Experiences with Particulate Control at PSI Cayuga Station during Test Burn with Low Sulfur Eastern Coal

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Abstract

To comply with Phase I requirements on acid control, PSI energy conducted a test on Unit #2 of its Cayuga generating facilities during the months of October/November 1991. Unit #2 is a base loaded unit rated at 500 MW and normally burns 4.2 lbs/mm BTU sulfur coal. The ESP is four field deep, 180 SCA, Research-Cottrell, weighted wire design. The test was conducted with 3.3 lb/mm BTU sulfur coal. Data show that stack opacity can be kept below 25% when the ash is conditioned with FACT 5000, a conditioner marketed by Calgon Corporation. Since some additional benefits were also noted while burning the 4.2 coal, the plant decided to install the permanent set-up on both units. This paper presents the data obtained during the test burn.

General

Since its inception in 1970-1972, the Cayuga Station of Public Service of Indiana has been burning Eastern coal with its two 500 MW units. Each unit is designed for 531 MW. The precipitators are Research-Cottrell, weighted wire design. The flue gases from the air preheaters are led in two separate ducts to two precipitators, labeled A & B. The discharges from the precipitators are combined and exit through the stack. The units are similar in design in almost all respects. The characteristics of the precipitator, coal, and the ash quality produced from unit #2 are listed in Tables 1, 2, and 3, respectively.

As seen in Table 1, the precipitator actually operates at an SCA of 158 ft^2 total, and the flue gas temperature at 500 MW load is around 300° F. The sulfur and ash contents of the coal normally burned are around 2.4% and 10% respectively. The test coal has a sulfur content of 1.7% and an ash level of around 11%. Because the BTU content of the test coal is slightly lower and the

ash level higher, the ash input to the ESP is about 14% higher with the test coal.

Table 1

The Precipitator Parameters, Unit # 2

Parameter	Design	Current
Gas Flow	1.972 mm ACFM	Not Available
SCA	180.5	157.7
Fields in series	4	4
TR sets/ppt	12	12
Avg. Gas Velocity	6.8 ft/sec	NA
Duct Spacing	9"	9"
Rapping freq.(in-out)	--	1/2/4/4

Table 2

Coal Parameters

Coal Characteristics	Regular Coal	Test Coal
Sulfur, %	2.35	1.73
Ash, %	10.3	10.9
Heating Value, BTU/lb	10,923	10,775
Moisture, %	14.7	15.6
Coal Type	Eastern	Eastern
HGI	47	48

Table 3

Fly ash characteristics, normal (4.4) coal

Ash Constituent	Inlet Hopper (A/B)	Outlet Hopper (A/B)
Na, Water sol., ppm	220/240	300/460
SO_4, Water sol., ppm	8600/10800	5700/9800
NH_3, water sol., ppm	Not Detected	Not Detected
Loss on ignition, %	1/3	1/2
pH, 1% slurry	4.7/4.9	4.3/4.9
SiO_2/Fe, %	49/17-50/17	54/17-51/20

Test Results

Several operating parameters such as load, gas temperature, excess oxygen, instantaneous and six-minute average opacities, chemical feed and feed equipment parameters, and fly ash characteristics were monitored both prior to and during chemical conditioning.

Based on the fly ash analysis as reported in Table 3 (sample collected in July 1991 when burning regular 4.4 lb/mm BTU sulfur coal), Calgon recommended FACT 5000. This product is a blend of organic and inorganic compounds and is designed to modify both the resistivity and cohesivity of the treated ash. The net result of conditioning the ash is that it keeps the opacity within the desired goals. In addition to opacity, ESP power levels also were monitored to ensure that conditioning is maintained at about the same level as when operated with the regular 4.4 coal.

The goal of the plant is to maintain the six-minute average opacity at less than 25% even though 40% is acceptable. During normal coal operation the six-minute averages generally remain below 20% and opacity spikes seldom exceed 60%. However, past experience suggests that minor reductions in coal sulfur cause rapid degradations to both opacities. Because of this experience, we suspected degradations with occurred the use of 3.3 test coal.

The purpose of this test (Phase I) was primarily to determine whether or not the units could utilize 3.3 coal before 1995. The ultimate plan (Phase 2) is to assess if the units can burn 2.5 compliance coal. The Phase 1 study was conducted between October 23 and November 8, 1991.

Chemical Feed Set-up

The Calgon FACT 5000 chemical was applied in the gas stream after the air preheaters. The chemical was diluted in line and fed as a fine mist atomized by the plant compressed air. A line drawing of the feed set-up is shown in Figure 1. According to Calgon, the feed point for air atomized feed must be selected 30 feet upstream of the ESP entrance and any internal structures (turning vanes, support beams, etc.) for preventing any ash build-up due to inadequate size reduction of the mist. The feed ports were located outside the building downstream of the first set of turning vanes. The feed ports were located slightly under 25 feet upstream of the ESP entrance, falling short of the recommended guidelines for air. Although the use of steam is recommended for distances of less than 30 feet, doing so would have required more work and delayed the test. An additional compromise on feed also was made. To save on installation time, the compressed air was brought in a header across the duct work instead of being routed through the air monitoring control panel.

The chemical was applied in each duct through a set of 12 nozzles located at two levels in the duct. The chemical spray was kept parallel to the gas flow. The appropriate flow of the chemical through each nozzle was ensured through dedicated flow meters located on the panel.

Test Results

Three types of tests were conducted with the test coal. In addition, conditioning tests with normal coal were also briefly conducted. With the test coal, the conditioning effects of both short (few hours) and long (several hours) durations were monitored during this period, as well as the effect of various dosage rates and the results of purposely removing two to four TR sets (from a total of 24 sets). The following conclusions were drawn from this test.

Conclusions

(a) Burning 3.3 lb/mm BTU sulfur coal rapidly increases the opacity. The six minute averages at nominal 500 MW generation were around 25% with heavy and frequent spiking observed in the instantaneous opacity.

(b) The test was short; therefore, the long term effects of burning 3.3 coal cannot be delineated nor can the long term effects of chemical treatment.

(c) FACT 5000 was effective in reducing the opacity. Most reductions were of 5% points or more. One of the most important changes noted was the treatment's ability to control the opacity peaks - for both six-minute average and instantaneous opacities.

(d) With all 24 TR sets operating, FACT 5000 was effective at a treatment rate of 0.33 lb/ton of coal. With four TR sets out of service, it was effective at 0.57 lb/ton of coal.

(e) Because of the chemical's ability to respond quickly and its effectiveness when only 80% of the precipitator is available, it was recommended that a permanent feed system be installed on both units (which was implemented in 1992).

Figure 1, Chemical Feed Location and set-up