POWER Engineering

Controlling Reheat Temperatures in Texas

By Drew Robb, Contributing Writer

Temperature control is a big deal in Pittsburg, Texas, where summer afternoons average in the mid-90s and frequently top 100. At AEP/SWEPCO's J. Robert Welsh Power Plant, however, the problem didn't lie in the outside temperature, but in controlling the reheat temperature. The pneumatic actuators on the attemperator valves couldn't smoothly control the valves at low levels, slamming back and forth between 10 percent open and fully closed.

"We were having trouble with controlling the valve at near-closed position and were also having trouble with wear and tear on the trim," said AEP/SWEPCO controls engineer Jeff Tucker. "The valves wanted to come off the seat and slam back on the seat and would shake the piping and tear the hangers up, which was a safety issue."

Besides the maintenance issues, the attemperator variability also led to units going off line. When the valve would fail, it would fail closed, causing the reheat line to overheat.

"We have temperature limits we can't exceed," said Welsh I&E Manager Johnny McGatlin. "When the temperature swings get out of control, we have to trip the unit or operate in a reduced manner."

Recently, however, AEP replaced the existing attemperator valves and actuators with Koso valves and Rexa Electraulic (electro-hydraulic) actuators, giving rangeability and control down to 0.5 percent open.

Out of Balance

Welsh is a 1,674 MW coal-fired plant in northeast Texas, midway between Shreveport, La. and Dallas. It consists of three 558 MW units installed in the late 1970s and early 1980s, each with a Babcock and Wilcox boiler and Westinghouse turbine generator. The units normally operate at about 520 MW.

The plant was built with pneumatically operated control valves installed for the superheat and reheat attemperators, but these were not meeting expectations. Over the years, the original valves had been modified to try to eliminate the violent instability and poor flow control resulting in excessive maintenance and temperature variability, which caused inefficiencies in the reheat turbine. Initial attempts to improve operations of these units focused on trim upgrades and/or valve body replacements, but these changes didn't produce the desired results for the plant.

"At low valve positions, such as during start up or low loads, we need to control near the seat and the valve was incapable of doing that," said McGatlin. "The pneumatic actuator would want to go fully closed. It would jump open then slam shut and would not balance at a small distance from the seat, anywhere below 10 percent."

Operators managed to modify the control system as a workaround, setting it so the valve would stay open 10 percent during startups. This eliminated the problem of the valve slamming shut and tripping the unit off line, but at the cost of control and efficiency. There was still the problem of frequent maintenance to address. The valves would need to be serviced every 6 to 8 months, meaning the units would have to operate well below their maximum output. When the reheat valve controls failed, the units had to be brought down below 300 MW to reduce the need for attemperation until the next maintenance opportunity.

Regaining Control

In 2007, Welsh decided to come up with a permanent solution for the attemperator control problem. At Tucker's invitation, Colin Knight, director of sales for Koso America Inc. visited the plant.

"With the old installation the process was extremely unstable," said Knight. "On my first site visit the noise and the physical bouncing around of the valve and pipe was alarming."

Both the valve trim and the unstable pneumatic cylinder needed replacement with equipment that would provide stable, accurate control with low-maintenance requirements. The decision was made to replace the original equipment with a combination of a KosoVeCTor 3" 1500 psi Model 510D valve and a Rexa X2L10K-2-C-E actuator.

VeCTor stands for "Velocity Control Trim" and the valves use a stacked disk design. Each of the metal disks has a series of tortuous flow paths machined into one surface. The disks are then aligned, stacked and vacuum-brazed together for stability. The fluid paths machined in the disk are designed to eliminate the cavitation, erosion, noise and vibration.

The electraulic actuators incorporate hydraulic, electronic and mechanical technologies. These actuators consist of two main components: an hydraulic cylinder with power module and a control enclosure. They do not require an external hydraulic pump or tubing. They operate by moving hydraulic fluid from one side of a double-acting cylinder to another. The design provides precision valve control from 0 to 100 percent open, without overshooting, an inherent weakness for pneumatics because of the use of air, a compressible control medium. The X2L series combines the power module with a linear control cylinder with pressures from 2,000 lb. to 120,000 lb. and strokes from 0.75 inches up to 106 inches.

"With the VeCTor + Rexa installation, the whole process is stabilized, the installation is quiet (relatively speaking) and the temperature control is dramatically improved, particularly at low flow conditions," said Knight. "At low load conditions they can dynamically control steam temperature to within 5 F while their previous best with the original valve was only within 30 F."

Extending Maintenance Periods

The first of the new attemperator control systems was installed on Unit 1 in a 2007 scheduled outage. After the first installation AEP/Welsh purchased two more VeCTor + Rexa combinations for the other units.

"It is the combination of the actuator on the Koso valve that is working for us; you need both for it to work or you are out of control," said McGatlin. "With the actuator, we can position the valve wherever we want, even at 0.5 percent open, while the pneumatic actuators didn't have enough control to hold it in place at 10 percent."

With hydraulics as a control medium, the "bathtub stopper effect" that was seen with pneumatically operated valves was eliminated. Inherent to all pneumatic actuators is a phenomenon called hysteresis or stiction. When the control valve is called to move, the air in the pneumatic actuator compresses prior to exerting enough force to move the diaphragm. The effect from this compression makes the actuator "jump" on initial movement and overshoot past the desired position. When the valve in question is operated close to the seat (<10 percent travel) the result is the hammering open/close of the valve plug/seat. This phenomenon is known as bathtub stopper effect.

In truth, the positioning inefficiencies are equivalent throughout the entire operational range of the valve due to pneumatics, but are most noticeable in this range. The use of electraulic actuators allows plants to operate at lower loads efficiently and without the risk of large dynamic temperature swings.

Upgrading to electraulic actuator technology also greatly reduced the frequency of maintenance. In January 2010, after 25 months of continuous service, the first unit was taken apart during an outage. During that time, the actuator had registered 6,773,000 motor starts (position changes) with 28,000 cumulative full-stroke cycles. That averages out to about a 0.2 percent step change every 9.5 seconds, 24/7 for over two years. It was in excellent condition and required no service. The VeCTor trim showed some signs of erosion and a spare trim was installed to take advantage of the maintenance opportunity.

"To make it to two years is very good and we could have run it for another six months without an issue," said McGatlin. "With the original valves, we had to do maintenance on it every six months."

The next stage, he said, is for the valves to go a full five years without maintenance, so they will only need to be serviced during major scheduled outages. He is working with Koso engineers on achieving that goal. pe