**A NOVEL APPROACH TO HIGHLY DISPERSING CATALYTIC
MATERIALS IN COAL FOR GASIFICATION**

Tenth Quarterly Report
for the Period
January 1, 1992 - March 30, 1992

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PREPARED FOR
UNITED STATES DEPARTMENT OF ENERGY
UNDER CONTRACT NO. L DE-FG22-89PC89760

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MAY 04 1992

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ABSTRACT

This project seeks to develop a technique, based on coal surface properties, for highly dispersing catalysts in coal for gasification and to investigate the potential of using potassium carbonate and calcium acetate mixtures as catalysts for coal gasification. The lower cost and higher catalytic activity of the latter compound will produce economic benefits by reducing the amount of K_2CO_3 required for high coal char reactivities.

As was shown in previous reports, coal loading with potassium or calcium at different pHs produced CO_2 gasification activities which increased in the order pH 6 > pH 10 >> pH 1. A similar trend was obtained when calcium and potassium were simultaneously loaded and char reaction times were less than about 75 min. Beyond this time, the coal impregnated with catalyst at pH 1 became more reactive, reaching 100% conversion after 1.5h. X-ray diffraction analysis suggest that the catalysts are well dispersed around pH 1 and 6 whereas reduced dispersion was obtained at pH 10. The reactivities are independent of the surface areas of the coals. X-ray microanalysis has been used to further characterize the dispersion of the catalysts. The results suggest, qualitatively, that the catalyst is well dispersed at a calcium loading of 3.3% wt.

INTRODUCTION

Catalyzed coal gasification requires the adsorption of the catalyst precursor onto the coal surface as the first step in a series of consecutive reactions. Previous studies (1) have shown that char reactivities are dependent on the catalyst precursor and the method applied to load the coal with the catalyst. This report is part of ongoing research aimed at understanding the roles of coal surface charge and the pHs of catalyst impregnating solutions on the adsorption and activities of calcium acetate and potassium carbonate. As reported previously (2,3), the reactivities of chars derived from a lignite, subbituminous, and bituminous coals are strongly dependent upon the coal surface charge and the pHs at which calcium or potassium was adsorbed onto the coal. In the ninth quarterly report for this project, the reactivities of the demineralized bituminous coal in carbon dioxide, catalyzed by a combination of calcium and potassium were presented. Catalyst dispersion was evaluated using X-ray diffraction while surface areas were measured by the N₂ BET technique. Catalyst dispersion has been further investigated using x-ray microanalysis and scanning electron microscopy.

EXPERIMENTAL

One of the major difficulties in heterogeneous catalysis involving coal is quantitative measurement of catalyst dispersion, which is complicated by the heterogeneity of coal. For this reason, efforts were made to obtain qualitative information on catalyst dispersion by measuring the distribution of calcium on the

coal surface. X-ray microanalysis technique was used and the measurements were conducted at Battelle Laboratories. SEM analysis was also conducted on the demineralized coal prior to and after loading with calcium at pH 1, or 10.

RESULTS AND DISCUSSION

The x-ray microanalysis was performed on the demineralized Illinois No. 6 coal (PSOC 1493) onto which calcium had been exchanged at pH 6. As reported previously (2), the char derived from this sample gave the highest reactivity in carbon dioxide at 800°C. To assess the distribution of calcium in the sample, several coal particles were selected during the x-ray microanalysis and examined for calcium. For each particle, calcium analysis was performed at three different locations. The results of such analysis are presented in Figures 1A - 1C. Comparison of the figures show that the calcium peaks occur at about 0.3, 3.7 and 4.1 keV in each case. In addition, the intensities of the peaks are similar, as indicated, for example, by the maximum peak intensities ($\sim 1.1 - 1.3 \times 10^3$ counts) which occur at 3.7 keV. These results suggest similar calcium dispersion on the coal.

The SEM micrographs for the unloaded coal and its sample containing calcium (exchanged at pH 6 are shown in Figures 2A & 2B. As can be seen, the calcium particles are indistinguishable from those of the coal. Other techniques for measuring the catalyst dispersion will be applied. However, the x-ray diffraction results reported earlier appear to be confirmed by the x-ray microanalysis data, both of which strongly suggest well dispersed calcium on the coals.

In the next quarter, efforts will be concentrated on determining the number and concentration of the sites responsible for the adsorption of calcium or potassium from solution.

REFERENCES

1. Wood, B.J. and Sancier, K.M., 1984, Catal. Rev.-Sci. Eng., 26(2), 233-279.
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Figure 1. Results of X-ray Microanalysis for Calcium at Different Locations (A, B and C) on the same Coal Particle. Coal used: Demineralized Illinois No. 6 (PSOC 1493). Calcium Loading was 3.3% wt.

A

B

Figure 2. Scanning Electron Micrograph of: (A) Unloaded and (B) the 3.3 % wt. Calcium Loaded Coal (PSOC 1493).

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