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AN EVALUATION OF A PRE-CHARGING
PULSE-JET FILTER FOR SMALL COMBUSTOR
PARTICULATE CONTROL

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PROJECT QUARTERLY REPORT

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1.0 INTRODUCTION

A current national initiative is the replacement of natural gas and petroleum derived fuels with coal. In response to this initiative, the Department of Energy and private industry are developing a group of small to medium scale coal fired combustors over a size range from residential to light industrial. The success of this program depends on the availability of air pollution control systems suitable for use on the combustors and capable of satisfying control regulations anticipated for the 1990's.

Historically, combustors in this size range, even when coal fired, have had only rudimentary pollution controls, or none at all. On the other hand, particulate control by an electrostatic precipitator has been the norm for large coal fired utility boilers for many years. There are several reasons for this size dependent regulatory structure. The principal reason is that the large coal fired combustors generate the majority of particulate. Another reason is that the typical small combustor owner does not have the resources to operate and maintain a pollution control device such as an electrostatic precipitator.

If the use of coal in small scale combustors is successfully encouraged, then suitable pollution control devices must be an integral part of the combustor's system in order to prevent deterioration of air quality resulting from increased coal combustion. The operation and maintenance of these devices must be tolerated by the individuals and small companies which will utilize the combustors. Such control devices need to be developed in parallel with the development of the small-scale combustors.

Considering the array of commercially available particulate control devices, the pulse-jet fabric filter most closely meets these specifications. It is among the smallest of particulate control devices per unit gas flow, and it is one of the most commonly utilized particulate control device for small (less than 10,000 CFM) applications. The pulse-jet fabric filter has no moving parts and yields a dry ash product which can be disposed with combustor bottom ash. Pulse-jet filters are often applied to processes in which severe load swings are commonplace, with frequent stops and starts.

The desired emission level for particulate of $.02 \text{ lb}/10^6 \text{ Btu}$ represents a collection efficiency of approximately 98% when burning Beneficiated Illinois #6 Coal. Fabric filtration is generally recognized as being capable of achieving the highest collection efficiency of any particulate control technology. Overall collection efficiency of 99.9% is commonly guaranteed by vendors. Recently it has been found that the good collection efficiency of the fabric filter can be substantially improved by means of charging the particles prior to filtration. Typically, this technique has been shown to increase collection efficiency from 99.9% to 99.99%, or a ten-fold reduction in emissions. It has also been found that lower pressure drop across the filter results when charged particles are filtered. This additional performance enhancement can result in lowered operating costs or can allow the designer to reduce the size of the filter.

Based upon results such as these, it is clear that a pulse-jet fabric filter, equipped with a particle charger, can provide superior particulate control for the small combustor application, as well as meet all the requirements of simplicity, compactness, and reliability.

2.0 OBJECTIVE

The objective of this test program is the performance and economic evaluation of a pre charged-pulse jet filter as the principal particulate control device for a commercial or industrial scale coal fired combustor. Performance factors that will be considered are the effects of particle charge, air/cloth ratio, fabric types, percent humidity and inlet particulate loading on fine particle collection efficiency, and pressure drop. Economic factors that will be considered are capital costs, energy and other operating costs, and maintenance costs.

The program will result in a recommendation regarding the relative suitability of the pre charged pulse-jet filter for small combustor particulate control, as compared to other control devices. Fine particle control capability, ease of operation, and overall economics will be taken into consideration in making comparisons.

3.0 PROGRAM PLAN

This research project is divided into six distinct functional categories, or tasks, which must be completed in sequence. These tasks are categorized as follows:

TASK 1: Work Plan

TASK 2: Design, Procurement, and Installation

TASK 3: Shakedown

TASK 4: Test Program

TASK 5: Analysis and Economic Evaluation

TASK 6: Reporting

A schedule for the completion of Tasks 1 through 6 is provided in Table I, Milestone Schedule, where shaded portions of the graphic represent the monthly status of work performed. The distribution of labor needed to carry out these tasks is provided in Table II, Labor Plan. A Cost Plan is provided in Table III which represents spending costs by reporting element. Table IV, Cost Management Report, represents the status of accrued costs and Estimated Accrued Costs up to November 1989. A Summary of Tables I, III, and IV is depicted by Table V, Summary Report.

4.0 WORK PERFORMED

- 4.1 Details of the program tasks 1 through 6, mentioned above were reported in detail in the Work Plan, completed in October, 1989.
- 4.2 The completion date for the system design was set for November, 1989 and has been met in accordance with the Work Plan.
- 4.3 A Kick-Off Meeting was held at the PETC office on 11/6/89.

Those in attendance were:

PETC	-	Thomas Brown
		Richard Tischer
		Soung Kim
		Charles Schmidt
		Diane Madden
		David Henzel
R-C		Dennis Helfritch
		Paul Feldman
		Sam Kumar

The Work Plan was presented at this meeting and was discussed. All in attendance were in general agreement with the proposed program and test matrix. One area of concern was the properties of the fly ashes selected for testing. The plan called for the testing of an Eastern and a Western coal fly ash. It was questioned whether these ashes would be representative of the flyash produced from the combustion of a beneficiated coal/water slurry. It was decided to use an ash with a size distribution matching that produced by coal/water slurry combustion. This size distribution will be supplied by PETC, and is expected to exhibit relatively small particle diameters. In order to generate ash with a similar size distribution, it is proposed that an inertial separation will be used to classify an ash sample into fine and coarse fractions.

4.4 D. J. Helfritch met with Edward Frederick on 11/7/89 in order to discuss potential fabrics to be used in the program. Mr. Frederick is a filter media consultant with an extensive background in fabric filtration and electrostatic affects.

Mr. Frederick agreed to compile a listing of recommended fabrics with justifications for the selection of each.

4.5 Work has been started on the modification of an existing laboratory baghouse for use in this program. The baghouse must be converted from an inside-bag-collection, shake clean, to an outside-bag-collection, pulse-jet clean. This modification requires that the shaker cleaning mechanism at the top be replaced with a pulse-jet mechanism and that the tube sheet (manifold to which the open ends of the bags are attached) be moved from the bottom of the housing to the top.

The completed assembly is presented in Figure 1.

4.6 A particle charge measurement device has been constructed and preliminary testing is underway. Figure 2 represents the arrangement of this device. Initial measurements have indicated that the device yields particle charge levels lower than actual. The reason for these low readings is being investigated.

5.0 WORK TO BE PERFORMED NEXT QUARTER

5.1 The particle charge measurement device will be completed to determine the charge per unit mass of particulate matter. Measurement will be accomplished by using a metalized filter that is grounded through an integrating electrometer.

5.2 Design of the particle pre charging system will be completed. A special pulse energization system will be utilized to produce 200 nanosecond voltage pulses of up to 30 kilovolts at a rate of 500 pulses per second.

5.3 Equipment purchases and installation are on target for completion in February 1990.

5.4 Shakedown testing after installation is targeted to commence in March 1990.

6.0 FORECAST

We are currently on schedule and within budget. No setback problems are anticipated.

FIGURE 1 Baghouse Design

FIGURE 2
PARTICLE CHARGE MEASUREMENT

END

DATE
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