TESTIMONY BEFORE THE
U.S. SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

on

Status of Sorbent Injection Mercury Control Technology

Dirksen Senate Office Building

Presented by

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Good morning, Mr. Chairman, I am Dr. Michael Durham, President of ADA Environmental Solutions (ADA-ES). ADA-ES is a company that develops and commercializes novel air pollution control technology for the power industry. We are currently managing a $6.8 million program involving a team of the-nations leading engineers and scientists to scale-up and demonstrate sorbent-based mercury control technology. The Department of Energy National Energy Technology Laboratory (NETL) is providing two thirds of the funding for the program. The remaining funds are provided by co-funding team members including: PG&E National Energy Group, Southern Company, Wisconsin Electric-Wisconsin Gas (WE-WG), EPRI, Ontario Power Generation, FirstEnergy, TVA, and Kennecott Energy Company as well as ADA-ES and other equipment suppliers.

During 2001 we successfully completed two short-term programs that represent the first full-scale demonstrations of sorbent-based mercury control technology in the US power industry. Tests were conducted on both bituminous and subbituminous coals. I have submitted detailed documents describing our program and am presenting results from these two demonstrations. These results provide us with an early indication of both the high potential and limitations of this technology. This morning I will briefly summary results and discuss plans for the continued development of this technology.

I. Summary

Sorbent injection technology represents one of the simplest and most mature approaches to controlling mercury emissions from coal-fired boilers. It involves injecting a solid material such as powdered activated carbon (PAC) into the flue gas. The gas phase mercury in the flue gas contacts the sorbent and attaches to its surface. The sorbent with the mercury attached is then collected by the existing particle control device along with the other solid material, primarily fly ash. This combined material is then either disposed of or beneficially used in building materials.

Two demonstrations were conducted during 2001. The first program was completed in the spring at the Alabama Power E.C. Gaston Station. This unit burns a low-sulfur bituminous coal and uses a COHPAC baghouse to collect the carbon and flyash. The second program was conducted during the fall at the WE-WG Pleasant Prairie Power Plant. This unit burns a subbituminous Powder River Basin (PRB) coal and uses an electrostatic precipitator (ESP) to collect the carbon and flyash.

These programs demonstrated that it is possible to design, build, and operate equipment at a scale capable of treating power plant flue gas. To date, the injection equipment has operated successfully at both sites. The results from the short-term (8 hour) parametric tests from both programs are plotted in Figure 1. We are encouraged by the potential shown by the PAC technology during these two successful demonstrations in that short-term removal levels in excess of 90% were achieved in the case where COHPAC was used. These tests also proved that activated carbon was effective on both forms of mercury, elemental and oxidized. Elemental mercury has been proven to be the most difficult form of mercury to capture. It is the dominant species in PRB coal (83% at Pleasant Prairie) but it is also found in bituminous coals (40% at Gaston).

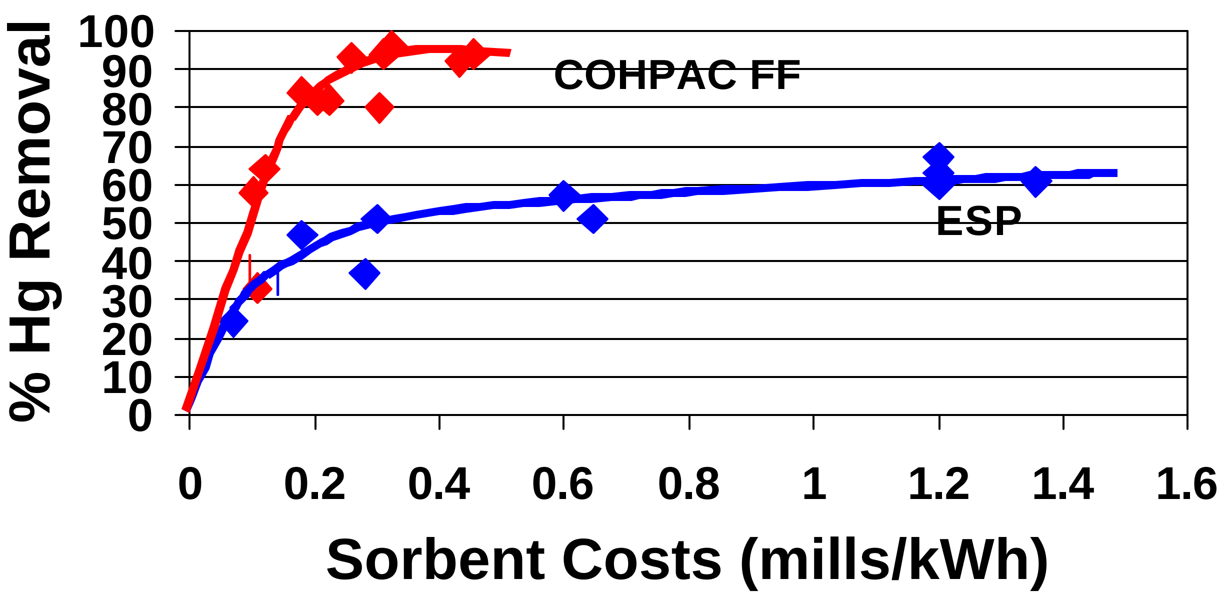

Figure 1. Results of Parametric Tests of Mercury Control by Injecting Powdered Activated Carbon at Two Power Plants

However, these results also documented several limitations of the technology. From the data in Figure 1 it is obvious that the downstream particle control is the dominating factor in determining removal efficiency. While removal levels of 90% were obtained with the fabric filter (baghouse), even with spray cooling the ESP collecting PRB ash was limited to levels of 50-70%. Since only 10% of the plants have baghouses, capital expenditures of $40-50/kW would be required to achieve the higher levels. Operating data obtained at Gaston also showed that PAC injection produced increased pressure drop in the baghouse. This will require that COHPAC baghouses designed for use with PAC will have to be larger to accommodate the increased mass. At Pleasant Prairie, it was discovered that the presence of activated carbon in the ash prevented WE-WG from selling the ash for use in concrete. This represents a significant cost that must be incorporated into the economics of the technology.

It must also be noted that these tests only ran for very short periods of time with the longest continuous runs being two weeks. During the test program, the plants accommodated the needs of the R&D program by operating at full load conditions. This produces more of a steady state condition than is found during their typical load cycling operations. Even with constant load conditions, with variations in coal characteristics, it was not possible to maintain the 90% removal levels over a five-day continuous run, with the average dropping to 80-85%.

II. Background on Sorbent Injection

Sorbent injection technology involves the injection of a dry sorbent, such as activated carbon powder, into the flue gas duct somewhere between the air preheater and the ESP or fabric filter (FF), as shown in Figure 2. This is typically in the 250-350 degree F range. Vapor-phase mercury is adsorbed onto the activated carbon, which is then collected in the ESP or FF. The mercury-activated carbon interaction continues to occur in the ESP or FF. The technology can be used in conjunction with flue gas temperature control, usually accomplished through the injection of water (spay cooling) droplets into the flue gas.

A variation of the configuration shown in Figure 2 using a high air-to-cloth Pulse-Jet Baghouse installed downstream of the existing ESP was developed and patented by EPRI. This configuration, without carbon injection, is called COHPAC. When a sorbent is injected into the baghouse for pollutant control, the process is called TOXECON. This approach focuses on improving the efficiency of sorbent injection by providing high efficiency particulate collection as well as a good "contact" scheme for the sorbent and mercury (e.g. the FF). This technology also minimizes the amount of the fly ash that can be contaminated by the mercury sorbent.

The most commonly studied sorbent for mercury control has been activated carbon. This material has been successfully used as a sorbent in municipal and hazardous waste combustors. Activated carbon is carbon that has been “treated” to produce certain properties such as surface area, pore volume, pore size. Activated carbon can be manufactured from a variety of sources, (e.g. lignite, peat, coal, wood, etc.). More commonly, steam is used for activation, which requires carbonization at high temperatures in an oxygen-lean environment. As some carbon atoms are vaporized, the desired highly porous activated carbon is produced. Commercially, activated carbons are available in a range of particle sizes, as well as other characteristics that are needed for a specific application.

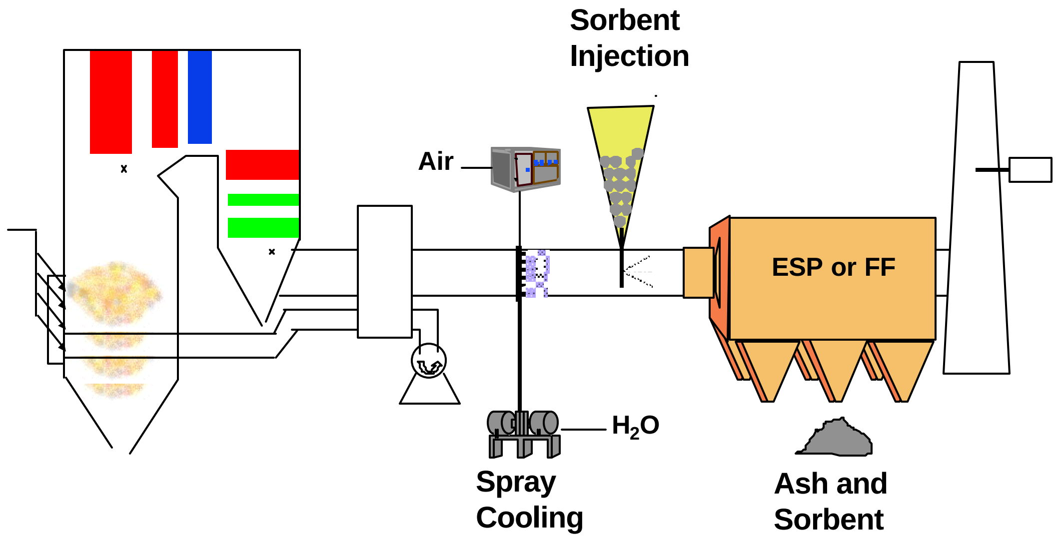

Figure 2. Schematic Diagram of Sorbent Injection Process

Laboratory, pilot scale and modeling programs have indicated that the following parameters can affect the ultimate performance of the technology:

- Particulate control device: ESP vs. fabric filter,
- sorbent type and properties,
- gas-phase mercury species (Hg^o or $HgCl_2$),
- temperature,
- concentration of acid gases (HCl, SO_2, NO, NO_2) in the flue gas, and
- residence time.

The type of particulate control equipment is a key parameter defining both the amount of sorbent that is required and provides the ultimate limitation of the amount of mercury that can be removed. When the sorbent is injected into the flue gas it mixes with the gas and flows downstream. This provides an opportunity for the mercury in the gas to contact the sorbent where it is removed. This is call "in flight" capture. The sorbent is then collected in the particulate control device where there is a second opportunity for sorbent to contact the mercury in the gas.

In an ESP, the carbon is collected on plates that are spaced parallel to the gas flow. Although the residence time in the ESP can be several seconds long, there is a limited amount of contact between the gas and the collected particles because the gas can be as far as four inches from the plates. On the other hand, the fabric filter provides the ideal opportunity for good interaction between the gas and the sorbent as the gas makes intimate contact with the sorbent collected on the filter. Therefore, sites with fabric filters will achieve higher levels of mercury removal and higher levels of sorbent utilization. Unfortunately, only 10% of the coal-fired power plants in the US have fabric filters.

III. Conclusions and Future Plans

The injection of powdered activated carbon offers a promising approach for mercury control for coal-fired boilers. The injection equipment is relatively inexpensive ($2/kW) and can be installed with minimal downtime of the plant. It is effective for both bituminous and subbituminous coals and when interfaced with a fabric filter it is capable of high levels of mercury removal. It is versatile in that it could also be integrated with a wet scrubber to remove elemental mercury that escapes the scrubber.

However, a great deal of additional testing is required to further characterize the capabilities and limitations of this technology. It is important to determine performance on a wider variety of fuels and plant operating configurations. Long-term testing will be necessary to discover if there are any negative impacts of the PAC on downstream components. Impacts such as deposition, fouling of the ESP, corrosion, and shortened bag life often take months to years to be observed or measured.

As with all other air pollution control technologies, sorbent-based mercury control is a developing technology that needs to go through a phased approach as it matures to become accepted as commercially viable. This approach to implementation of new technology has evolved from thirty years of lessons learned by the power industry from applying new technology.

The schedules announced by EPA and Federal and State legislatures to require widespread implementation of mercury control for the coal-fired boiler industry by 2007 represents an extremely challenging schedule. To advance the sorbent injection technology to meet this tight timeframe, we plan to participate in partnerships with DOE and power companies in risk-shared programs such as the Clean Coal Power Initiative (CCPI). The following schedule will allow us accomplish this in a controlled manner that doesn't put generation capacity at risk:

- Short-term full-scale evaluations (2000-2003)
  - Parametric evaluations
  - Multiple sites to evaluate different configurations and fuels
- Long-term full-scale demonstrations (2003-2005)
- First commercial installations at a few early adopters (2005-2007)

In addition, there are two other areas where advancements must be made to assure the ultimate success of this technology. In order to respond to changes in fuel and operating conditions, it is critical to have a reliable continuous measurement of the mercury in the flue gas. This is important from both a process control and a compliance monitoring perspective. The other area involves increasing the production of activated carbon to a level sufficient to supply the power industry. Current capacity of US suppliers is only 10% of what may be required for widespread implementation of the technology.