MERCURY CONTROL WITH FABRIC FILTERS FROM COAL-FIRED BOILERS

Technology Overview

The combined use of fabric filters with sorbent injection systems has been utilized for many years in the municipal incinerator, as well as other industries as a way to enhance the removal of mercury and other pollutants such as dioxins, furans, and a wide range of heavy metals. Fabric filters, also known as baghouses, filter out the particles from the flue gas stream through a tightly woven fabric by sieving and other mechanisms. The dust cake which forms on the filter from the collected particulates can significantly increase particulate and mercury collection efficiency.

With a carbon injection system upstream of the fabric filter, the carbon enriched dust cake on the fabric serves as a fixed bed reactor providing excellent contact between the mercury laden flue gas and the reactive carbon. A fabric filter provides a relatively long residence time of several minutes compared to an electrostatic precipitator (ESP), which may only have 2-3 seconds of only in-flight exposure. This enhanced filter cake provides higher inherent removal of mercury with much lower required sorbent injection rates, thus reducing the overall operation and maintenance (O&M) costs associated with sorbent injection for mercury control.

Types of Fabric Filter Systems Available

There are several types of fabric filters utilized today on electric utility coal-fired boilers including reverse gas (RGFF), pulse jets (PJFF), and combinations of ESP & PJFF (TOXECON™/COHPAC®). The primary difference between the various designs is the mechanism used to clean the dust cake from the filter bags.

All of these fabric filter designs can be utilized for mercury reduction with use of dry sorbents such as activated carbons. Fabric filters can also be utilized upstream of wet flue gas desulfurization (FGD) systems and downstream of dry FGD systems for SO₂ control, particulate reduction, as well as mercury control.

Fabric filter technologies can be located in a multitude of locations, including being used as the primary particulate control device or downstream of an existing or new ESP collector in the TOXECON™ configuration. Some designs place the fabric filter within the ESP casing in the design of a full ESP conversion to a pulse jet fabric filter or even a partial conversion with the last few fields being converted to a high ratio pulse jet in the COHPAC II configuration.

Some basic differences between these various fabric filter technologies are as follows:

Reverse Gas Fabric Filters:

- Used on large coal-fired boilers for over 30 years
- Utilize woven fiberglass filter bags up to 36’ in length
- Designed at conservative air-to-cloth ratios (filtration rates) of 1.5 to 2.0 fpm
- Large real-estate requirements (40 to 50 percent larger than PJFF)
• Highest capital cost of all types of fabric filters (20-30 percent higher installed cost over PJFF)
• Utilizes low pressure, reverse gas type centrifugal fans for fabric cleaning
• Gentle cleaning system provides longest bag life of any other fabric filter system as well as lower O&M costs

Reverse Gas Fabric Filters

Pulse Jet Fabric Filters:

• Current standard for new and retrofit fabric filter systems
• Utilizes synthetic felt fabrics such as PPS or P-84 felt with bag lengths up to 27’ in length
• May provide lower emission levels over reverse gas designs because felt fabrics are inherently more efficient than woven fabrics.
• Higher filtration rates of 3.5 – 4.0 fpm greatly reduces the overall real estate requirements by as much as 40-50 percent and capital cost by 20-30 percent
• More aggressive fabric cleaning system requires use of either compressed air or low pressure blowers
• Higher filtration rates combined with higher cleaning energies may result in reduction in bag life in comparison to reverse gas designs. O&M costs are therefore potentially higher over a 20-30 year life cycle.
Pulse Jet Fabric Filter

COHPAC®/TOXECON™ Technologies:

- EPRI developed, patented and licensed technologies
- Combination of both ESP and pulse jet technologies
- PJFF is installed in series (Downstream) of existing or new ESP as a polishing device to improve overall particulate control (COHPAC®) or to remove mercury, SO₂, or air toxics by sorbent injection (TOXECON™).
- PJFF’s can be retrofitted within an existing ESP casing at standard air-to-cloth ratios or into the last few fields with higher air-to-cloth ratios (COHPAC II).
- With the addition of sorbents, such as activated carbon for mercury control, COHPAC® becomes TOXECON™ with the majority of the fly ash removed in the primary ESP and the activated carbon being injected between the two devices.
- With the majority of fly ash collected in the primary ESP, the pulse jet filtration rates can be significantly increased to 6 fpm.
- As the sorbent/carbon is collected in the fabric filter portion, fly ash sales are not impacted as the majority (>98 percent) of the uncontaminated ash remains in the ESP collector and the remaining carbon enriched ash stream is separated out for separate landfill or pond disposal.
- Higher filtration rates reduce both required real-estate and capital costs.
For existing power plants, this may be one of the lowest cost options for mercury and particulate control enhancement.
All technologies are equally good for mercury reduction with ACI systems with the greatest difference between the various FF technologies being both cost and space requirements.

Commercial Activity

Sorbent injection technologies in combination with fabric filter systems are currently being offered and purchased by the electric utility industry for the control of mercury emissions from coal-fired boilers. Numerous commercial systems have been recently sold, many of which carry mercury reduction guarantees. Testing shows that fabric filters can achieve greater than 90 percent removal.

The first commercial sorbent injection system on a coal-fired boiler is in operation at the WE Energies Presque Isle Station as part of a DOE/NELT Clean Coal Program project using a TOXECON™ type fabric filter system.

The following are tables showing both baseline mercury data with fabric filters (No Sorbent Additives) from past ICR testing results and graph of mercury reduction across a fabric filter system with sorbent injection.
ICR Data Base- Natural Hg Reduction Across Fabric Filters For Various Coals

Mercury Removal Comparisons Between ESP’s and FF’s With Sorbent Injection
For Further Reference:

- Operation and Maintenance of Fabric Collectors, 2002, ICAC F3 Technical Standard
- Types of Fabric Filters, 1991, ICAC F5 Technical Standard
- Baghouse Operation and Maintenance Log for Assessment of Stack Test Results, 1994, ICAC F6 Technical Standard
- Structural Design Criteria for Fabric Filters, 2001, ICAC F8 Technical Standard