Article

Valves in Flue Gas Desulfurization

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One company discovered a valve that withstands the corrosive and abrasive conditions of wet limestone flue gas desulfurization

Power Plant Emissions

Sulfur emissions are one of the most environmentally harmful air emissions from coal fired power plants. Sulfur creates an unpleasant haze in the atmosphere and causes human respiratory problems. It returns to the earth in rain, commonly known as acid rain, which destroys plants in streams and lakes. The water may look clean, but fish die from the lack of a food source.

To combat these environmental problems, power plants worldwide use technology to filter out harmful ash, sulfur, heavy metals and carbon. Significant progress has been made to filter emissions through flue gas desulfurization (FGD). Modern FGD systems help the environment by scrubbing flue gases to create cleaner air emissions. Many companies have implemented FGD systems to negate the harmful effects of emissions from coal fired power plants.

Implementing an FGD System

Dayton Power & Light (DP&L) is leading the way in protecting the environment from sulfur emissions by using a wet limestone flue gas desulfurization (WFGD) process at their Stuart and Killen power stations. The WFGD process went into initial operation in May 2007 at the DP&L Killen Unit 2 plant, an existing, nominal 650-MW (gross output) coal-fired unit located on the Ohio River about two hours east of Cincinnati, Ohio. About 15 miles down the Ohio River, DP&L's Stuart station began operating its fourth WFGD system in late spring 2008.

Construction of the WFGD system at DP&L's Killen Unit

The WFGD process includes a Jet Bubbling Reactor (JBR) where absorption, oxidation, neutralization and crystallization happen at the same time particles are removed. The process typically guarantees 98 percent removal of Sulfur Dioxide (SO2) and consumes less power than standard methods.

The WFGD process works differently than a spray tower (countercurrent system) typically used in power plants. First, cooling sprays reduce the flue gas' saturation temperature. In the JBR, the flue gas contacts the reagent (limestone slurry). The plant's induced draft fans draw the flue gas through the reagent slurry, causing the flue gas to be cleaned within the reagent tank.

In the reagent tank, a continuous layer of bubbling froth on the slurry surface called the "jet bubbling zone" dissolves SO2 and captures multi-pollutants from the flue gas. The clean flue gas bubbles out the reagent tank (hence, "jet bubbling reactor") to the mist eliminator and then out the stack. Users can automatically control pollutant removal by adjusting the liquid level. Although the JBR and spray tower processes are different, there are similar applications in both processes. The common applications are limestone slurry, gypsum slurry, centrifuge isolation, equipment drain lines and flush water systems.

The WFGD process uses an aqueous solution of limestone sprayed countercurrent to the exhausting flue gas, which effectively wet scrubs the majority of harmful sulfur from the air. Sulfur drops into the aqueous limestone slurry mixture. Unfortunately, scrubbing sulfur into the aqueous solution creates sulfuric acid, a corrosive and abrasive solution. Therefore, pumps and valves need to be extremely corrosion and abrasion resistant to be used in the WFGD process and many other similar FGD processes.

Urethane-lined knife gate valve used at DP&L Stuart and Killian power stations

Corrosion-Resistant Valves for FGD Systems

During the early stages of the WFGD installation at DP&L, its consultant, Black & Veatch, sought a tough valve that could handle the corrosive and abrasive limestone slurry in the JBR. During the search, one valve manufacturer explained how a urethane-lined knife gate valve would work in the WFGD process.

First, the replaceable urethane liners in the knife gate valve protect the valve body from the abrasive and corrosive limestone slurry. The liners also protect the perimeter seal from direct abrasive flow. Since the liners are not used for sealing, the liner material remains hard for superior abrasion resistance.

A triple scraper incorporated into the liners cleans the gate and prevents media build-up in the chest area. The triple scraper works during operation so the process does not need to be shut down for routine maintenance. A taper is added to the liner's internal diameter to eliminate the possibility of material collecting at the bottom of the port and preventing proper closure. The taper ensures automatic clean-out and flushing.

Second, the perimeter seal of the valve provides bi-directional, drip-tight shutoff without discharging limestone slurry into the environment. The perimeter seal has shoulders, which mechanically retain (lock) the seal in the seal groove located in the liners. The seal groove is specially designed to prevent seal pull-out but also allows the seal to move and prevent over-compression.

Moreover, the one-piece perimeter and chest seal design eliminates leakage paths because the chest seal wraps around the entire gate. The chest seal also completely encloses injectable packing, which eliminates contamination of the limestone slurry by "loose" packing. Additionally, even at low pressures, shutoff performance is unaffected by differential pressure, and bi-directional shutoff is excellent.

Finally, injectable packing allows easy packing adjustments under line pressure without valve disassembly or removal of the valve from the pipeline. These valve features provide a reduced total cost of ownership, easy maintenance and solution for the conditions present in the WFGD process.

DP&L accepted the proposal and installed 200 ITT Fabri-Valve® urethane-lined knife gate valves in their power plants. The valves have performed well with no maintenance issues. The improvements made at the five DP&L power plants will eliminate 97 percent of SO2 and a large portion of the fine particulate matter and mercury oxide emissions.

Conclusion

Ultimately, projects like this one will advance FGD technology in the utility marketplace and provide flexibility in fuel choices, regulatory compliance, reducing acid rain-causing emissions and a cleaner environment for local communities.