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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 of the role on pore structure on the reactivity of coal chars will be conducted using an electrodynamic balance. The reaction difference between the meso-, micro- and macro-porosity regions will be investigated. Aside from chars, studies will also be conducted on soots, which only contain meso- and micro-pores. Large particles will also be used in a fluidized bed in order to determine effect of diffusion limited reactions on the char structure. A full range of particle size and temperatures will be investigated and these studies will be used to guide refinement of char reactivity models.

Progress Report

The project has had a slow start due to delays in enrolling a student and his inability to work on the program during the summer months. The program was reinitiated on his return 9/8/92. The main activity in the last few weeks has been literature research and determination of the experimental work to be pursued.

Preliminary work in defining the actual problem to be studied has been completed. It has been decided to deal with three distinct size distributions, soots, char particles, and fluidized bed particles, as they have distinctly different pore distributions from each other. Currently, one hypothesis is that most reactions take place in the mesopore region. This work will seek to validate this hypothesis.

Char particles will be examined in order to evaluate the effect of all three pore regions on reactivity and pore evolution. The electrodynamic balance will be used to react the particles, and pertinent physical data, such as surface area and weight change will be taken. This data, along with actual microscope pictures will be used to investigate the pore evolution.

Aside from char produced from Wyoming lignite, char particles generated by Levendis will be used. These chars are quite uniform in structure, and production can be varied in order to control the size of the particles, their porosity and their pore structure. For example, particles without macropores can be generated, and their reactivity compared to particles with large macropores.

Soots in the nanometer size range will be evaluated to remove the effects of combustion without the presence of macropores. The soots will be slightly graphitized in order to take X-Ray diffraction and electron microscope samples on the soots. The soots will then be partially reacted, and the difference in L_0 , the average length between defects, and d_0 , the distance between graphite planes will be determined. It is expected that these values will evolve during reaction, as shown by Ishiguru.

The effect of diffusion limited reactions will also be studied with

a fluidized bed. The fluidized bed will be used to react particles in the range of 1 to 4 mm in size under short residence times. This short residence time will reduce penetration, allowing for the diffusion limited regime to be tested.

All of the particles that will be generated will be characterized by numerous techniques. BET and mercury intrusion porosimetry will allow for accurate measurements of the surface area. X-ray diffraction will be used to obtain characteristic data on soots, while scanning electron microscopes will be used to characterize both soots and chars. Optical microscopy will also be used in order to obtain information on orientation and size.

Future Work

Experimental work will commence by the beginning of October. Currently, the student is in the process of reviewing literature and experimental techniques.

The student will familiarize himself with microscopy used to view sectioned particles, electron microscope measurements and X-ray diffraction in order to visualize pore structure. Surface area measurement techniques involving BET and Mercury Porosimetry analysis will be learned. These techniques will be used to characterize all char generated.

Once characterization techniques are learned, the chars and soots will be prepared. These reaction materials will then be reacted in either an electrodynamic balance, thermogravimetric apparatus or fluidized bed as deemed appropriate. A time table of the proposed work is as follows:

Month Week	September 3 4 5	October 1 2 3 4	November 1 2 3 4	December 1 2 3 4
Basic Literature	X X X			
Surface Area Determination	X	X X X X	X X	
Char/Soot Generation		X X X X	X X	
Model Review		Continuing		
Electrodynamic Balance/TGA			X X X X	X X X X

References

- Ishiguru, T., Suzuka, N., Fujitani, Y., and Morimoto, H., Combustion and Flame 85, 1-6 (1991)
Daer, K. and Levendis, T., Journal of Applied Polymer Science, Vol 45, 2061-2074 (1992)

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