AIR POLLUTION TECHNOLOGY, INC.

LABORATORY/BENCH-SCALE TESTING AND
EVALUATION OF A.P.T. DRY-PLATE SCRUBBER

10th. Quarterly Progress Report

Contract No. DE-AC01-80ET15492

September 17, 1982

Project Manager: Mr. Kenneth Markel
5191 SANTA FE STREET SAN DIEGO, CA 92109-1675 (714) 272-0050

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10th. Quarterly Progress Report

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For the period June 1, 1982 through August 31, 1982

Contract No. DE-AC01-80ET15492

Prepared for the Department of Energy
Morgantown Energy Technology Center
Morgantown, WV 26505

Project Manager: Mr. Kenneth Markel

10th. Quarterly Progress Report

TECHNICAL PROGRESS REPORT FOR:
TESTING AND EVALUATION OF THE
A.P.T. DRY PLATE SCRUBBER
DE-AC21-90ET15492

INTRODUCTION

The A.P.T. Dry Plate Scrubber (DPS) uses a shallow, dense mobile bed of solid collector granules which move across a perforated plate. The gas stream containing fine particles and vapors is moved upward through the perforations to form high velocity gas jets. The fine particles are removed by inertial deposition onto the collector granules or by direct interception. Electrostatic forces also can be used to improve the collection efficiency and increase the adhesive forces between the particles and collectors.

The DPS column consists of a series of collection stages (perforated plates) with the collectors either passing sequentially over each stage or being fed separately to each stage. The stages can be designed so as to promote the collection of large particles on the lower stages and the collection of fine particles and alkali vapors on the upper stages.

The objective of this project is to conduct a bench scale experimental evaluation of the DPS at high temperature and pressure to determine its potential for controlling particulate and alkali vapor emissions from PFBC processes.

Approach

This project is divided into two phases and seven major tasks as listed in Table 1. Phase I is a preliminary study consisting of a theoretical review, preliminary particle collection experiments and preliminary alkali sorption experiments. The purpose of Phase I is to provide specific design criteria for Phase II.

Phase II is a bench scale evaluation of the DPS at high temperature (900°C) and pressure (1,000 kPa). The bench scale DPS will be designed and evaluated for both particulate matter and alkali vapor control. The results will be used to develop an engineering design model for predicting the efficiency and power costs for the DPS. A detailed process design of a DPS sub-pilot plant installed at a PFBC facility will be made. The process economics will be evaluated in terms of capital and operating costs as a function of cleaning efficiency.

TABLE 1. OUTLINE OF WORK

Task 1.0		THEORETICAL STUDY
	1.1	Literature Reivew
	1.2	Calculations
Task 2.0		PRELIMINARY PARTICLE EXPERIMENTS
	2.1	Single Stage DPS
	2.2	Electrostatic DPS
	2.3	Multiple Stage DPS
Task 3.0		PRELIMINARY ALKALI EXPERIMENTS
	3.1	Sorbent Screening
	3.2	Sorbent Capacity and Efficiency
	3.3	Sorbent Attrition
Task 4.0		HIGH TEMPERATURE AND PRESSURE EXPERIMENTS
	4.1	Design and Construction
	4.2	Simulated PFBC Experiments
	4.3	AFBC Experiments
Task 5.0		DESIGN MODEL (deleted)
Task 6.0		PROCESS DESIGN
Task 7.0		FINAL REPORT

TECHNICAL OBJECTIVES FOR THIS MONTH

The principal objectives for this quarter are listed below:

Task 4.2 HTP-DPS Experiments

1. Start particle and alkali vapor collection experiments.

Task 7.0 Final Report

1. Start the preparation of the final report.

TECHNICAL PROGRESS FOR THE MONTH OF AUGUST

No technical work was performed in the month of August. Due to upward adjustments to the overhead rate of last fiscal year, the contract is out of funds. The DOE contracting officer and Project Manager were informed of this situation. Work on this contract was halted pending instructions from the Contracting Officer.

TECHNICAL PROGRESS FOR THIS QUARTER

<u>TasK 4.2 HTP- DPS Experiments</u>

Particle sampling was continued in this reporting period. The DOE Project Manager and Program Manager visited A.P.T. in June to observe the HTP-DPS operations.

Several mechanical problems occurred in this reporting period. The circuit board in the air heater control box failed and was replaced with a new one. The alumina high voltage insulator in the polarizing section was modified due to mechanical problems. In the original design (Figure la), the DPS column of the polarizing section was made of 20.3 cm dia. (8 in.) alumina tube. Due to thermal stress, the insulator was broken beyond repair.

Since a new insulator requires 10 weeks of delivery, the DPS polarizing section was modified to that as shown in Figure lb. The alumina tube was replaced with 8" Sch. 40 RA 330 S.S. pipe. A free standing 17.8 cm dia. alumina tube was installed between

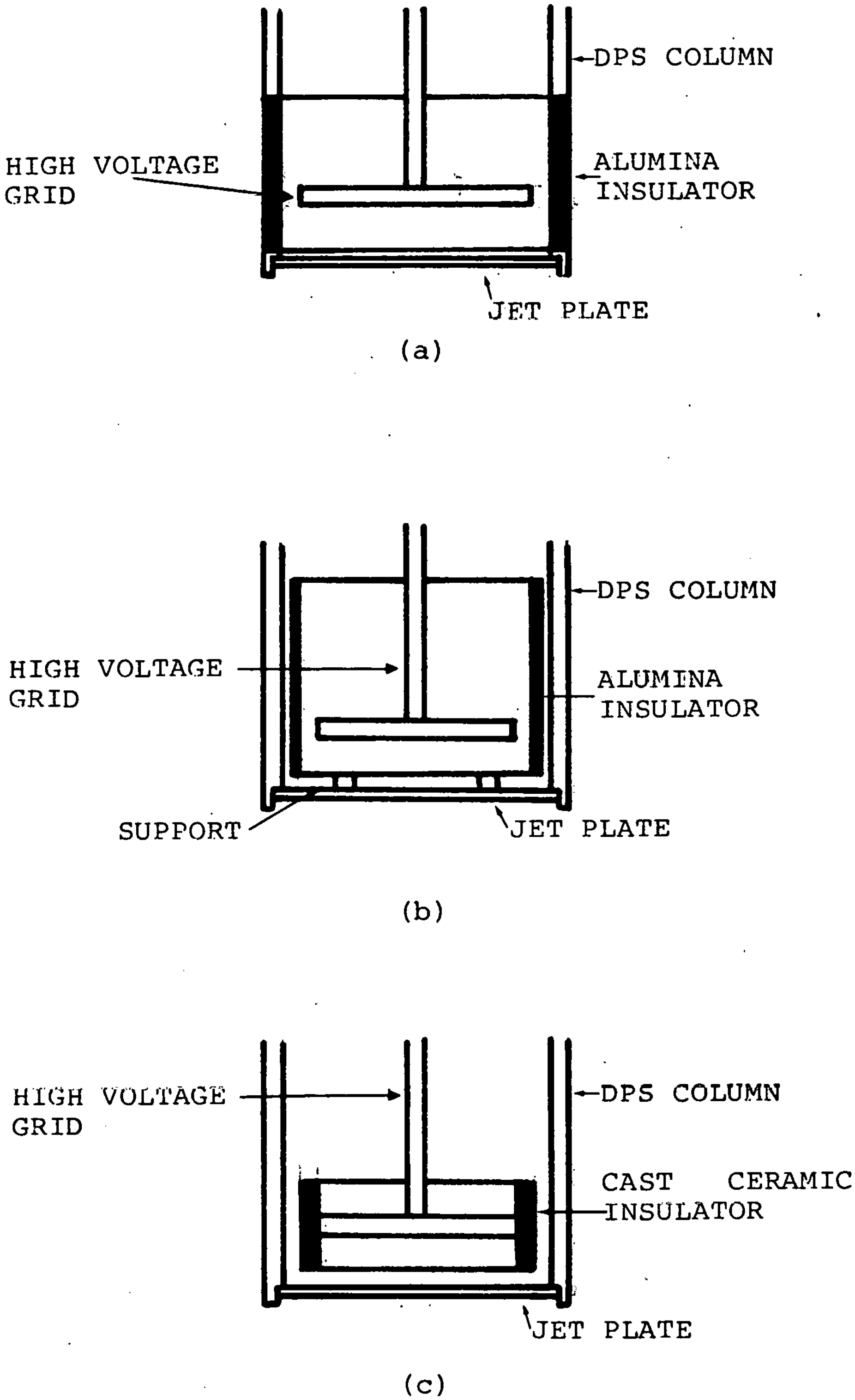

Figure 1. Polarization section design.

the high voltage grid and wall to shield the electric field from the grid to the wall. The diameter of the high voltage grid was trimmed from 18.7 cm to 14.6 cm so that it can be fitted inside the alumina tube.

The free standing alumina tube in the new design lasted 1 heating cycle and broke into pieces. The insulator was then modified to that as shown in Figure 1c. The high voltage grid was wrapped with 5.1 cm wide ceramic paper and cemented into place. The modification survived daily heating and cooling cycles.

The modified polarizing section might not be fully effective because:

1. The grid is smaller and only the central part of the jet plate is polarized. Gas flowing near the perimeter will not pass through the polarizing field.
2. The distance between the grid and the column is shorter than that between the grid and the jet plate. Therefore, the polarizing field may short-circuit to the wall.

Three sampling runs were done. Run No.s 27/1 and 27/2 were obtained on a 4-stage DPS. An alkali vapor sorption stage was not installed. The average DPS temperture was 650°C and the pressure was 9.5 atm. Particles were pre-charged and the polarizer was turned on for these two runs. The polarizer design was that shown in Figure 1b for Run No. 74/1 and Figure 1c for Run No. 74/2. Run No. 27/1 used fly ash from a coal-fired power plant and Run No. 27/2 used ash from Curtiss-Wright PFBC plant.

Figure 2 shows the grade penetration curves. The overall penetration was 23.3% and 13.9% for Run No.'s 74/1 and 74/2, respectively.

The polarizer design shown in Figure 1b is more effective than that shown in Figure 1c. Therefore, Run 27/1 shows higher collection efficiency in sub-micron particles. Fly ash from Curtiss-Wright PFBC is more resilient than that from power plant ash and there is less bouncing upon impact with the Curtiss-Wright ash than power plant ash. As can be seen from Figure 1,

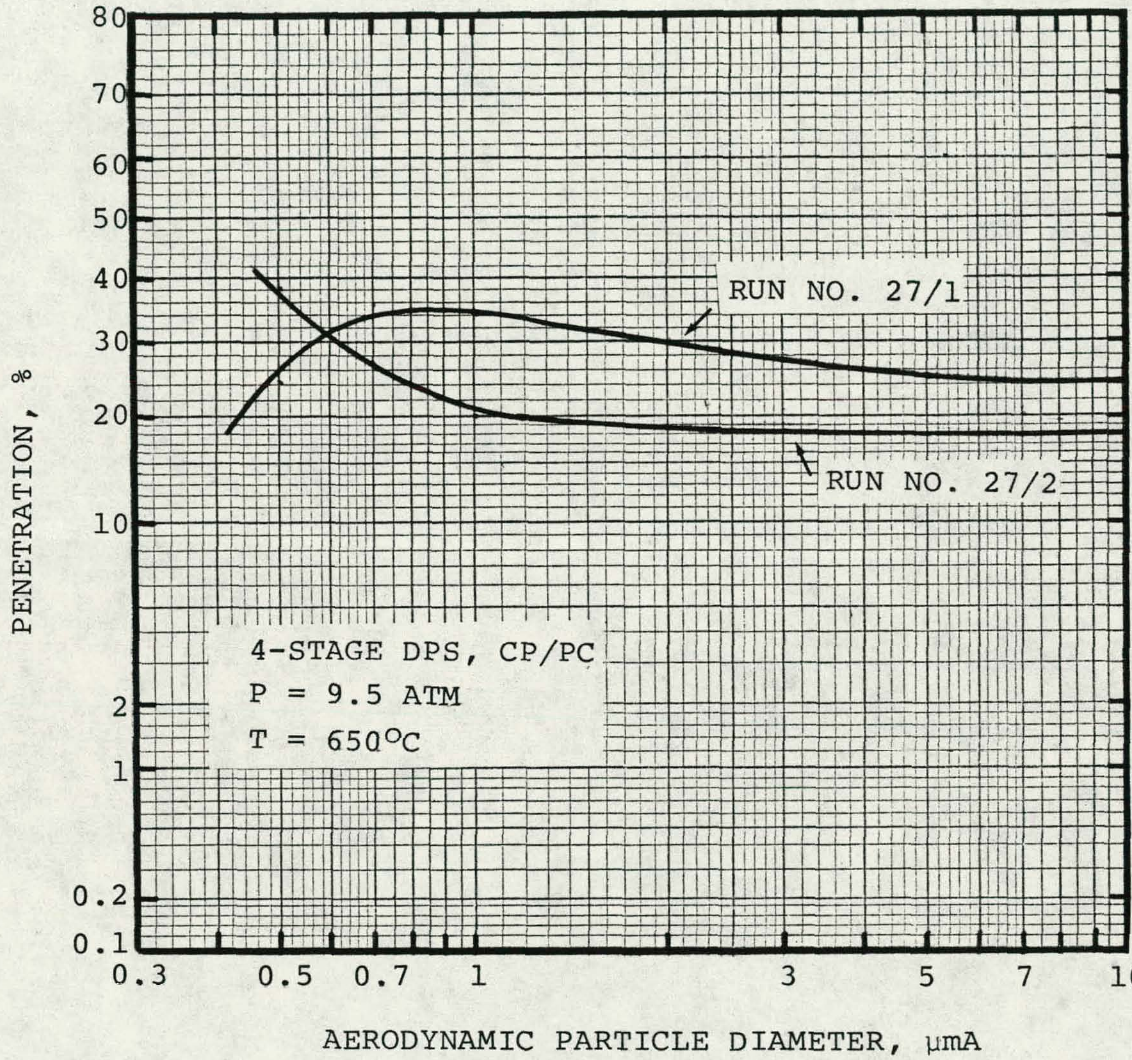

Figure 2. Experimental grade penetration curves.

Run No. 27/2 which used Cutiss-Wright fly ash shows higher collection efficiency for large particles than Run No. 27/1.

Run No. 27/3 was done on a 5-stage DPS. Stage 4 was the alkali vapor sorption stage. The sorption bed was a 12.7 cm deep bed of 1 mm to 2 mm dia. diatomaceous earth. No sorbent was fed or withdrawn from the bed during the experiment.

The fly ash (Curtiss-Wright) particles were precharged and polarizer (design 1c) was turned on for this run. The overall penetration for this run is 3%. Figure 3 shows the grade penetration. The penetration for sub-micron particles are higher than expected, probably due to ineffective polarization.

After these experiments, the heating element of the main air-heater was burned. The heater manufacturer sent replacements twice; however, both replacements did not fit inside the heater tube. The heating element was of clam shell type design. The diameter of the replacement heater sent by the manufacturer was about 0.32 cm (1/8") larger than the existing one.

A third replacement was received from the manufacturer. However, it was not installed yet because work on this contract was halted. Due to upward adjustments to the overhead rate of last fiscal year, the contract is out of funds. The DOE Contracting Officer and Project Manager were informed of this situation. Work on this contract was halted pending instructions form the Contracting Officer and the Project Manager.

Task 7.0 Final Report

The preparation of the final report was about 20% completed. It was also halted pending instructions from DOE.

TECHNICAL OBJECTIVES FOR THE NEXT QUARTER

No work is scheduled until instructions from DOE are received.

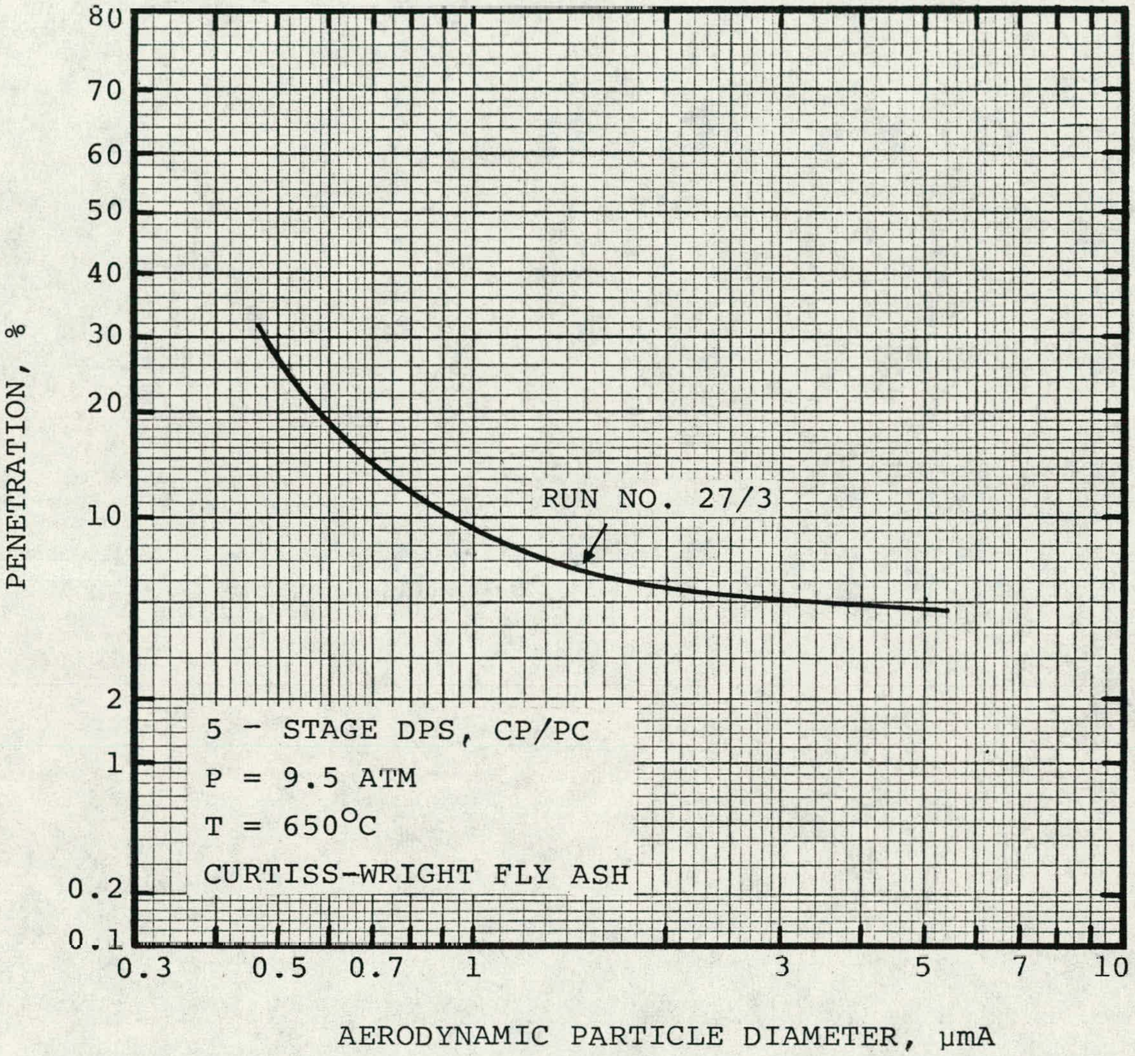

Figure 3. Experimental grade penetration curve.