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“Superior Opacity and SO₂ Emissions Reduction in Coal Fired Utility Plants Using Advanced Flue Gas Catalytic Conditioning Technology”

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Under ideal flue gas conditions, the ESP of a typical coal burning power plant can perform very effectively in meeting regulatory emissions requirements for opacity. However, when different types of low sulfur coals are used, the effectiveness of the ESP can be substantially reduced. To facilitate improved operational performance of the ESP, a technology has been developed and proven to enhance emissions performance even when different types of coals are used.

The proprietary catalyst formulation and process has now been made available to Applied Catalysts Environmental for commercial manufacture and is currently available to power plants around the world. Thus far, this technology called AC-712, has been installed and evaluated in twelve different power plants throughout the US. The results in each plant, has shown a marked improvement in fly ash removal and a corresponding decrease in opacity of the flue gas exhaust emissions. In addition, tons of SO₂ are reduced which can be used in banking and trading of emission credits. This technology avoids the expensive installation costs and hazardous transport and storage of elemental sulfur or SO₂ on site. In addition, this unique catalyst effectively uses the power plant’s own process to meet and exceed the emission requirements of the facility.

How The Technology Works

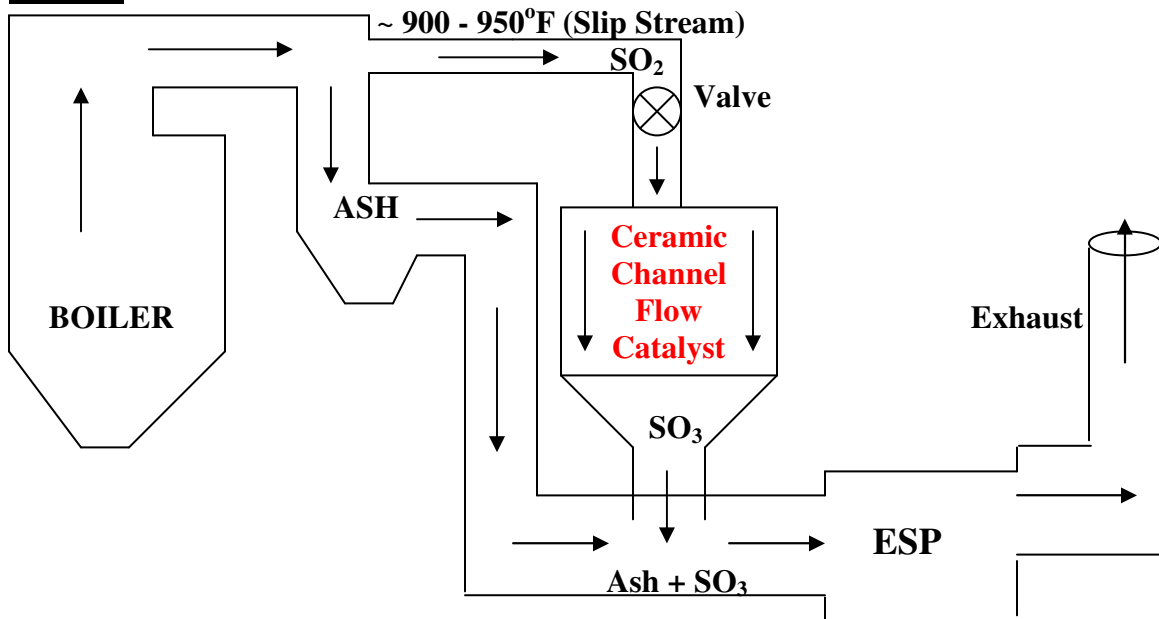
With the burning of various low sulfur coals, some produce high levels of ash. Typically these coals have sulfur contents below 1%. The high ash content contained in the flue gas from these coals can quickly overwhelm ash collection and handling systems. Under these conditions, the flyash particles exhibit a high electrical resistivity. This resistivity reduces the performance and effectiveness of the ESP in the removal of flyash. Applied Catalysts AC-712 effectively overcomes this high resistivity by increasing the SO₃ content adsorbed on the flyash which enters the ESP. The catalyst technology works by utilizing a small slip stream from the boiler of the power plant. Generally less than 5% of the flue gas is needed for this process. The slip stream is then processed through a proprietary catalyst bed, which is highly selective in converting SO₂ to SO₃. In this case, a fixed flow-through honeycomb monolith impregnated with highly active catalytic sites is used. With the AC-712 technology, there is no need to transport and stockpile elemental sulfur in storage tanks adjacent to high temperature ductwork in the plant. The AC-712 yields very high conversion rates of SO₂ → SO₃, which immediately adsorbs onto flyash particles. This adsorption of SO₃ instantly reduces electrical resistivity of the

ash and allows the ESP to function as it was designed. The AC-712 catalyst is a specially optimized second generation catalyst technology that has demonstrated exceptional performance under many different plant conditions with many different types of coal. The effectiveness of the technology is based on a proprietary chemistry that yields an active catalyst with good physical and chemical durability. The manufacturing formulation and process is well defined and is currently produced at Applied Catalysts' production facility in Atlanta, Georgia. The catalyst technology can be used with a variety of different cell density configurations to facilitate almost any pressure drop requirement. In addition, an appropriately sized monolith can be selected to yield optimum processing of flyash, which enters into the catalyst flow-through channels.

Some of the benefits of using AC-712 are as follows:

- (1) Opacity standards can be exceeded which greatly reduces the potential for emissions violations**
- (2) Immediate SO₂ credits are realized which can be traded or kept in reserve for future needs**
- (3) Does not require addition of any chemicals or reagents such as injection of molten sulfur or SO₂**
- (4) No additional costs for chemical transport, delivery, storage, safety containment areas or emergency plans are needed**
- (5) AC-712 presents no safety issues for personnel regarding fire, chemical spills, containment or cleanup**
- (6) No need for additional mechanical fans or specialized electrical equipment to transport conditioned flue gas through the catalyst to the ESP**
- (7) Does not require expensive monitoring equipment**
- (8) There is lesser need for specialized training or a dedicated operator**
- (9) AC-712 provides years of highly effective, stable and uninterrupted service and performance**

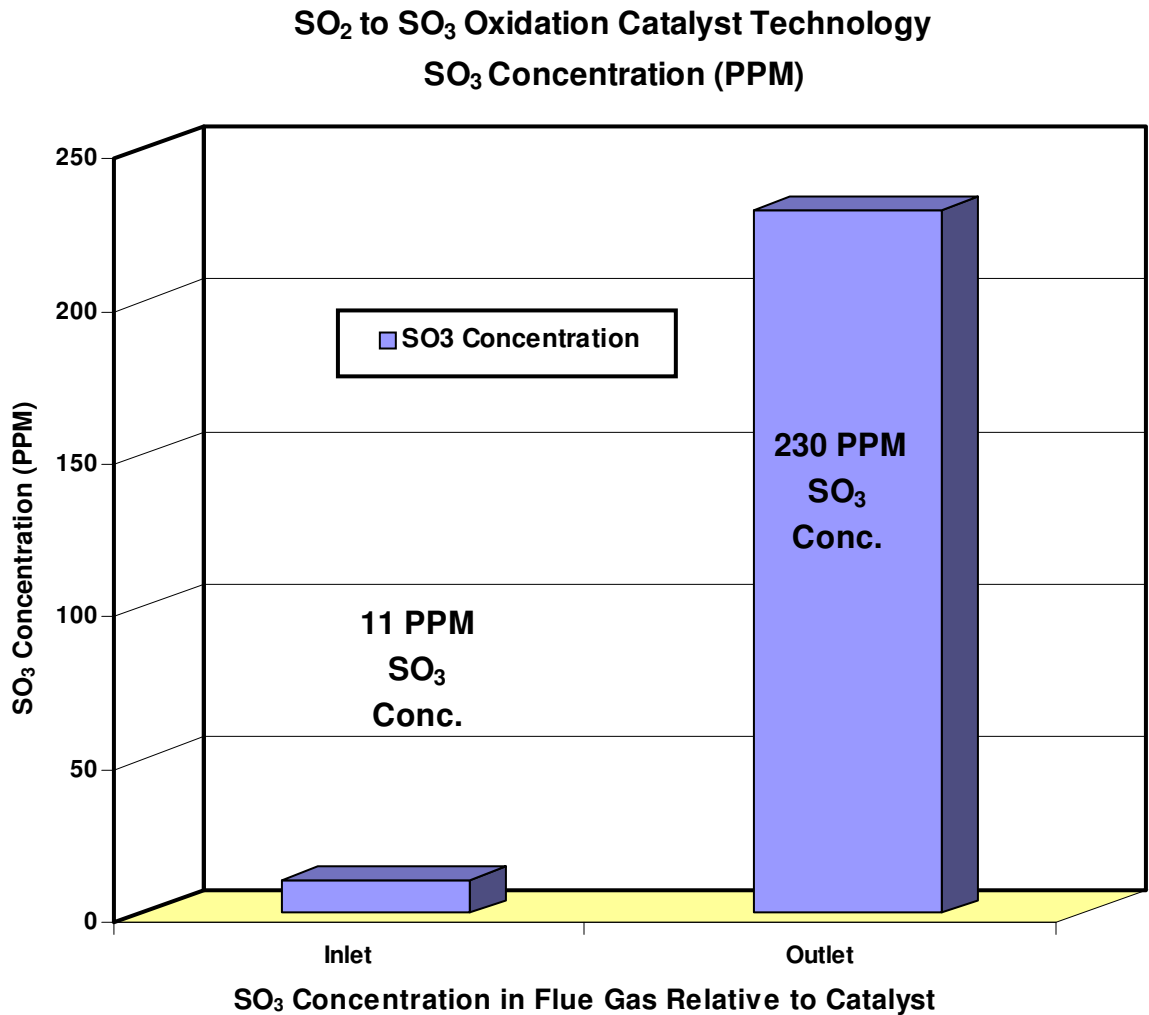
Figure 1



SO₃ Conversion and Control

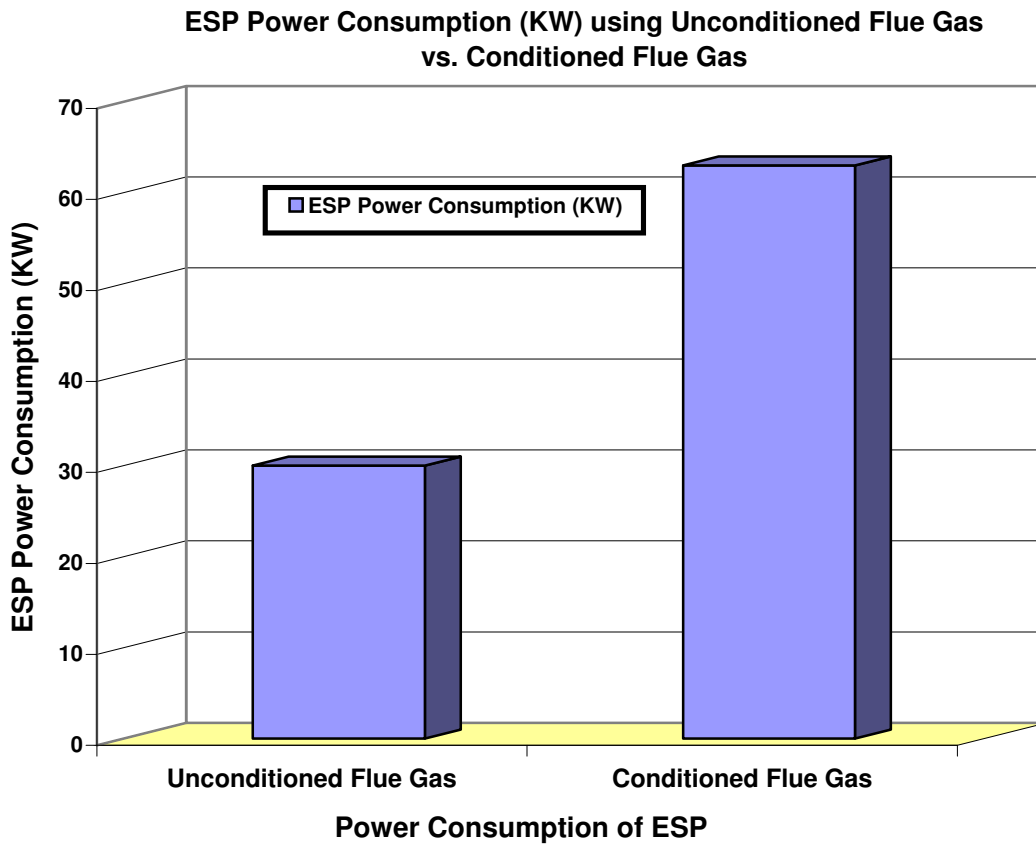
Using both an analyzer installed on the boiler and standard wet chemical procedures, SO₃ was measured at the inlet and outlet of the catalyst chamber during 16 separate tests. Data shows excellent conversion efficiencies. Control of SO₂ conversion to SO₃ is achieved using a standard modulation system. A flow transmitter in the inlet duct modulates a louvered flow control damper in the duct directly. Inlet and outlet data shows average SO₃ concentrations as follows:

Figure 2



Under full load conditions, the conversion efficiency of the catalyst averaged approximately 70%. Under low load conditions, the conversion increased to about 85%.

Figure 3



Conclusions

The AC-712 gas conditioning system eliminates the need for chemical addition in the reduction of electrical resistivity of flyash and reduces SO₂ emissions. The system provides a viable cost effective solution to high resistivity ash, which is often produced from low sulfur coals. For situations where additional equipment and storage space is not available, the AC-712 system provides an effective alternative to conventional chemical addition systems.

Capital Costs

Versus other systems, this technology is expected to be considerably lower cost. This is due, in part, to the lack of need for storage, transfer and extra monitoring equipment needed with elemental molten sulfur and SO₂ injection systems.

Operating Costs

The two areas identified in the study were the thermal penalty of the slip stream and the maintenance of the catalyst monolith. Thermal penalties are estimated to be relatively insignificant as slip streams are expected to be approximately 3 – 5%. It is anticipated that a typical catalyst may require rejuvenation about every 2 to 4 years. The cost for cleaning is expected to be minimal at about \$0.10 per KW

Present Status

Over 5,000 cubic feet of AC-712 catalyst has been installed in coal burning power plants. Excellent results have been achieved with the current new generation technology. Currently, Applied Catalysts is accepting orders for immediate shipment and installation. The catalyst coated substrates can be made in virtually any cell density that is required. The monolith is supplied in square pieces having a dimension of 5.91 X 5.91 X 3.0 inches. The length of the substrate can be up to 12 inches depending on cell density needed for the application. Applied Catalysts can provide the catalyst in a one cubic foot stainless steel module (See Figure 4 below). Each of the individual substrates or bricks is sealed in the metal module with a specially designed thermally stable insulation. This insulation has exceptionally high temperature and mechanical stability even under the most demanding conditions. Applied Catalysts can manufacture several hundred or several thousand of these modules in approximately 6 - 8 weeks. These catalyst modules can then be shipped to the customer's location where the modules are easily installed in metal frames. Placement in a metal frame allows easy access during downtime intervals for cleaning and maintenance. Each module weighs approximately 40 lbs. so one or two plant operators can easily install the catalysts.

Your Specific Catalyst Requirements

Every system is custom designed to meet your particular needs. To establish your catalyst requirement, we ask you to fill out a brief questionnaire to assist us in designing and recommending the best possible catalyst for your needs. Simply call (888) 243-6228 ext 5 and we will give you the details concerning this form.

Consultation or Order Placement

Call Martin Jenkins in Atlanta, GA at (888) 243-6228 ext. 5 or at (770) 317-7433. Email address is martin.jenkins@appliedcatalysts.com

Note: A more detailed report is available concerning the work that has been done with this technology. Please contact us at the phone number above and we will forward a copy to you.

Figure 4

**Applied Catalysts' Stainless Steel Module and
Substrates Coated with Catalyst**

