AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

2
DOE/PC/89660--T4

**ADVANCED FLUE GAS DESULFURIZATION (AFGD)
DEMONSTRATION PROJECT**

TECHNICAL PROGRESS REPORT NO. 13

January 1, 1993 to March 31, 1993

PARTICIPANT

**Pure Air on the Lake, L.P.
Allentown, Pennsylvania**

HOST UTILITY

**Northern Indiana Public Service Company
Hammond, Indiana**

**Prepared for the United States Department of Energy
Pittsburgh Energy Technology Center
Under Cooperative Agreement No. DE-FC22-90PC89660**

Patents Cleared by Chicago on (TBD)

MASTER

We have no objection from a patent
standpoint to the publication or
dissemination of this material.
A.W. Hbm 7/18/94
Office of Intellectual
Property Counsel
DOE Field Office, Chicago

EXECUTIVE SUMMARY

The "Advanced Flue Gas Desulfurization (AFGD) Demonstration Project" is a \$150.5 million cooperative effort between the U.S. Department of Energy and Pure Air, a general partnership of Air Products and Chemicals, Inc. and Mitsubishi Heavy Industries America, Inc.

The goal of the AFGD project is to demonstrate that, by combining state-of-the-art technology, highly efficient plant operation and maintenance capabilities and by-product gypsum sales, significant reductions of SO₂ emissions can be achieved at approximately one-half the life cycle cost of a conventional Flue Gas Desulfurization (FGD) system. Further, this emission reduction is achieved without generating solid waste and while minimizing liquid wastewater effluent.

Briefly, this project entails the design, construction and operation of a nominal 600 MWe AFGD facility to remove SO₂ from coal-fired power plant flue gas at the Northern Indiana Public Service Company's Bailly Generating Station, located approximately 12 miles northeast of Gary, Indiana. The facility is used to demonstrate a variety of advanced technical and business-related features, during a three-year period of operation which began in the summer of 1992. The aim of this demonstration is to accelerate near-term commercialization. Key features of the AFGD project are:

- Large single absorber for multiple boilers
- Single loop absorber with in situ oxidation to produce commercial gypsum
- SO₂ removal levels of 95% without chemical additives
- High velocity co-current absorber
- Direct injection of pulverized limestone
- Air rotary sparger
- Wastewater evaporation system
- "Own-and-Operate" business arrangement

In broader terms, the AFGD demonstration offers several potential benefits, including: protection of markets for high-sulfur U.S. coal, smaller space requirements, lower costs for electric utilities and their customers, and improved environmental performance compared to conventional FGD systems.

During this reporting period January 1993 through March 31, 1993,

- The AFGD facility achieved 99.97% availability for the quarter with 99.91% year-to-date.
- The AFGD facility achieved an average SO₂ removal of 95.1% year-to-date.

- The AFGD facility produced 52,980 tons of Gypsum during this Quarter and 18,103 tons of SO₂ was removed.
- Contract to date production of Gypsum is 160,981 tons of Gypsum and 57,264 tons of SO₂ were removed.
- Examination of the data from the first DOE Demonstration Test was in progress during the quarter.
- Completed EMP (Environmental Monitoring Plan) Class I testing with the WES (Wastewater Evaporation System) in operation.

INTRODUCTION

The "Advanced Flue Gas Desulfurization (AFGD) Demonstration Project" is a \$150.5 million cooperative effort between the U.S. Department of Energy and Pure Air, a general partnership of Air Products and Chemicals, Inc. and Mitsubishi Heavy Industries America, Inc. The AFGD process is one of several alternatives to conventional flue gas desulfurization (FGD) being demonstrated under the Department of Energy's Clean Coal Technology Demonstration Program. The AFGD demonstration project is located at the Northern Indiana Public Service Company's Bailly Generating Station, about 12 miles northeast of Gary, Indiana.

PROJECT DESCRIPTION

The AFGD demonstration at Bailly station is showcasing several advanced features, compared to conventional FGD systems in operation throughout the United States. These features are described below.

Single Large Absorber

Ordinarily, an FGD facility contains several SO₂ absorber or "scrubber" modules, with one or two spare modules added to improve system reliability. The AFGD facility at Bailly utilizes a single nominal 600 MWe absorber module. It is the largest capacity absorber module in the United States, and it scrubs all of the flue gases from the Bailly station's two coal-fired boilers. There is no spare or back-up modules. Instead, a high degree of system reliability will be demonstrated, as the scrubber is capable of removing 95% or more of the SO₂, without the use of performance-enhancing chemical additives.

Single Loop Scrubber with In Situ Oxidation

Another space-saving feature is the utilization of the SO₂ absorber to perform three separate functions: prequencher, absorber, and oxidation of scrubber sludge (CaSO₃, calcium sulfite) to gypsum (CaSO₄•H₂O, calcium sulfate). Old FGD systems often employ two or three separate vessels to perform these functions. The AFGD system at Bailly produces a gypsum by-product that is suitable for commercial uses such as wallboard or cement. This is in lieu of producing scrubber sludge, which would have to be landfilled as a solid waste.

High Velocity Co-Current Absorber

The SO₂ absorber utilizes a high velocity concurrent design, in which the scrubbing slurry moves in the same direction as the flue gas flow. Operation at a relatively high flue gas velocity of approximately 20 feet per second allows for a more compact absorber. This feature, combined with the absence of any back-up modules, contributes to improved space requirements for the AFGD system.

Direct Limestone Injection

At Bailly, pulverized limestone is injected directly into the SO₂ absorber. The pulverized limestone is purchased from a limestone supplier, thereby eliminating the need for on-site wet grinding systems.

Air Rotary Sparger

A novel device known as an air rotary sparger (ARS) is demonstrated within the absorber module. Basically, the ARS combines the functions of mixing and air distribution within the absorber, thereby facilitating the oxidation of scrubber sludge to gypsum. In a conventional FGD system, mixing would be done by agitators while oxidation air distribution would be performed by a separate fixed sparger arrangement. Merging these functions into one equipment item is expected to provide better mixing within the base of the absorber.

Wastewater Evaporation System

Wastewater disposal often poses a difficult problem for scrubber operators, particularly where the oxidation of scrubber sludge to gypsum is employed. The AFGD project at Bailly will demonstrate a novel wastewater evaporation system (WES), whereby process wastewater is injected into the flue gas ductwork upstream of the existing electrostatic precipitator (ESP). The hot flue gas will evaporate the wastewater, and dissolved solids in the wastewater will solidify so that they are collected by the ESP, along with the fly ash. At Bailly, the WES will be demonstrated only on one boiler unit (i.e., 345 MWe). If

successful, it could lead to zero liquid discharge scrubbers. That is, scrubbers which produce a usable gypsum by-product and no wastewater effluent.

PowerChip™ Gypsum

The AFGD by-product gypsum is in a finely powdered form. However, the Bailly project includes a process to agglomerate and flake part of the by-product gypsum stream, in an attempt to improve the marketability of scrubber gypsum to end-users which are more accustomed to using natural gypsum rock. This PowerChip™ gypsum can be transported more easily and handled with existing equipment at most wallboard and/or cement plants. Pure Air will also attempt to blend fly ash and wastewater treatment solids into the PowerChip™ gypsum by-product. Although these impurities would make the gypsum unacceptable for wallboard applications, it could still be used in cement. Pilot tests have indicated that maximum fly ash loadings of 20% to 30% may be achieved. In combination with wastewater evaporation and the co-production of wallboard grade gypsum, this process may bring coal-fired power generation technology one step closer to the goal of a zero-discharge power plant.

On-Site Own and Operate

In addition to state-of-the-air technical features, the AFGD project will showcase a novel business arrangement. Normally, utility companies must contract with several different firms to design and build a scrubber. And once it is built, the utility must operate the scrubber. By contrast, Pure Air designed, financed, built, owns, maintains and operates the Bailly AFGD facility for Northern Indiana as a contractual service. This "own and operate" approach has been employed successfully by Pure Air's parent, Air Products and Chemicals, Inc. in other business lines. Its application to flue gas cleanup is attractive to many utilities for a variety of reasons. For example, it allows the utility company to focus on the business of electricity generation and distribution, while Pure Air utilizes its own expertise to own and operate the scrubber facility.

The project was originally selected for award under DOE's Clean Coal Technology Program in September 1988. Following negotiations, Pure Air entered into a long-term flue gas processing agreement with Northern Indiana in October 1989 and a cooperative agreement with DOE in December 1989. Construction activities began in March 1990 and were completed June 1992. A three-year demonstration period started in July 1992 to prove the efficacy of AFGD technology with a range of high sulfur United States coals. If successful, the demonstration will be followed by a long-term commercial operation period, pursuant to the agreement between Pure Air and Northern Indiana.

**Project Status
January - March 1993**

During the reporting period of January 1 to March 31, 1993 the AFGD unit continued with stable commercial operation. The 90-day AFGD availability test was conducted during the quarter; it will be completed during the next quarter. Testing of the WES (Waste Evaporation System) was conducted during the quarter.

Project Milestones

- The AFGD facility achieved 99.97% availability for the quarter with 99.91% year-to-date.
- The AFGD facility achieved an average SO₂ removal of 95.1% year-to-date.
- The AFGD facility produced 52,980 tons of Gypsum during this Quarter and 18,103 tons of SO₂ were removed.
- Contract to date production of Gypsum is 160,981 tons of Gypsum and 57,264 tons of SO₂ were removed.
- Examination of the data from the first DOE Demonstration Test (3-3.5% sulfur coal) was continuing during this quarter.
- Completed EMP (Environmental Monitoring Plan) Case I testing with the WES (Wastewater Evaporation System) in operation.

Design Activities

- No PowerChip™ design activities this quarter.

Construction Activities

- No PowerChip™ construction activities this quarter.

General Performance

January

- 45 minute FGD Outage due to electrical fault on January 11, 1993.
- Unit #8 operating normally at reduced load.
- Unit #7 operating at 50% capacity for most of the month due to problems with boiler feed water pump.

February

- Unit #8 operating normally at reduced load.
- Unit #7 operating at 50% capacity for the entire month due to boiler feed water pump problem.

March

- Unit #7 Boiler Feed Water Pump Repair - back to full load 3/1/93.
- Unit #8 down for steam leak - 3/1/93 through 3/4/93.
- Power failure 3/31/93 - FGD down from 0542 hours until 0615 hours.

Maintenance Activities

January

- Industrial vacuum system installed in Dewatering Building.
- Installed automated vent system on B-520 "A" limestone truck unloading blower.
- Adjusted impeller clearance on P-120 Warman Pumps for increased flow.
- Inspected and required termination wiring on all M-300 centrifuge drive motors.
- Repaired air tube on A-120 "C" ARS Unit.
- Modified piping on limestone truck unloading lines.

February

- Industrial vacuum system installed in gypsum conveyor tunnel.
- Rebuild of P-700 "B" Absorber Sump Pump.
- Inspected and repaired rotary limestone feed systems on both silos.
- Installed new doors on Gypsum Building.
- Krauss-Maffei on site for M-300 Centrifuge inspection.
- Checked capacity and adjusted clearances on all P-120 pumps.
- Warman Pump on site for inspection of P-120 "A" Pump.

March

- Installed and rubber lined extended shaft on A-10 Absorber Hold Tank Agitator.
- Inspected lining in V-700 Absorber Hold Tank.
- Installed sound abatement insulation on P-350 WES Pump piping.
- Installed new level indicators in V-500 "A" and "B" Limestone Silos.
- Hinged all grating in the conveyor tube to facilitate cleaning.
- Inspected and repaired all wiring in motor terminal boxes of M-300 Centrifuges.
- Inspected and repaired M-500 "B" Rotary Limestone Feeder.

- Finished installation of in plant vacuum system.
- Started first year electrical p.m.
- Repaired leaks on two flue gas inlet duct expansion joints.

Testing Activities

January

- Ninety (90) day Availability Test started at 0800 on January 4, 1993.
- J. Henderson met with NIPSCO Coal Procurement Department on January 4, 1993 to discuss coal for second DOE Demonstration Test scheduled to begin on May 1, 1993.
- Conducted WES testing on January 19-21, 1993.

February

- Conducted four (4) day test on 4% sulfur coal (preparation for May test).
- Availability test continued.
- Modifications/inspection of the WES System 2/28/93. Testing continues.

March

- WES System Test - 3/22/93 through 4/5/93. Clean Air Engineering on site for testing.
- Availability test continues.

1. High Sulfur Coal Test Burn

High sulfur coal test burn at the Bailly Station was conducted during the quarter in preparation for a DOE Demonstration Test in the second quarter of 1993. The power station must run a short test prior to committing to purchasing 150,000 tons of coal. A four day run was made to determine fuel handling characteristics. The test was successful, with no reported problems during the test. The boiler showed no changes and the ESP (Electrostatic Precipitators) functioned well. As a result of the test it was decided to proceed with the procurement of the coal for the DOE test in the Spring.

2. EMP (Environmental Monitoring Plan)

Testing of the WES (Wastewater Evaporation System) triggered required testing under the EMP (Environmental Monitoring Plan). The testing consisted of characterizing the flue gas in and out of the FGD unit, as well as testing Product Gypsum and Fly Ash. More detailed information will be included in the EMP.

3. WES System Testing

The WES testing was completed on April 5, 1993 a complete report will be issued on the WES in the 2nd quarter of 1993 Technical Progress Report.

Technology Transfer Activities

In January, the AFGD was named an "Outstanding Engineering Achievement" by the National Society of Professional Engineers; one of only eight such engineering achievements recognized nationwide during 1993.

A technical seminar was held at the DOE's Pittsburgh Energy Technology Center on February 18, 1993.

The following project-related paper was issued during the reporting period:

"Advanced Flue Gas Desulfurization: An Integrated Approach to Environmental Management" by T.A. Sarkus, E.W. Evans and G.W. Pukanic. Presented at the Sixth International Symposium on Integrated Energy and Environmental Management, New Orleans, LA, March 10-12, 1993.

**DATE
FILMED**

9 / 19 / 94

END

1