工業污染防治 第21期 (1. 1987)

PERFORMANCE OF A SPRAY DRYER/ESP FLUE GAS CLEANUP SYSTEM DURING TESTING AT THE PITTSBURGH ENERGY TECHNOLOGY CENTER

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ABSTRACT

Wheelabrator Air Pollution Control and the United States Department of Energy jointly sponsored a project to evaluate the potential for the application of spray dryer flue gas desulfurization (FGD) systems to existing coal-fired boilers equipped with electrostatic precipitators for particulate emissions control. The objectives of this project were to characterize the performance of a spray dryer FGD system using flue gas from the combustion of different types of coal, and to study the effectiveness of an electrostatic precipitator (ESP) in controlling particulate emissions from this system. Three different coals (low-, medium-, and high-sulfur coal) were burned in a 500 lb/hr pulverized-coal combustion test facility at the Pittsburgh Energy Technology Center. Sulfur dioxide was removed from the flue gas by injection of a lime slurry in a spray dryer. Particulate emissions were controlled using a mobile electrostatic precipitator. For each fuel, a three-part test program was conducted. This test program consisted of (1) base-line ESP performance tests without spray dryer operation to determine requirements for fly ash collection; (2) parametric tests defining sulfur dioxide removal efficiency and ESP collection efficiency at various spray dryer operating conditions; and (3) sorbent recycle tests in which the particulate collected by the ESP was

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recycled by injection into the spray dryer with the fresh sorbent to improve reagent utilization. Test results show that sulfur dioxide removal efficiencies of 90 percent can be achieved for each of the three coals tested using the combined spray dryer and electrostatic precipitator system for emissions control. Performance criteria for the electrostatic precipitator were met during all phases of testing.

INTRODUCTION

With increasing concern over sulfur dioxide emissions, many electric power generating utilities are evaluating the modifications that would be required to equip existing power plants with flue gas desulfurization systems. One of the flue gas desulfurization processes being considered is the installation of a spray dryer before the existing particulate collector. In most existing coal-fired electric power generating facilities, the particulate collection device is a high-efficiency electrostatic precipitator. A test program was conducted between September, 1983, and June, 1984, to evaluate the potential for the application of spray dryer flue gas desulfurization systems to existing coal-fired boilers equipped with electrostatic precipitators for particulate emissions control.

The use of dry-scrubbing technology for the control of sulfur dioxide emissions from coal-fired electric power generating facilities is attractive to utility and other industries because of the ease of operation and the anticipated economic advantages it can offer compared to wet scrubbing [1]. Considerable progress has been made in the past several years in adapting conventional spray-drying technology for the control of sulfur dioxide emissions from coal-fired industrial and utility boilers [2-15]. A spray dryer flue gas desulfurization (FGD) system uses an alkaline sorbent material injected into the flue gas as an aqueous solution or slurry; the sorbent reacts with the sulfur dioxide (SO_2) to form a dry product containing sulfates and sulfites [16-17]. A mixture of spent sorbent and fly ash is removed from the flue gas stream by an electrostatic precipitator (ESP) or by a fabric filter.

Dry FGD systems have predominantly been installed on new facilities with fabric filters used for particulate control. As a result, few investigations of spray dryer/ESP systems have been conducted, and limited information and operating experience is available, for the application of spray dryers to existing facilities using electrostatic precipitators for particulate control.

In this study, the combined performance of a spray dryer and an electrostatic precipitator was evaluated. Three coals were used, a 1.6 percent sulfur Pittsburgh seam coal, a 2.7 percent sulfur Pittsburgh seam coal, and a 0.7 percent sulfur Kentucky Harlem seam coal. Analyses of the coals used in these tests are given in Table 1. For each type of coal fired, a three-part test program was conducted. The first part evaluated ESP performance without the spray dryer in operation (base-line tests). The second part involved operation of the spray dryer at 70, 80, and 90 percent overall sulfur dioxide removal efficiencies while measuring ESP performance. The third part of the program evaluated ESP performance during the injection of a fly ash and spent sorbent mixture (recycle tests) that had been collected from the previous

TABLE 1. Typical Analyses of Coals Used

	Coal I	Coal II	Coal III
	Pittsburgh Seam	Pittsburgh Seam	Kentucky
PROXIMATE ANALYSIS WT.% (Dry Basis)			
Volatile Matter	37.5	39.6	38.9
Fixed Carbon	53.0	52.1	57.3
Ash	9.5	8.3	3.8
ULTIMATE ANALYSIS WT.% (Dry Basis)			
Hydrogen	5.3	5.3	5.8
Carbon	74.0	73.5	78.0
Nitrogen	1.2	1.0	1.7
Sulfur	1.6	2.7	0.7
Oxygen	8.4	9.2	10.0
Ash	9.5	8.3	3.8
HEATING VALUE (Btu/lb)	13,314	13,490	14,240
MOISTURE IN COAL (As Fired)	1.0	1.1	1.0
ASH ANALYSIS			
Al_2O_3	22.68	21.68	26.47
CaO	1.30	1.19	2.07
Fe_2O_3	12.76	23.58	10.52
K_2O	1.99	1.46	1.70
Na_2O	0.30	0.36	0.41
SiO_2	58.37	47.37	51.12
MgO	0.84	0.94	1.60
SO_3	1.22	1.63	2.00

spray dryer tests conducted with fresh slurry.

DESCRIPTION OF THE TEST FACILITY

Combustion Test Facility

The 500 lb/hr (227 kg/hr) combustion test facility is shown schematically in Figure 1. The furnace was designed to simulate the performance of a industrial or utility steam generator. The furnace walls are refractory-lined and water-cooled. The unit is 7 ft (2.13m) wide, 5 ft (1.52m) deep, and 12 ft (3.66m) high, and has a volumetric heat liberation rate of about 16,000 Btu/hr-ft^3 (165,550 J/sec-m^3) at a thermal input of 6.5 million Btu/hr (6.86 (10^9) J/hr). The flue gas flow rate is approximately 1300 scfm.

Coal is charged to the hopper, pulverized to a size consist of 70 percent minus-200 mesh, and then conveyed by the primary air into a recycle coal loop where intimate mixing of coal and air occurs. Four adjustable exit tubes are connected to the recycle loop; these convey the primary air-coal mixture to each of the four burners. Secondary air at 600°F (316°C) is fed through adjustable swirl vanes surrounding each burner. Approximately 20 percent excess air is used. The flue gas exits the furnace at about 2000°F (1093°C), passes through a convective heat transfer section, and is then used to preheat the secondary air to the desired inlet temperature. By controlling the air through the recuperative air preheater, the fue gas exit temperature can be maintained in the range of 300°-475°F (149°-246°C).

Spray Dryer and Electrostatic Precipitator

The spray dryer and electrostatic precipitator used in these studies are shown in Figure 2. Sorbent slurries were prepared in separate facilities and transferred to the slurry scorage tank. The sorbent used in this study was freshly slaked lime prepared on site by mixing 1 part of quicklime to 2.8 parts water. The exothermic reaction produced a temperature rise of between 110°F (43.3°C) and 120°F (49°C) over a 3-4 minute period. The composition of the quicklime used is given in Table 2. A centrifugal circulating pump and aeration were both used to maintain a uniform suspension of solids in the slurry. A progressing cavity pump, equipped with a variable-speed drive, provided the desired slurry flow rate. The slurry flow was measured by a mass flowmeter. The slurry was diluted with water near its point of entry to the spray dryer in order to maintain the desired flue gas temperature at the exit of the spray dryer,

The 7-ft (12.3-m)-diameter spray dryer and all ancillary equipment used in this study are identical to a unit used in a three-year pilot effort conducted by Wheelabrator Air Pollution Control at their Joliet, Illinois, pilot facility. The spray dryer is equipped with a 6-in. (15.24-cm)-diameter disc atomizer containing three 1/4-in. (0.635-cm)-diameter holes. The disc can be rotated at speeds up to 23,000 rpm, corresponding to a maximum tip speed of 600 ft/sec (183 m/sec). The vertical wall of the spray dryer is 4 ft (1.22m) high, ending in a 60° bottom cone that tapers down to a 12-in. (30.5-cm)-diameter flue gas line. This flue gas line at the bottom of the spray dryer carries the strean of flue gas and the mixture of fly ash and spent sorbent to the electrostatic precipitator.

TABLE 2. Chemical Analysis of Quicklime

	Percent
Calcium Oxide–Available	94.00
Calcium Carbonate	2.00
Silica	1.20
Aluminum Oxide	0.32
Ferric Oxide	0.13
Magnesium Oxide	0.60
Sulfur	0.025
Calcium Sulfate	0.055
Phosphorus Pentoxide	0.013
Manganese Oxide	0.003

Flue gas enters the spray dryer at about 400_{o}F (204°C) and passes through a set of vanes that surround a rotary atomizer. These vanes, as shown in Figure 3, are designed to provide adequate mixing of the flue gas with the alkaline slurry being injected through the rotary atomizer. The dried sorbent and fly ash are then carried by the flue gas to the electrostatic precipitator, where the particulates are removed and the clean flue gas is discharged to the stack. The plug flow gas residence time in the spray dryer is estimated to be 7-8 seconds (based on spray dryer exit temperature).

The electrostatic precipitator used in these studies was a Wheelabrator Air Pollution Control mobile electrostatic precipitator (MESP) [18]. This electrostatic precipitator is a three-field unit complete with automatic voltage controls, transformer/rectifier sets, rappers, vibrators, hoppers, and an induced

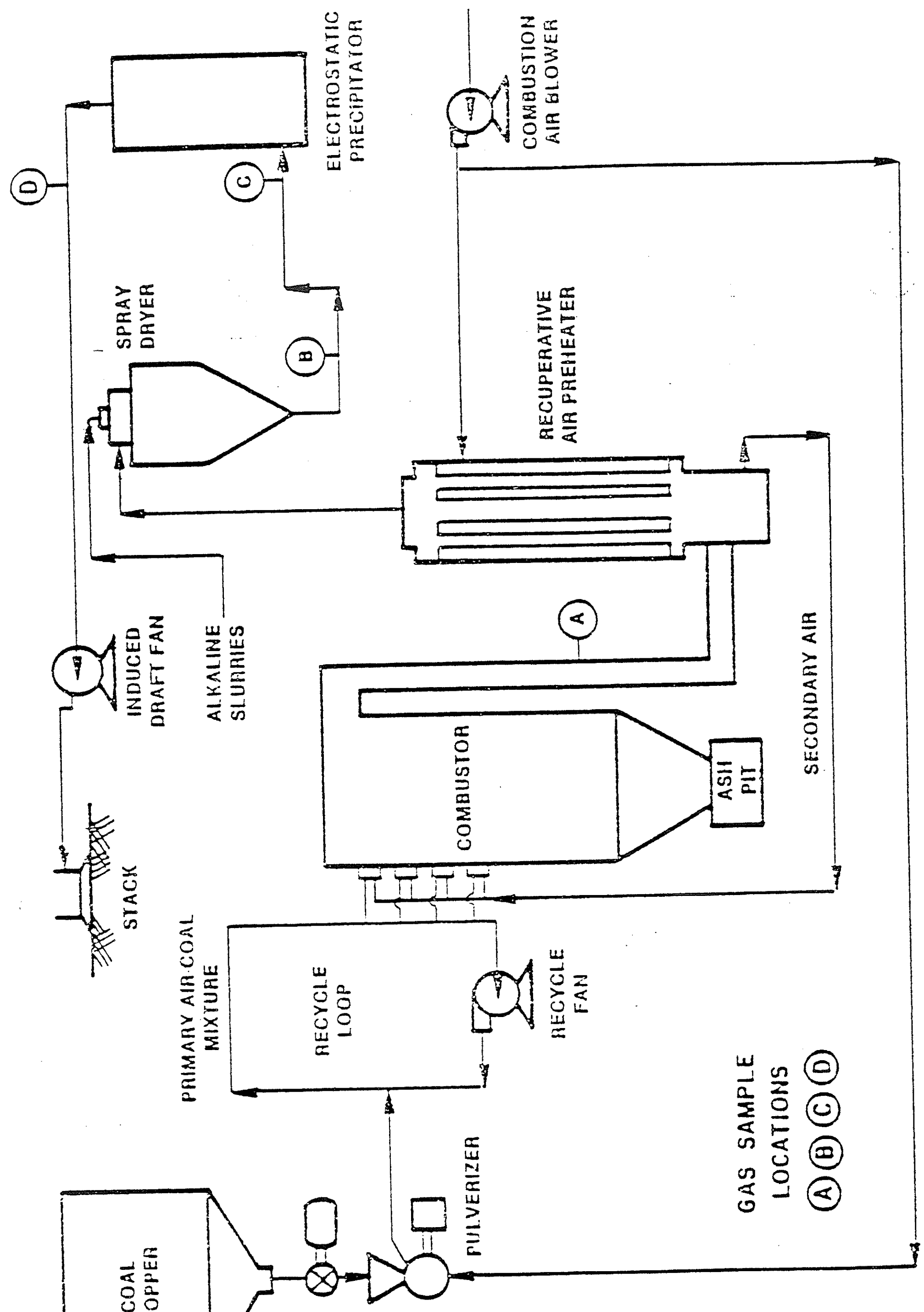
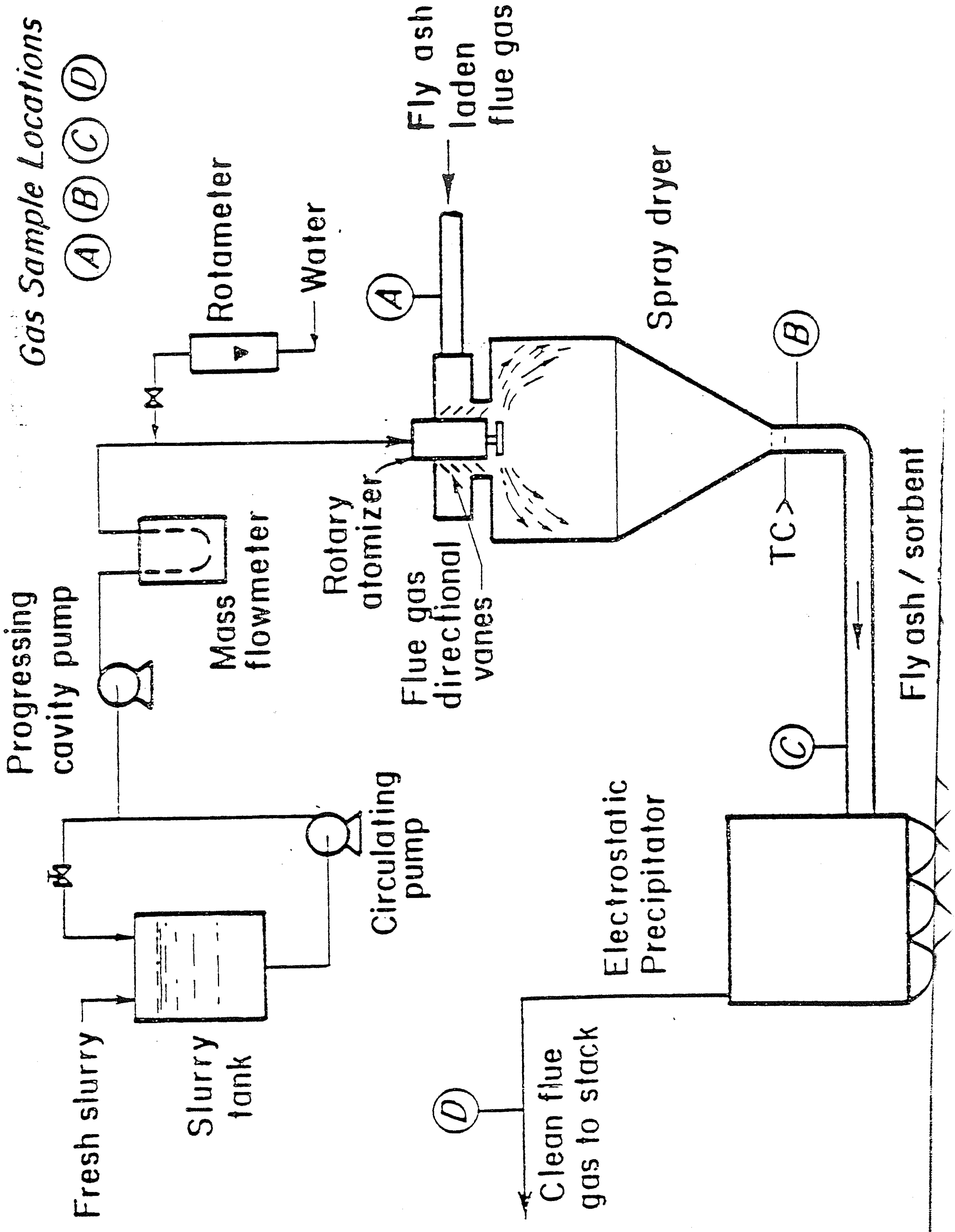


Figure 1. Simplified Flow Sheet of 500 LB/HR Pulverized-Coal-Fired Test Facility.



Gas Sample Locations Ⓐ Ⓑ Ⓒ Ⓓ
Fly ash laden flue gas
Rotameter
Water
Spray dryer
A
B
Rotary atomizer
Flue gas directional vanes
TC
Mass flowmeter
Progressing cavity pump
Circulating pump
Fly ash / sorbent
C
Electrostatic Precipitator
Fresh slurry
Slurry tank
D
Clean flue gas to stack

draft fan capable of delivering 9000 acfm (254.9 actual cubic meters per minute) at 700°F (371°C). The mobile electrostatic precipitator is mounted on a trailer 8.0 ft wide, 54.5 ft long, and 13.5 ft high (2.44 m wide, 16.61 m long, and 4.12 m high).

Each of the three fields consists of sets of discharge electrodes and collecting plates. The standard discharge electrodes consist of pipe frames that are 5 ft high and 6.25 ft long (1.52 m high and 1.91 m long), having 12 wires per frame. The Wheelabrator standard star-shaped wire was used in this program. The collecting plate is 6.5 ft (1.98 m) high and consists of 4 interlocking strips, providing a length of 6.25 ft (1.91 m) for each field.

Each collecting plate is individually rapped at the bottom with a rotating, falling hammer. All of the discharge electrodes in each field are cleaned with side-mounted vibrators. Both the pilot rappers and the discharge electrode vibrators are manually controlled for each field.

The ash- or dust-removal system consists of two trough hoppers with screw conveyors per field. The screw conveyors discharge into two pyramidal hoppers that empty into 55 gallon drums through a vacuum system.

Data Collection System

Flue gas constituent concentration, temperature, pressure, and flow were recorded using a computerized data collection system. Flue gas was sampled and analyzed at four locations (see Figure 1): the furnace outlet; the spray dryer outlet; the precipitator inlet; and the precipitator outlet.

The dew point of the flue gas was calculated using a computer code developed at the Pittsburgh Energy Technology Center [19]. The code requires information on the fuel composition, the fuel feed rate, the amount of excess air, the sorbent slurry concentration and feed rate, the dilution water feed rate, the moisture content of the combustion air, and the spray dryer system pressure, to compute the dew point, the flue gas composition, the moles of flue gas produced, and the air-to-fuel ratio. The code automatically corrects the calculated dew point for system pressure.

RESULTS AND DISCUSSION

Sulfur Dioxide Removal

The sulfur dioxide removal efficiencies obtained in tests conducted without

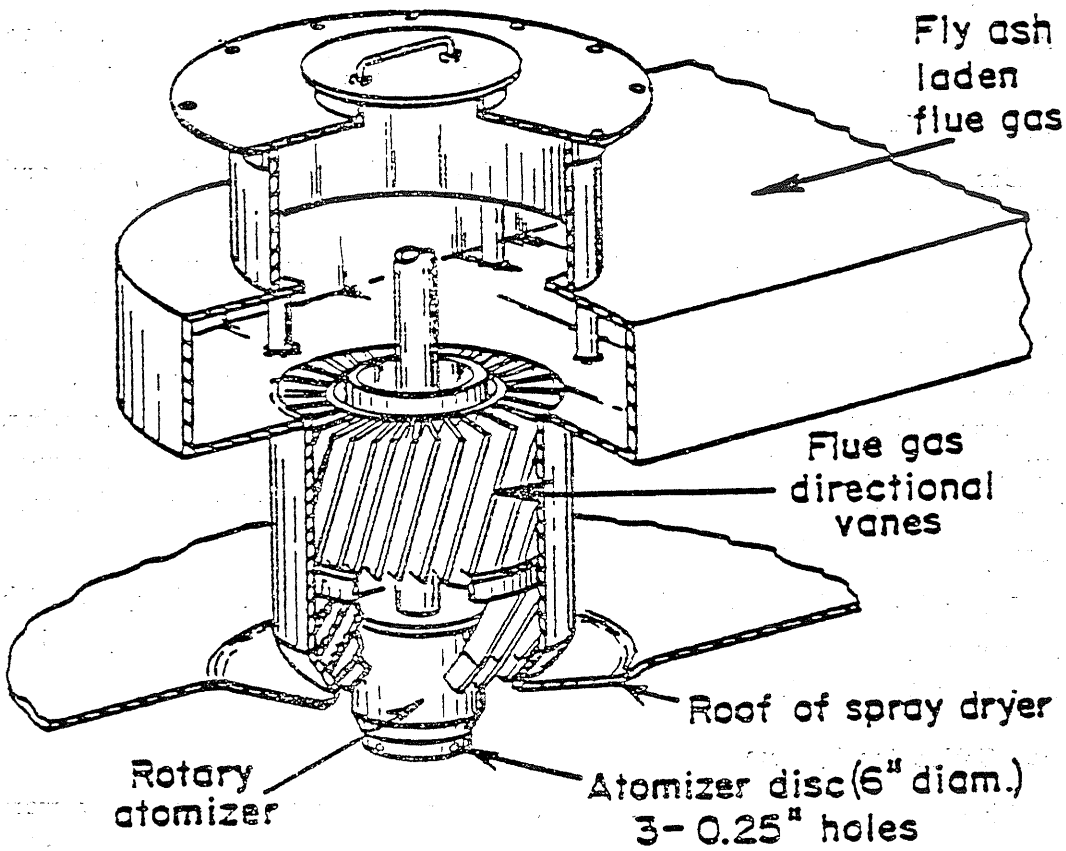


Figure 3. Spray Dryer Inlet Assembly.

recycle are shown in Figure 4. The spray dryer reactor was operated at an average approach of 25F° (13.9C°) to the flue gas saturation temperature at the exit of the reactor. The approach-to-saturation temperature is the difference between the flue gas temperature at the exit of the spray dryer and the flue gas dew point at the exit of the spray dryer.

A 90 percent sulfur dioxide removal efficiency for the overall system (spray dryer reactor and electrostatic precipitator) was obtained at a Ca/S molar ratio of 2.8 (the Ca/S molar ratio is defined as the moles of available calcium in the sorbent slurry per mole of sulfur in the inlet flue gas).

Tests conducted using recycle of the fly ash collected in the ESP showed that this mode of operation was not effective in improving sorbent utilization or sulfur dioxide removal efficiency. Little available calcium was detected in the recycled fly ash.

Contribution of the Electrostatic Precipitator to Sulfur Dioxide Removal

The sulfur dioxide removal efficiency of the ESP is defined as follows:

$$\left[\frac{SO_2 \text{ entering ESP} - SO_2 \text{ leaving ESP}}{SO_2 \text{ entering ESP}}\right](100).$$

For example, if the spray dryer removes 80 percent of the sulfur dioxide entering the spray dryer, and the ESP removes 20 percent of the sulfur dioxide entering the ESP, then the total system sulfur dioxide removal efficiency will be 84 percent. Sulfur dioxide removal in the ESP occurs when the flue gas contacts unreacted sorbent collected on the plates of the ESP. The sulfur dioxide removal efficiency observed within the ESP was less than 20 percent on average for all conditions tested (based on the sulfur dioxide concentration entering the ESP). Because of the enhanced contact between unreacted sorbent and the flue gas that occurs in a fabric filter, the sulfur dioxide removal efficiency for fabric filters has been found to be about double that observed in an ESP at the same approach-to-saturation temperature [20]. However, industrial and utility boiler operators are willing to operate spray dryer/ESP systems at 10F° closer to the flue gas dew point than similar spray dryer/fabric filter systems [20]. This is because ESP systems are not susceptible to "blinding" by moist particulate matter when the flue gas approaches its dew point as are fabric filters. The lower operating temperature that can be maintained in spray dryer/ESP systems increases the sulfur dioxide removal efficiency obtained in the spray dryer, compensating for the less efficient sulfur dioxide removal in the ESP.

Particulate Removal

The pilot ESP was operated at constant conditions during the entire test program to maintain consistent ESP operation, while spray dryer operating parameters were varied. The ESP operating conditions kept constant include the volumetric gas flow rate, the collecting surface area (i.e., specific collection area, or SCA, in ft^2/1000 acfm), and the power input (watts/1000 acfm). The performance of the ESP during each test was determined by the measured ESP particulate collection efficiency. The performance of electrostatic precipitators has traditionally been described by the Deutsch-Anderson Equation [21]:

$$E = 1 - e^{-(A/V)w} \qquad (1)$$

where E=ESP particulate collection efficiency (%)

A=ESP collecting surface area (ft^2)

V=Volumetric flow rate of gas through ESP (ft^3/sec)

w=Migration velocity (ft/sec)

Since gas flow and collecting surface area were held constant during these tests, the measured ESP particulate collection efficiency is directly related to the migration velocity (w). Thus by comparing ESP particulate collection efficiencies, we are also comparing migration velocities.

A summary of the testresults for the three coals studied is shown in Tables3 and 4. A detailed discussion of the particulate removals obtained for each coal studied is given below.

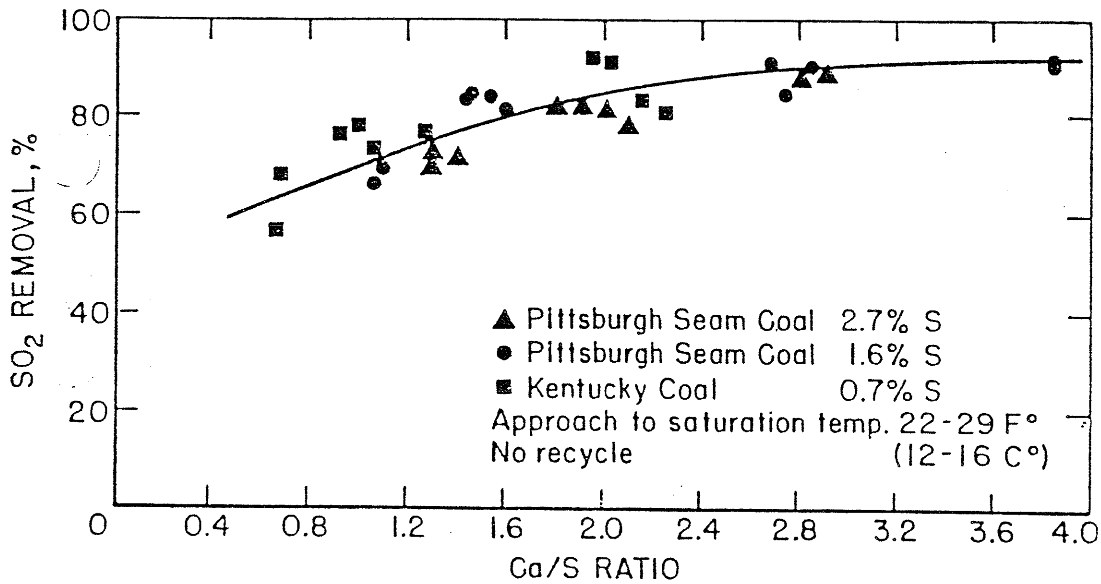


Figure 4. Total SO_2 Removal By The Spray Dryer/Esp System.

ESP Performance While Firing Coal No. I

Coal No. I was a 1.6 percent sulfur Pittsburgh seam coal. The average ESP inlet particulate loading measured while the spray dryer was not operating (base-line tests) was 3.71 $lb/10^6$ Btu. Under these conditions. the ESP outlet particulate loading varied between 0.022 and 0.044 $lb/10^6$ Btu. An average ESP particulate collection efficiency of 99.03 percent was obtained during the base-line tests.

With the spray dryer operating at 70, 80, and 90 percent overall sulfur dioxide removal efficiencies, the inlet particulate loading increased with the slurry feed rate to 6.75, 7.20, and 12.31 $lb/10^6$ Btu, respectively. This incre-

TABLE 3. ESP Performance (No Sorbent Recycle)

	Coal I	Coal II	Coal III
Sulfur (%)	1.6	2.7	0.7
Ash (%)	9.5	8.3	3.8
BASE-LINE TESTS (SPRAY DRYER NOT OPERATING)			
Particulate Loading (lb/10^6 Btu)			
ESP Inlet	3.711	2.900	1.838
ESP Outlet	0.031	0.021	0.011
ESP Collection Efficiency (%)	99.03	99.23	99.41
SPRAY DRYER TESTS (NO SORBENT RECYCLE)[1]			
70% Overall SO_2 Removal Efficiency			
Ca/S Ratio[2]	1.08	1.33	0.86
SO_2 Removal (%)	68.6	71.8	71.7
Slurry Solids (lb/hr)	14.4	33.0	5.3
ESP Inlet Loading (lb/10^6 Btu)	6.748	12.160	3.373
ESP Outlet Loading (lb/10^6 Btu)	0.035	0.111	0.022
ESP Collection Efficiency (%)	99.48	99.08	99.34
80% Overall SO_2 Removal Efficiency			
Ca/S Ratio[2]	1.51	1.94	1.52
SO_2 Removal (%)	83.9	80.7	79.5
Slurry Solids (lb/hr)	21.1	45.3	9.6
ESP Inlet Loading (lb/10^6 Btu)	7.200	14.259	3.749
ESP Outlet Loading (lb/10^6 Btu)	0.074	0.115	0.040
ESP Collection Efficiency (%)	98.93	99.18	98.92
90% Overall SO_2 Removal Efficiency			
Ca/S Ratio[2]	3.18	2.82	1.98
SO_2 Removal (%)	90.0	88.3	92.5
Slurry Solids (lb/hr)	43.5	66.0	12.0
ESP Inlet Loading (lb/10^6 Btu)	12.306	17.630	4.800
ESP Outlet Loading (lb/10^6 Btu)	0.058	0.233	0.032
ESP Collection Efficiency (%)	99.54	98.68	99.30

Notes:

[1] Approach-to-saturation temperature at spray dryer outlet: 22F° to 29F° (12C° to 16C°).

[2] Moles of available calcium in the sorbent slurry per mole of sulfur in the flue gas.

lb/hr=0.454 kg/hr

lb/10^6 Btu=0.43 kg/10^9J

TABLE 4. ESP Performance (With Sorbent Recycle)[1]

	Coal I	Coal II	Coal III
2:1 RATIO (LB FLY ASH/LB FRESH LIME)			
Ca/S Ratio[2]	2.02	1.18	0.72
Overall SO_2 Removal Efficiency (%)	82.2	69.5	55.1
Slurry Solids (lb/hr)	86.4	84.0	17.1
ESP Inlet Particulate Loading (lb/10^6 Btu)	15.510	18.965	4.468
ESP Outlet Particulate Laoding (lb/10^6 Btu)	0.137	0.275	0.032
ESP Collection Efficiency (%)	99.12	98.55	9.30
4:1 RATIO (LB FLY ASH/LB FRESH LIME)			
Ca/S Ratio[2]	1.54	1.03	2.23
Overall SO_2 Removal Efficiency (%)	77.3	70.9	81.6
Slurry Solids (lb/hr)	84.4	85.0	42.0
ESP Inlet Particulate Loading (lb/10^6 Btu)	16.370	15.717	7.000
ESP Outlet Particulate Loading (lb/10^6 Btu)	0.140	0.182	0.086
ESP Collection Efficiency (%)	99.14	98.84	98.77

Notes:

[1] Approach-to-saturation temperature at spray dryer outlet: 22F° to 29F° (12C° to 16C°).

[2] Moles of available calcium in the sorbent slurry per mole of sulfur in the flue gas.

lb/hr=0.454 kg/hr

lb/10^6 Btu=0.43 kg/10^9J

ased particulate loading resulted in increased outlet residuals but also showed a trend toward increased ESP particulate collection efficiency over the base-line data. However, at a sulfur dioxide removal effi-ciency of 80 percent, the ESP particulate collection efficiency was lower than that observed during base-line testing. During tests conducted with sorbent recycle, the ESP particulate collection efficiency was slightly higher than at baseline tests but was lower than at 70% and 90% SO_2 removal levels.

ESP Performance While Firing Coal No. II

Coal No. II had a higher sulfur and lower ash content than Coal No. I. During base-line tests with this coal, average ESP inlet particulate loadings of 2.90 lb/10^6 Btu, average ESP outlet particulate loadings of 0.021 lb/10^6 Btu, and average ESP particulate collection efficiencies of 99.23 percent were observed.

Because of the higher sulfur content of Coal No. II, the spray dryer slurry feed rate had to be increased to obtain the same overall sulfur dioxide removal efficiency. The highest ESP particulate loading (17.63/10^6 Btu) occurred during spray dryer operation at 90 percent sulfur dioxide removal. Under these conditions, the ESP outlet residual was 0.233 lb/10^6 Btu, and the ESP particulate collection efficiency was 98.7 percent.

The trend observed during testing with Coal No. II was that of decreasing ESP particulate collection efficiency with increasing sulfur dioxide removal efficiency (increasing particulate loading). During tests conducted with sorbent recycle, the ESP particulate collection efficiency followed a similar trend, decreasing with increasing particulate loadings.

ESP Performance While Firing Coal No. III

Coal No. III was a low-sulfur, low-ash coal from Kentucky. Base-line tests with this coal resulted in average ESP inlet particulate loadings of 1.8 lb/10^6 Btu, the lowest of the three coals tested. The average ESP outlet particulate loading was 0.011 lb/10^6 Btu, resulting in an ESP particulate collection efficiency of 99.41 percent during base-line tests, the best performance observed while firing these three coal types.

Because of the low-sulfur content of Coal No. III, the spray dryer slurry feed rate required to obtain 70, 80, and 90 percent sulfur dioxide removal efficiencies was lower than for Coals No. I and II. As a result, the average ESP inlet particulate loadings ranged from 3.373 to 4.800 lb/10^6 Btu, while the average ESP outlet particulate loadings ranged from 0.022 to 0.040 lb/10^6 Btu. The ESP particulate collection efficiencies ranged from 98.9 percent to 99.3 percent.

When fly ash and spent sorbent collected during initial spray dryer tests were recycled to the spray dryer, the average ESP inlet particulate loadings increased, ranging from 4.5 to 7.0 lb/10^6 Btu. The average ESP outlet particulate loadings were observed to be 0.03 and 0.09 lb/10^6 Btu at recycle ratios of 2:1 and 4:1, respectively. The ESP particulate collection efficiencies for these recycle tests were 99.3 and 98.8 percent, respectively.

The particulate collection trend for Coal No. III was similar to that for

Coal No. II. The ESP particulate collection efficiencies decreased from the base-line ESP particulate collection efficiency when the sorbent slurry was injected in the spray dryer. The observed particulate collection efficiencies for tests using sorbent recycle were inconclusive, as the particulate collection efficiencies for a 2:1 recycle ratio are similar to the base line, while they are substantially lower than the base line for a 4:1 recycle ratio. This may be due to the higher ESP inlet particulate loadings in the 4:1 recycle ratio tests compared with the 2:1 recycle ratio tests.

Compliance with Emissions Control Regulations

The capacity of an existing ESP is important in determining whether an electric power generating facility will meet particulate emissions control standards after installation of sulfur dioxide emissions control equipment (such as a spray dryer). Based on the data previously reviewed in this paper, if an ESP is operating with outlet particulate loadings close to compliance levels, it may not meet emissions control standards after the addition of a spray dryer to the system unless modifications to the ESP, such as increasing power, improving plate alignment, improving gas distribution, or replacing aged components, are made. Many operating electrostatic precipitators were designed for "worst case" conditions, such as lowsulfur, high-resistivity-ash Western coal, but operate with easier to precipitate Eastern coal. The results from this study show that these units should have enough collection area to meet compliance with the higher particulate loading inherent in the operation of a spray dryer. Operating parameters, such as migration velocity and specific collecting area of the ESP, would have to be analyzed for each installation to determine whether the particulate collection efficiency of the ESP would be sufficient while operating a spray dryer.

CONCLUSIONS

The efficient removal of sulfur dioxide from coal combustion flue gas can be achieved with low-, medium-, and high-sulfur Eastern U. S. coals using a system combining a spray dryer and an electrostatic precipitator. The results of this investigation provide the information required to determine whether an existing electric power generating facility can install a spray dryer for sulfur dioxide emissions control while using an existing ESP for particulate emissions control. The data show that the major parameter affecting ESP performance was the inlet particulate loading, which increased with increasing sorbent slurry flow rates. As a result, the ESP outlet residuals increased. However, the ESP particulate collection efficiency was about the same whether or not the spray dryer was operating except when the inlet particulate loadings were very high (either during operation to achieve 90 percent sulfur dioxide removal efficiencies or with sorbent recycle.) In addition to achieving good particulate collection efficiencies in the ESP, handling of the collected mixture of fly ash and spent sorbent posed no problems.

In determining whether a spray dryer can be used for sulfur dioxide emissions control at an electric power generating facility equipped with an ESP, the operating parameters of the existing ESP must first be evaluated. If particulate emissions just meet emissions standards, the ESP will most probably not meet particulate emissions standards after installation of a spray dryer without modifications. If the ESP easily meets emissions standards, the system will probably also meet emissions standards while operating a spray dryer. It can generally be concluded that the behavior of an electrostatic precipitator receiving flue gas treated in a spray dryer is similar to that normally expected for a conventional cold-side electrostatic precipitator in a coal-fired application.

Acknowledgment

The assistance of John D. Sherow of wheelabrator Air Pollution Control, Precipitator Research and Development, in the ESP data analysis for this study was most helpful and greatly appreciated.

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