

**ANNUAL PROJECT REPORT
AS OF DECEMBER 1993**

1. PROJECT SPONSOR:

Ohio University
Dept. Of Chemical Engineering
182 Stocker Center
Athens, OH 45701-2979

2. PROJECT MANAGER:

Dr. Robert L. Savage
Emeritus Russ Professor
Chemical Engineering

TELEPHONE: (614) 593-1503

3. OCDO GRANT NO#: CDO/R-90-3

4. PROJECT: Final

5. PROJECT TITLE: Use of Ethanol to Remove Sulfur From Coal

6. PROJECT TERM: FROM August 1, 1991 TO February 28, 1993

7. PROJECT	<u>NAME</u>	<u>COST-SHARE</u>
CO-SPONSORS:	OCDO	\$ 75,000
	Ohio University	60,330
	Ohio Corn Marketing Board	74,910
	National Corn Growers Assoc.	68,300
	Kentucky Corn Growers Assoc.	<u>5,100</u>
TOTAL PROJECT COST:		\$283,640

I. ABSTRACT

8. OBJECTIVES:

The goal of the research program is to develop a chemical method for the cost effective removal of both inorganic sulfur (pyrite) and organic sulfur from coal. Organic sulfur, which is chemically bound sulfur in coal, is very difficult to remove. The technical objective has been changed to develop a new chemical process using ethyl alcohol in the laboratory and then to convert a small scale laboratory batch process to a larger scale continuous process which can serve as the basis for commercial development of the process. If the laboratory process can be successfully scaled up to pilot plant and commercial operation, it will allow the use of Ohio coals to meet the strict acid rain restrictions. These restrictions now prevent its use without the installation and operation of expensive wet scrubbers. Waste disposal or other environmental issues are not a major concern in the potential commercial operation of the ethanol process to remove sulfur from coal. There are no liquid or solid waste materials that would require a sludge pond, incineration or other waste disposal methods.

9. WORK DONE AND CONCLUSIONS:

Experiments were conducted in a laboratory batch autoclave to verify the effectiveness of the reaction for removing the sulfur from five Ohio coals. These coals were selected from the five largest tonnage coal seams in Ohio and included Pittsburgh No. 8, Meigs Creek No. 9, Clarion No. 4a, Middle Kittaning No. 6, and Waynesburg No. 11. Data from these experiments will be used to set the operating conditions for continuous reactors of a fluid bed type or a moving bed type. Both of these types of reactors are used in large scale petroleum or chemical plants and should readily be adapted to use ethyl alcohol to remove sulfur from coal. Favorable results from the laboratory autoclave experiments conducted in 1992 have indicated that the sulfur content of 3.5% sulfur Ohio coals can be reduced to less than 1.0% sulfur.

10. PLANS FOR COMING YEAR:

Work on this project under OCDO sponsorship was completed in 1992 but was continued in 1993 under sponsorship by the Ohio Corn Marketing Association, the Kentucky Corn Growers Association and the National Corn Growers Association. Continuation of the work into 1994 will be under the sponsorship of the National Corn Growers Association.

II. HIGHLIGHTS/ACCOMPLISHMENTS

11. The projected potential use of corn to produce ethanol to be used to remove sulfur from coal is 6 bushels of corn per ton of coal treated. In Ohio, about 30 million tons of high sulfur coal are produced annually. If this coal were treated with ethanol to remove sulfur from the coal and make it a compliance coal the benefits to both the corn growers and the miners in Ohio would be very substantial. There will be continuing efforts to use our plentiful coal reserves in an environmentally acceptable manner.

III. ARTICLES/PRESENTATIONS

12. Two papers describing the chemistry of using ethanol in a laboratory process to remove sulfur from coal were presented. The first paper, entitled "DESULFURIZATION OF COAL AT 500°C USING NASCENT HYDROGEN AND H₂S-ACCEPTOR" was presented by Dr. Lazarov at the 7th International Conference on Coal Science, September 12-17, in Banff, Alberta, Canada. The second paper, entitled "USE OF ETHANOL TO REMOVE SULFUR FROM COAL", was presented by Dr. Savage at the 1993 Annual Meeting of the American Institute of Chemical Engineers in St Louis.12.