Technical Progress Report for the Project
ENHANCEMENT OF SURFACE PROPERTIES FOR COAL BENEFICIATION

Principal Investigators: S. Chander and F. F. Aplan

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Table of Contents

Cover Sheet	i
Table of Contents	ii
Report Distribution List	iii
Statement of Objectives	1
Scientific and Technical Progress	2

Report Distribution List

- A. Thomas J. Feeley, III
Project Manager
MS 922-206
U.S. Dept. of Energy
Pittsburgh Energy Technology Ctr.
P.O. Box 10940
Pittsburgh, PA 15236
- B. Cynthia Y. Mitchell
Contract Specialist
AD-22, MS 921-165
U.S. Dept. of Energy
Pittsburgh Energy Technology Ctr.
P.O. Box 10940
Pittsburgh, PA 15236
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- I. Marilyn Keane
PM-01. MS 922-206
Pittsburgh Energy Technology Ctr.
U.S. Dept. of Energy
P.O. Box 10940
Pittsburgh, PA 15236

Project Title: ENHANCEMENT OF SURFACE PROPERTIES FOR COAL BENEFICIATION

PI's: S. Chander and F. F. Aplan

STATEMENT OF OBJECTIVES

The need to clean coal for its effective utilization in steam generation is well recognized. To use the coal as a source of energy in an environmentally safe manner, pre-combustion desulfurization is considered to be a very cost-effective method. The main objective of this research project is to study ways to modify surface properties of coal, pyrite and ash-forming mineral matter for beneficiation of fine coal. Since the differences in surface properties of coal and mineral matter are utilized in several oil based preparation technologies, such as: froth flotation, emulsion flotation, spherical agglomeration and liquid-liquid separation, another objective is to delineate the role of oil.

The following studies are being carried out to achieve the objectives stated in the previous paragraph:

- Investigation of the natural hydrophobicity of coal and pyrite
- Development and evaluation of enhanced coal hydrophobicity
- Development and evaluation of reagents which modulate the hydrophobicity of pyrite
- Development and evaluation of emulsion processes and their underlying principles.

SCIENTIFIC AND TECHNICAL PROGRESS

The progress made in this reporting period is described in the paragraphs that follow:

Modification of Pyrite Surfaces

Flotation tests were carried out to determine the effect of EDTA concentration on collectorless flotation of pyrite. These tests are part of the study to delineate the reasons for collectorless flotation of pyrite observed under some conditions. The tests conducted so far are consistent with the contact angle results given in a previous report. A substantial increase in pyrite flotation occurred in the presence of EDTA especially in slightly acidic solutions. When the flotation was performed on pyrite preconditioned with quartz, an increase in flotation was also observed. These results could explain the interaction between physical and chemical variables in the flotation system reported in the literature. Based on these results a manuscript is being prepared and the paper will be presented at the forthcoming meeting of the Society of Mining, Metallurgy and Exploration, Inc. SME, in Denver, February 25-28, 1991.

Modulation of Pyrite Hydrophobicity

In the rejection of pyrite during coal flotation one can either depress the pyrite (see F. F. Aplan, "Coal Flotation -- The Promise and the Problems" Adv. in Coal and Mineral Processing Using Flotation, SME, 1989, pp. 95-104) or the coal can be depressed and the pyrite floated as in the DOE/USBM two-stage reverse process (K. J. Miller, "Coal Pyrite Flotation",

Trans AIME, Vol. 258, 1975, pp. 30-33). Our most recent studies have focused on the use of xanthate to float the pyrite. It became immediately obvious that coal-source pyrite is much more refractory to xanthate flotation than is ore-source pyrite.

Using micro-flotation, it was found that ethyl xanthate (C_2H_5OCSSK) did not float coal-source pyrite very well even at concentrations as high as 5×10^{-3} moles/liter, while the flotation of ore-source pyrite was highly variable. The concentration of ethyl xanthate required for good flotation of ore-source pyrite differed by 1000-fold between the least and the most readily floated sample tested. Amyl ($C_5H_{11}OCSSK$) and octyl ($C_8H_{17}OCSSK$) xanthates floated both coal-and ore-source pyrites much better than did the ethyl xanthate. The xanthate concentration for 50% recovery of the coal-source pyrite was found to be $\sim 10^{-5}$ moles/l (range: 3×10^{-6} to 7×10^{-4} moles/l), while that of the ore-source pyrite averaged $\sim 10^{-6}$ moles/l (range: 10^{-7} to 1.5×10^{-6} moles/l). An exception to this is anthracite source pyrite which floated similarly to the ore-source pyrites.

Flotation with dodecyl xanthate ($C_{12}H_{25}OCSSK$) showed the following pattern for flotation of coal-source pyrite in comparison to the other xanthates used:

$$C_2 \gg C_5 = C_8 \leq C_{12}$$

and for ore-source pyrite:

$$C_2 \gg C_5 = C_8 \approx C_{12}$$

Reasons for these differences are currently under study. A technical paper reporting our most recent findings is scheduled for presentation at the SME/AIME Annual meeting in Denver, February 24-28, 1991.

Emulsion Processes and Principles

To quantify the three phase phenomena involving coal, water and oil, a technique was developed to measure contact angle of particles at interfaces. The contact angles are estimated, in this method by measuring the extent to which each particle is partitioned at a fluid-fluid interface. We have used this method to determine contact angle distributions of three coals, namely, an anthracite, sub-bituminous and a hVA bituminous coal. The results show that contact angle varies in a wide range. In comparison, contact angles for a homogeneous material such as polymethylmethacrylate are narrowly distributed. These results demonstrate that the method described above can be used to measure the wetting distribution of a heterogeneous substance such as coal.

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