TITLE: **VALUE-ADDED PRODUCTS FROM FGD SULFITE-RICH SCRUBBER MATERIALS**

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1. ABSTRACT

Objectives: According to the American Coal Ash Association, about 29.25 million tons of flue gas desulfurization (FGD) byproducts were produced in the USA in 2005. Out of 29.7 million tons, 17.7 million tons were sulfite-rich scrubber materials. At present, unlike its cousin FGD gypsum, the prospect for effective utilization of sulfite-rich scrubber materials is not bright. In fact, almost 17 million tons are leftover every year. In our pursuit to mitigate the liability of sulfite-rich FGD scrubber materials' disposal, we are attempting to develop value-added products that can commercially compete. More specifically, we have the following overall objectives to: (1) thoroughly characterize sulfite-rich scrubber materials, from two different power plants burning different coals, and natural byproducts for their variabilities in physical and chemical properties; (2) evaluate the chemical stability of the scrubber products, especially under our material fabrication conditions; (3) optimize the fabrication conditions for the development of wood substitute materials from sulfite-rich scrubber material; (4) establish manufacturing conditions for the fabrication of load-bearing lumber material from sulfite-rich scrubber materials; (5) evaluate the long-term stability of our products; (6) generate technology transfer parameters so that products can move from laboratory to pilot-scale manufacturing. The focus of the project during the performance period was directed toward objectives 3 and 5.

Achievements During the Performance Period: During the last year, the major effort of the research was directed toward establishing the mix and fabrication parameters needed to develop wood-substitute composites from sulfite-rich scrubber materials. One of the fabrication concerns was whether there was any potential of mercury re-emission during product manufacturing from sulfite-rich scrubber material. To answer this, two independent sets of experiments were conducted where we evaluated the possibility of mercury emission under our product manufacturing conditions. At ambient pressure, i.e., when no load was applied to the scrubber sample, we observed significant mercury re-emission at T > 150^{o}C. However, once load was applied, we did not observe any significant mercury emission from our scrubber

material at 25°C < T < 260°C. Even pressure as low as 3 MPa (435 psi) inhibited mercury emission during the product manufacturing. The following summarizes the main outcomes of our research on the mix needed and the fabrication approach required to produce our wood-substitute composites: (a) Besides two natural polymeric materials, we tested four commercially-available polymers in our mixes with scrubber material. Our results suggested that up to 5% of natural complex carbohydrate polymer could be used as a binder for our wood-substitute composites. However, while the strengths up to 90 MPa (13,051 psi) were achieved, the high fabrication pressures needed for making these composites resulted in sample densities exceeding 1600 kg/m^3. Moreover, the composites were hydrophilic, requiring surface treatment to retard water wettability. (b) While natural carbohydrate polymers had a good compatibility with the crop fibers we used in the mix, the polymers did not chemically cross-link with scrubber crystallites, which prohibited the amount of scrubber material to ~ 50 wt% in the mix. The scrubber material in this case acted as filler and did not contribute to the strength of the composites. (c) Two synthetic polymers, with a known compatibility with crop fibers and lignin, were tested in fabricating composites composed of scrubber material and crop fibers. These materials were successfully fabricated at low pressures, attaining the flexural strength approaching 30 MPa (4,350 psi). The low fabrication pressures resulted in densities lower than 1200 kg/m^3. (d) We have attempted to reduce further the density of the wood-substitute composites by adding low density fillers, e.g., fly ash. One of the fillers did bring down the density, but we also observed a decrease in the flexural strength of composite. It is worth mentioning that even with reduced strength our materials appeared to be stronger than commercially-available products. (e) The composite fabrication temperature did not significantly affect either the flexural strength or density of the composites formulated from sulfite-rich scrubber material.

Plans for the Remaining Period of Performance: During the next twenty-one months, the following research activities are planned:

- To upscale the wood-substitute composites to 6" x 6" size and subject them to various mechanical testing.
- To develop load-bearing lumber materials from sulfite-rich scrubber and natural waste materials. This will be demonstrated by fabricating 10" x 10" products.
- To produce procedural and technical parameters needed to upscale our products for pilot scale manufacturing.

2. LIST OF PUBLISHED JOURNAL ARTICLES, COMPLETED PRESENTATIONS AND STUDENTS RECEIVING SUPPORT FROM THE GRANT

(1) G. Markevicius, S. C. Jones, and V. M. Malhotra, "Structural, Thermal, and Mechanical Properties of Miscanthus-Derived Biocomposites", Society of Plastic Engineers ANTEC, pp 1702 – 1706 (2007).
(2) G. Markevicius, S. Jones, V. M. Malhotra, F. B. Botha, and C. E. Miller, "Characteristics of Sulfite-Rich Scrubber Materials and Potential Value-Added Materials from Them", World of Coal Ash Conference, Covington, KY, May 7-10 (2007).
(3) G. Markevicius, R. D. West, V. M. Malhotra, C. E. Miller, and F. B. Botha, "The Fate of Mercury in FGD Scrubber Materials during Product Manufacturing", Presented at Mercury Control Technology Conference (DOE), December 10-13, 2007.

3. STUDENTS WORKING ON THE PROJECT: G. Markevicius (Ph.D. student), Sean Jones (M. S. student), Scott Myers (undergraduate student), Brice Russell (undergraduate student), Daniel Muehl-Miller (undergraduate student), Stephen Hofer (undergraduate student), Timothy Milligan (undergraduate student), Joshua Stoll (undergraduate student).