ANNUAL PROJECT REPORT
AS OF DECEMBER 1990

1. PROJECT SPONSOR:

The Ohio State University
Department of Chemical Engineering
121 Koffolt Laboratories
Columbus, Ohio 43210-1180

2. PROJECT MANAGER:

Dr. Liang-Shih Fan, P.I.
Dr. Y.A. Attia, Co-P.I.

TELEPHONE: (614) 292-0209

3. OCDO GRANT NO#: RN1-87-090

4. PROJECT: Final Report

5. PROJECT TITLE: A Novel Three Phase Fluidized Bed Process for Simultaneous Selective Flocculation and Microbial Desulfurization of High Sulfur Coal

6. PROJECT TERM: FROM August, 1988 **TO** October, 1990

7. PROJECT	**NAME**	**COST-SHARE**
CO-SPONSORS:	OCDO	$148,951.00
	The Ohio State University	93,699.00
TOTAL PROJECT COST:		$242,650.00

I. ABSTRACT

8. OBJECTIVES

The objective of this project is to develop an efficient and cost-effective process for deashing and desulfurization of ultrafine coal prior to combustion. The proposed process utilizes an integrated circuit of selective flocculation followed by enhanced microbial desulfurization processes in a draft-tube gas-liquid-solid fluidized bed bioreactor. Our specific goals are to identify and optimize the important process parameters of each of these component techniques which would yield an overall efficient integrated system.

9. WORK DONE AND CONCLUSIONS:

Following phases have been successfully completed:

1- Search and development of selective dispersant and flocculants
2- Optimization of pyrite and ash minerals rejection by selective flocculation

3- Microbial leaching in the fluidized reactors.
4- Oxygen Transfer and mixing effects in the draft-tube fluidized bed
5- Techno-economic assessment of the proposed process

In the first phase, we study the effect of different flocculants and dispersant chemicals. The major criteria were the selectively of the flocculants toward carbonaceous materials in the coal and selectively of the dispersants toward the pyrite particles in the coal. Note that the sulfur in pyrite is the major source of sulfur in Ohio's coals.

In the second phase, we studied different operation aspects of the selective flocculation. These parameters were the effects of coal-floc separation technique, particle size and size distribution of the coal slurry, and the effective concentration of each of the chemical reagents selected in the previous phase for maximum coal recovery and sulfur rejection.

In the third phase, we studied the use of fluidized bed bioreactor for microbial desulfurization process. Different microbial cultures which were adapted for various periods to coal-pyrite slurry were used. The obtained results indicated a very significant increase in the oxidation rate of pyrite in the fluidized bed reactor with adapted microorganisms. Over 90% of the pyritic sulfur content were rejected within the residence time of 24 hours in the reactor. Note that the observed rates are 500% faster than the previous results reported in the literature.

In the fourth phase, the superior effects of fluidized bed bioreactor were investigated. In a series of experiments oxygen transfer rate was measured in a coal-water slurry system. These results were then correlated with the actual bioleaching process at similar operating conditions. The results indicate that the hydrodynamics of a fluidized bed bioreactor, more specifically, the efficient oxygen delivery mechanism, was the primary reason for the observed bioleaching rates.

Finally in the last phase, we prepared the Final Report in which we proposed a technically feasible process for cleaning ultrafine high sulfur coals. The operating and the capital investments associated with this process were also estimated. Based on this information the costs of ash and sulfur removal were also calculated.

10. PLANS FOR COMING YEAR:

Project was completed.

II. HIGHLIGHTS/ACCOMPLISHMENTS

11. Using the fluidized bed bioreactor for microbial desulfurization was proven to be the most effective method for removal of the pyrite in the coal slurry. The results indicate that 90% of the pyritic sulfur content is removed in 24 hours of treatment in the fluidized bed reactor. Note that this period has been widely reported to be within 5 to 15 days. The final coal product contained about 1.% total sulfur and less than 3% ash after combined selective flocculation and microbial desulfurization processes.

III. ARTICLES/PRESENTATIONS

12. 1. Bavarian, F., L.S. Fan, M. Elzeky, and Y.A. Attia, “A Novel Process for Deashing and Desulfurization of High Sulfur Coal Using Selective Flocculation and Microbial Desulfurization in a Draft Tube Slurry Bubble Column,” Paper No. 168Ak/113b presented in AIChE 1989 Annual Meeting, San Francisco, CA., Nov. 5-10.

2. Elzeky, M., F. Bavarian, Y.A. Attia, “Feasibility of Selective Flocculation/Froth Flotation Process for Simultaneous Deashing and Desulfurization of High Sulfur Coals,” Paper No. 105 presented in the Third International Conference on Processing and Utilization of High-Sulfur Coals, Ames, Iowa, Nov. 15-20.