ANNUAL PROJECT REPORT
AS OF DECEMBER 1991

1. PROJECT SPONSOR:

University of Cincinnati
Chemical Engineering
Mail Location 171
Cincinnati, Ohio 45221

2. PROJECT MANAGER:

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Principal Investigator

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3. OCDO GRANT NO#: D-86-55B

4. PROJECT: Final Report

5. PROJECT TITLE: DEMONSTRATION OF AN ADVANCED CIRCULATING FLUIDIZED BED COAL COMBUSTOR. PHASE I: COLD MODEL STUDY

6. PROJECT TERM: FROM February 1, 1989 **TO** January 31, 1991

7. PROJECT	**NAME**	**COST-SHARE**
CO-SPONSORS:	OCDO	$138,611.00
	University of Cincinnati	69,306.50
TOTAL PROJECT COST:		$207,917.50

I. ABSTRACT

8. OBJECTIVES

The overall objective of this demonstration project is to demonstrate the advantages and disadvantages of swirling flow and alternate feed system as applied to circulating fluidized bed coal combustor burning Ohio's high sulfur coal. The objective of the Phase I of this research, is to study the hydrodynamics of a cold model, swirling circulating fluidized bed with tangential injection of secondary air, and to quantitate the extent of erosion in the bed.

9. WORK DONE AND CONCLUSIONS:

A literature study was conducted on cold model erosion studies. Based on the theories that have been developed to quantitate the erosion due to particle impaction, a procedure to quantitate the erosion in cold model experiment was developed.

Based on hydrodynamic similarity, scaling factors were identified and a complete design of a cold model circulating fluidized bed (bed diameter 4 in and bed height of 12 ft.) was developed. The bed was constructed according to our design specifications by a subcontractor.

A detailed test plan was prepared to study the effects of air flow rates (primary and secondary air),

swirl ratio and solid recirculation rates on the hydrodynamics of the system. The test plan also includes an experimental program to investigate both qualitatively the erosion of the bed by impaction of solids.

The cold model was operated according to the test plan and data on the pressure drop, gas velocity, solid recirculation rates, solid mass flux and erosion was collected as a function of the operating variables.

From the data it was concluded that wall erosion was mainly caused by the particles sliding down the combustor wall and that erosion due to particle impaction was negligible at all swirling ratios that were investigated. Furthermore, the erosion was independent of bed diameter, since the sliding velocity of the particles down the combustor walls was independent of the bed diameter. Hence it was unnecessary to experiment with different bed diameters.

The extent of erosion, quantified by the weight loss of the sample in a fixed time interval, initially increased with increase in swirl velocity, and then decreased as the swirl number was increased further. This surprising result was attributed to the fact that as the swirl ratio increases, the particle diameter sliding down the walls increases, since the centrifugal force moves smaller particles towards the center of the bed and the larger particles towards the wall.

The hydrodynamic behavior was also characterized for the swirl and non-swirl cases, and design equations have been developed.

10. PLANS FOR COMING YEAR:

The final report on this project will be submitted before December 31, 1990, and this project will terminate.

II. HIGHLIGHTS/ACCOMPLISHMENTS

11. Technical papers will be prepared and presented at national and international meetings. This study represents the first study to quantitate the hydrodynamics and erosion in a swirling circulating fluidized bed system.

III. ARTICLES/PRESENTATIONS

12.

1. Ilias, S., Ying, S., Mathur, G.D., and Govind, R., “Studies on a Swirling Circulating Fluidized Bed”, In Circulating Fluidized Bed Technology II, P. Basu and J.F. Large (eds.), Pergamon Press, pp. 537-546 (1988).

2. Ilias, S. and Govind, R., “Two-Phase Flow in a Swirling Circulating Fluidized Bed (CFB) Coal Combustor”, AIChE Annual Meeting, Washington, D.C. p. 162b (1988).

3. C.H. Li and Govind, R., “Studies on the Hydrodynamics and Erosion in a Swirling Circulating Fluidized Bed Coal Combustor”, in preparation for the AIChE Journal, 1990.