ANNUAL PROJECT REPORT
as of December 1995

1. PROJECT SPONSOR
Case Western Reserve Univ.
Mechanical Engineering
University Circle
Cleveland, OH 44106

2. PROJECT MANAGER
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3. OCDO GRANT NO.: OCDO/R-88-2C/B

4. PROJECT: UPDATE

5. PROJECT TITLE: Ohio Coal Research Consortium
Project 2.1 - Transport Processes Involved in FGD

6. PROJECT TERM:

FROM	06-01-90	TO	06-30-91	(Year#1)
FROM	07-01-91	TO	08-31-92	(Year#2)
FROM	09-01-92	TO	08-31-93	(Year#3)
FROM	09-01-93	TO	08-31-94	(Year#4)
FROM	09-01-94	TO	02-28-96	(Year#5)

7. PROJECT CO-SPONSORS:

Name	Cost-Share(Y#1)	Cost-Share(Y#4)
OCDO	$ 68,986	$ 80,180
CWRU	$ 20,368	$ 20,368

	Cost-Share(Y#3)	Cost-Share(Y#4)
OCDO	$ 85,499	$ 74,843
CWRU	$ 21,245	$ 19,177

	Cost-Share(Y#5)
OCDO	$ 69,808
CWRU	$ 18,724

I. ABSTRACT

8. OBJECTIVES: The improvements in the basic knowledge of fluid mechanics, heat and mass transfer rate effects are needed to understand and achieve substantial improvements in many key areas of induct FGD processes. In the utilization of high sulfur Ohio Coal emphasis has been placed on increasing the efficiency of dry, high sulfur flue gas scrubbing processes using calcium based sorbents. This entails the need to improve our understanding of the mixing processes which play a crucial role in enhancing sorbent utilization.

The objectives of the study are to obtain a basic understanding of (1) turbulent flow structure of the mixing zone and its influence on particle dispersion, (2) the effect of particle loading on turbulent properties and mixing, (3) the effect of jet entrainment, (4) water spray-sorbent interaction, sorbent wetting and mixing, (5) the

flow field where certain ratios of water jet velocity to flue gas velocity result in regions of negative flow and define onset of negative flow and (6) sorbent reactivity in immediate mixing zone.

9. WORK DONE AND CONCLUSIONS (1993-94)

In the first two years of the project a sorbent injection facility which can simulate the conditions encountered in COOLSIDE set up was designed and built. Non-intrusive laser based diagnostic tools PDA/LDA were used for flow characterization. In the third year a new technique called TTLDV which combines particle transit time in measurement volume of LDV and LDV velocity measurements to simultaneously obtain non-spherical lime particle size and velocity was developed. Better sorbent injection schemes were investigated. Spray cocurrent flow tests were conducted. During the fourth year the spray cocurrent flow interaction data was analyzed. A criterion based upon mass flow rate of the two phases was developed for predicting the flow reversal which results in deposition of water droplets on the duct wall. The criterion successfully predicted the flow reversals encountered in the experiments and will be a very useful practical tool. Tests on a new design swirling flow nozzle have been conducted. The results indicate that the mixing is enhanced and the turbulence intensities in the radial direction show an increase of 10 to 30%.

10. PLANS FOR COMING YEAR:

The plans include (a) Installation of a heat exchanger system to run experiments at 160°F, (b) Investigate sorbent cocurrent flow interaction in presence of spray including flow separation, (c) Conduct tests in simulated flue gas to investigate sorbent reactivity with new design nozzle and (d) contribute to OCDO/UCRC monograph on "Duct Transport phenomena."

II. HIGHLIGHTS/ACCOMPLISHMENTS

11. A fourth year final report (1993-94) providing details of the work performed was submitted. A criterion to predict the onset of separation and flow reversal for spray-cocurrent duct flow was developed. The criterion successfully predicted occurrence of flow reversal in the experiments, and will be a useful tool. The swirling nozzle design is a substantial improvement for enhance mixing of particles injected into cocurrent flow.

III. ARTICLES/PRESENTATIONS(in 1994)

1. "A New Approach Using Transit Time for Simultaneous Measurement of Size and Velocity of Non-spherical Particles," C. Yurteri, V. Kadaba and J.R. Kadambi, Laser Anemometry: Advances and Applications, ASME Symposium. FED vol 191, June, 1994.

2. "Spray Cocurrent flow Interactions and Flow Reversal," V. Kadaba, C. Yurteri and J.R. Kadambi, accepted for ASME Solid-Liquid Flow Symposium to be held at Hilton Head, August, 1995.

3. "Simultaneous Measurement of Irregular particle Size and Velocity", C. Yurteri, M. Assar and J.R. Kadambi, Poster Session, Advanced Subsonic Transport Workshop, sponsored by NASA Lewis Research Center, Cleveland, Ohio August 1994.