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The Role of Pore Structure on Char Reactivity

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Quarterly Progress Report

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Introduction

Studies will be conducted on coal chars in the electrodynamic balance to examine the role of mesopore structure on reactivity. Larger particles will also be examined using a fluidized bed to examine diffusion control reactions. Soots will also be investigated to examine the role of meso- and micro-pores without macro-pore interference. These studies will allow a full range of particles sizes and temperatures to be investigated and eventually modelled.

Progress Report

The project is continuing with its focus on the development and refinement on the equipment that will provide the data needed for modelling.

Work has continued on the electrodynamic balance (EDB) for use in measurement of char micropores. Numerous refinements to the equipment have been made to increase particle stability. A collaboration with Prof. Levendis of Northeastern University has started to obtain his artificial produced chars. His chars offer the advantage of uniform size and pore distribution, which will reduce the complexity of data analysis. The control system for particle levitation is working well without heating by the laser.

Currently, we are working on a recently encountered drifting motion. When the 20 W CO₂ laser is turned on to heat the particle, a sideways drifting motion is induced that the control system is unable to compensate for. While the photonic force may be pushing the particle sideways, the AC current should be able to compensate for this. Currently, it is thought that when the system was last disassembled for cleaning that irregularities may have been induced, such as a slightly tilted electrode. The control system is also operating at 500 hz, which may be too slow for fine control, and alternatives are being examined.

The fluidized bed has continued to function well, and will soon be used to examine large particle pore evolution. A cage was constructed to test single particles and remove them for analysis. The cage originally constructed did not perform well, due to the weakness of construction. Currently, the Newark Wire Mesh Co. is looking into welding a cage of appropriate specifications. The computerized data acquisition system for the CO₂ analyzer has been installed. The replacement A/D board arrived in February, and it has performed well, although it has only been used in its tests. This is because the glass frit used to support the fluidizing medium has clogged. Currently, the decision of whether to replace frit and connected liner as is or to redesign the system to reduce freeboard volume and limit back-mixing is being debated. However, the need for redesign has been lessened by a new cooling system design. The new system, using the CO₂ analyzers, showed a 50% reduction in residence time, although no significant back-mixing reduction was observed.

The soot particles needed in the work to model micropore evolution have proven to be more difficult to examine than originally thought, and process used to examine and prepare the soots is being re-evaluated. It was first thought to take our soot and examine it with X-ray diffraction techniques and SEM analysis. Using a high temperature furnace the soot would be slightly graphitized at temperatures of between 1000°C and 1500°C. In a previous progress report, increased partial graphitization could clearly be seen as temperature was

increased. However, X ray diffraction patterns with attached lattice spacing do not show clean differentiation(Figure 1). Although nearly hidden by the amorphous character of the soot, instead of a single peak of near graphitic spacing, a gaussian type profile is seen. While this is to be expected, the width of the peak makes further work difficult, as the slight change in spacing would be difficult to resolve. Currently, attaching the soots to a SEM grid via carbide formation with the grid is hoped to allow for isolation of soot during combustion. This will allow for individual soot agglomerates to be examined after combustion.

Analysis methods to examine the particles have been learned by the student. Along with BET analysis, the student has completed the X-ray diffraction course taught at MIT. Only certification for unsupervised use remains to be completed. Mercury porosimetry will be done by an Italian colleague using their specialized apparatus that allows for individual particles to be examined.

In a previous progress report, a paper discussing the modeling the role of pore structure had been discussed. The attached report has been accepted as of January, 1993, by *Combustion and Flame*.

Future Work

The construction of the cage to allow for single particle combustion in the fluidized bed will be completed by mid-May, by which time the frit will have been replaced or redesigned allowing for experiments to begin. The EDB will continue to be worked on to solve the drifting motion, and a variety of tests will be done to validate the equipment for further experimental use.

References:

Levendis, Y., Daer, K., *Journal of Applied Polymer Science*, Vol. 45, 1992

Figure 1. X-ray diffraction of Soot graphitized at 1200°C for approximately 2 hours. Note the large broad peak in the region of 15 to 35 degrees due to the amorphous nature of soots. The background subtracted data shown in the insert shows very scattered data that is not easily interpreted.

Region of interest

Background Subtracted Data

Preprint / removed

Region of interest

Figure 1. X-ray diffraction of Soot graphitized at 1200°C for approximately 2 hours. Note the large broad peak in the region of 15 to 35 degrees due to the amorphous nature of soots. The background subtracted data shown in the insert shows very scattered data that is not easily interpreted.

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