (6235 psi). Enhanced concentration of natural proteins did not further increase the strength. It is worthwhile to point out those commercial wood products we tested in our laboratory, e.g., particle floor board, OSB, and sawdust board, had a flexural strength of 16 MPa (2320 psi), 25 MPa (3625 psi), and 29 MPa (4205 psi), respectively.
5. We investigated how the addition of cheap polymeric material along with lignin extracted from crop byproducts can affect the mechanical properties of the composites formulated from sulfite-rich scrubber materials. This was undertaken because the thrust of our research is to develop wood-substitute products, thus our products should be amenable to conventional wood tools, i.e., they can be cut with regular saws and can be routed using conventional routers besides being able to be

nailed. The strength linearly increased from 3 MPa as the polymeric concentration increased. In fact, for 30 wt% polymeric material our products' flexural strength was in excess of 48 MPa (6960 psi). This should be contrasted with commercial plywood we tested whose strength was 40 MPa (5800 psi).