Project Summary

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

2. PROJECT PARTICIPANTS:

V. M. Malhotra (Principal Investigator)
J. Mussleman (Undergraduate Student)
G. Markevicius (Graduate Student),
Southern Illinois University,
Carbondale, Illinois 62901-4401.

3. PROJECT DESCRIPTION:

A. Objectives

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

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

After successfully demonstrating the viability of our research, a more comprehensive proposal will be submitted.

B. Background

According to the American Coal Ash Association, about 29.25 million tons of FGD byproducts 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 17.35 million 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 3.63 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 258,608 tons for mining applications. The rest, i.e., 16,886,000 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.

It is expected that more electric utilities in the future will utilize FGD technology to surmount environmental concerns associated with coal burning. It is highly unlikely that a single or even a few technologies are going to overcome the efficient and economical utilization concerns of sulfite-rich scrubber materials. Only an incremental approach is going to have a significant impact. Therefore, we propose to develop technology which will successfully convert sulfite-rich FGD scrubber sludge into high value wood construction composites.

C. Period of Performance

October 1, 2004 through February 28, 2005

D. Project Summary

A radically different approach is proposed in which we will combine sulfite-rich flue gas desulfurization (FGD) scrubber materials with renewable agricultural byproducts to develop commercially-feasible, value-added materials. Our proposed approach is significantly different from the current thinking of using sulfite-rich scrubber materials for mine reclamation, road base construction, and stabilizing biosolids. The significance of developing value-added construction composites stems from our recent preliminary experiments which provide strong initial evidence that certain agricultural byproducts' properties can be harnessed to fabricate large volume use composites from sulfite-rich sludge. These structural composites will be cheap and will offer certain advantages over typical wood products.

4. PROJECT COSTS

A. DOE Cost:	$ 49,997
B. Recipient Share:	$ 25,994
C. Illinois Clean Coal Technology:	$ 10,010
D. Project Total:	$ 86,001

5. MAJOR ACCOMPLISHMENTS SINCE THE BEGINNING OF THE PROJECT

In our pursuit to develop value-added wood substitute products from sulfite-rich FGD scrubber material, we collected samples of scrubber material from a power plant, which burns Midwestern coal. This scrubber material had not undergone stabilization with fly ash and was in a wet cake form. The following experiments were undertaken to achieve our objectives:

1. The wet cake was 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.
2. 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 to 30 MPa.
3. 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 2 wt% natural proteins improved the strength of the composites from 2 MPa to 30 MPa. 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, 25 MPa, and 29 MPa, respectively.
4. 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. This should be contrasted with commercial plywood we tested whose strength was 40 MPa.

6. MAJOR ACCOMPLISHMENTS PLANNED DURING THE NEXT 6 MONTHS

During the next six months, the following research activities are planned:

- To map the fate of mercury as the wood-substitute composite materials are formulated from sulfite-rich FGD scrubber material.
- To further enhance the mechanical performance of our wood-substitute products by optimizing the co-processing of the agricultural byproduct additives and scrubber material. The major thrust of this task will be to maximize the scrubber material content without compromising the advantages of our potential products over natural wood products.
- To explore whether we can exploit our recent nanocomposite research to further exceed the strength of our wood-substitute products.

- To identify the technological parameters needed to upscale the size of our products.

7. ISSUES

The project is on schedule.