

Severe Service Journal

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BOILER FEEDWATER RECIRCULATION VALVE WITH 5-STAGE CAVITROL® IV TRIM ON A 7800 PSIG PRESSURE DROP

RESULTS

- Trim design withstands high temperature, prevents cavitation, and flashing.
- FIELDVUE® digital valve controller improves valve monitoring and enables Performance Diagnostics.

APPLICATION

Boiler feedwater recirculation service

CUSTOMER

Coal-fired power plant in Colorado

CHALLENGE

In 2007, an EPC in Denver, Colorado faced some challenging process conditions at a new coal-fired power plant under construction. Valves in boiler feedwater recirculation service experienced extreme pressure drops (up to 7800 psi) and temperatures up to 400-degrees F.

To address the applications control and cavitation issues, engineers at Applied Control Equipment, Emerson LBP in Denver, sought assistance from the Engineered Products' team in Marshalltown, Iowa. Together, they custom-designed a pair of forged block-body Fisher® valves for this process and used the field-proven Cavitrol® IV trim.

The Cavitrol IV, five-stage design will handle an 8000 psi continuous pressure drop in normal conditions.

SOLUTION

A properly sized CAV4 valve directs flow through a series of successively larger flow areas, with each causing a reduction in pressure. This "staging" of the overall pressure drop results in more than 90% of the total drop being taken in the early stages preventing cavitation. The later stages ensure low pressure recovery and minimal fluid energy exiting the trim. The pressure staging, together with the separation of shutoff and throttling functions within the CAV4 trim, prevent flow erosion.

The pair of NPS10X10 valves have block-forged bodies and bonnets and an ANSI 3700 intermediate rating (8450 psig and 410-degrees F).

The assemblies include FIELDVUE® DVC6020f digital valve controllers with Performance Diagnostic and FOUNDATION fieldbus capabilities. Fieldbus communication is relatively new to the power industry. The EPC emphasized Performance Diagnostics to ensure the end-user received the best possible control and performance from these valves.



This is one of two identical, block-body Fisher® valves featuring five-stage Cavitrol® IV trim. The 16,000-pound assembly was hydro-tested at 13,000 psig. Its trim was designed to stage the pressure drop, separate shutoff and throttling, and prevent erosion.

REVAMPING VALVES, ADDING FIELDVUE® INSTRUMENTS SAVES A REFINERY AND ITS PSA UNIT \$2M PER YEAR

RESULTS

- Fisher® valves provide tight shutoff, high-cycle life, and diagnostic capabilities.
- PSA unit increases its hydrogen recovery rate by ~20%.

APPLICATION

Pressure Swing Adsorption (PSA) skid for hydrogen purification

CUSTOMER

Refinery in Texas

CHALLENGE

Many industrial processes require high-quality hydrogen as a feed stock. Plants can either produce their own H₂, using steam-reforming or methanol-cracking processes, or they can recover hydrogen from "waste" process streams. This refinery chose the recovery method and uses a Pressure Swing Adsorption (PSA) skid for hydrogen purification. The unit provides uninterrupted vapor processing and purified hydrogen as a fuel for other parts of the refinery.

The PSA process involves the adsorption of impurities from a hydrogen-rich gas onto a fixed bed of adsorbents at high pressure. Switching valves are manipulated in a predetermined sequence, and the plant must be continually tuned to account for changes in feed flow and composition. Impurities are subsequently desorbed at low pressure into an off-gas stream, thereby producing extremely-pure hydrogen at levels up to 99.9% recovery.

The PSA unit is a very abusive process for control valves. The challenge in the PSA skid is not the process but rather the rapid cycling required for the constant production of vapor. Valves and actuators are expected to stroke up to once every three minutes. Depending on the type and size of PSA skid, the number and type of control

valves will vary. In any case, the valve and actuator selected must provide tight shutoff and high-cycle stroking ability.

Due in part to poor valve performance, the PSA skid was recovering only about 65 to 70% hydrogen. Plant maintenance personnel worked with Asset Managers from Puffer-Sweiven (Emerson's Local Business Partner) to identify the unique application requirements for their PSA skid. They used offline diagnostics to analyze the performance of the PSA valves and thereby justified the unit's revamp.

SOLUTION

More than two dozen PSA valves were repaired. About three-dozen others were replaced with new Fisher® high-cycle rotary valves, some with special constructions: Chromium carbide-coated shafts, PEEK bearings, and UHMWPE seals. The assemblies included Field Q actuators and FIELDVUE® DVC6000 AD-tier digital valve controllers. FIELDVUE DVC6000 Series instruments with Advanced Diagnostic (AD-tier) capabilities, in conjunction with ValveLink® Solo software, improve valve monitoring, reduce operating costs, and enable predictive maintenance.

In 2006, Emerson Process Management installed 40 new Fisher valves in the PSA skid. After the revamp, the PSA unit recovered H₂ at a rate of 80 to 84%. In addition, the tail gas compressor was operating with 26% hydrogen compared to the 45 or 50% before the valve revamp. Increased density of the process flow has improved the compressor's performance.

Typically, there is 25 MMSCFD of H₂ in the feed to the PSA. The ~20% improvement in H₂ recovery equates to an additional 3.75 MMSCFD. Figuring \$1500/MMSCFD, this valve project saved about \$5600 USD per day or \$2 Million per year.



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