

Severe Service Journal

A Publication of the Severe Service Team at Fisher Controls

Volume 2 Issue 1

March 2002

RESEARCH PRODUCTS NEWS STEAM CONDITIONING

FISHER REPLACES SUPERHEATER BYPASS VALVES AT AEP

Fisher Controls was recently awarded an order to replace the superheater bypass systems at American Electric Power's Amos 1 & 2 generating stations. Both units are 800 MW supercritical once-through boiler designs.

The superheater bypass system is designed to handle 1.4 million pounds per hour of fluid ranging from cold water to superheated steam. The existing bypass system utilized six valves, two for initial cold water circulation and four valves for the later stages of startup to handle steam flow. Because of a lack of cavitation protection, the valves were noisy, required some manner of maintenance during each outage and delayed startup on numerous occasions.

During initial startup, high pressure (3000 psig) water is routed through the valves to the flash tank, which is under minimal pressure. During this mode of operation, the formation of damaging cavitation is possible. Cavitation, the formation and subsequent collapse of vapor in liquid fluids, is a major source of valve damage and vibration.

As the unit continues to ramp, the fluid temperature and flash tank pressure increase causing the fluid to flash rather than cavitate. This creates concerns about erosion caused by the high velocity steam carrying entrained water droplets past the metal trim components of the valve.

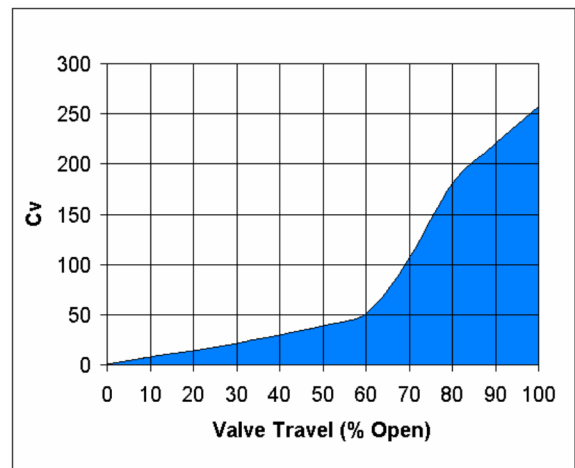
As the fluid temperature continues to rise, the fluid will turn to steam creating the need for noise attenuation. At this point, the bypass system begins to shut down to transfer to once-through operation. After this occurs, the valves are set to act as relief valves dumping the entire steam load to the flash tank during a unit trip to prevent the safety valves from lifting.

As part of the units' selective catalytic reduction (SCR) upgrade, modernization of the superheater bypass system was explored. Based on previous experiences at other AEP units, the plant explored the possibility of replacing the six-valve system with a two-valve arrangement. This solution provides better control during startup, quicker startup times and reduced maintenance costs.

The solution consisted of 6" Special Class 2987 Rated EHDs with characterized Cavitrol III/3-stage trim designed specifically for the application. Cavitrol is designed to eliminate damaging cavitation by staging

the pressure drop ensuring that the pressure never drops below the vapor pressure. Characterizing the trim allows the valves to handle the initial startup conditions where cavitation concerns arise. The trim is also designed to eliminate erosion to the valve seat and plug by utilizing a lower metal piston ring around the plug. This virtually eliminates all clearance flow between the plug and cage, which is a common source of control valve plug and seat erosion. The cavitation protection then eventually gives way to less staging as the downstream pressure increases and more flow is required.

Proper characterization is a necessity to account for the given phase changes. The Cavitrol trim eliminates damaging cavitation during initial startup and provides protection against flashing damage by reducing the available energy at the outlet of the trim. The staged pressure drop also helps to reduce the velocity of the steam thus reducing the associated valve noise. Figure 1 shows the valve characteristic curve.



The Cavitation protection on the low end of the valve travel provides tight controllability during initial valve startup. As the temperature and unit load begin to rise, the trim transitions to a more open passages that meet the mass flow requirements.



Figure 1: Cv vs. Travel Curve

Superheater bypass valves can have a huge impact on the bottom line of a power plant. Older valve designs do not address the severe nature of the service in terms of cavitation and noise protection. Another concern is valve shutoff. Leaking valves in this service can cost a plant between 1 – 15 MW. Fisher's experience in these applications show that replacing the superheater bypass valves can yield plant savings of \$250K or more.

HYDRODOME SOLVES CAVITATION PROBLEM AT PLANTATION PIPE LINE COMPANY

Plantation Pipe Line was recently experiencing problems with a rotary control valve at one of their mainline take-off delivery terminals. The valve and downstream piping and equipment were being battered by cavitation and vibration. This created concern in terms of potential damage to the control valve, damage to downstream equipment and the possibility of a significant gasoline release.

To solve the problem, the damaging cavitation had to be eliminated. For ball valve applications where cavitation and noise are a concern, Fisher developed the V260 Hydrodome (Figure 2). This device uses a series of drilled holes to break up the fluid and stage the pressure drop in order to eliminate damaging cavitation and associated vibration.

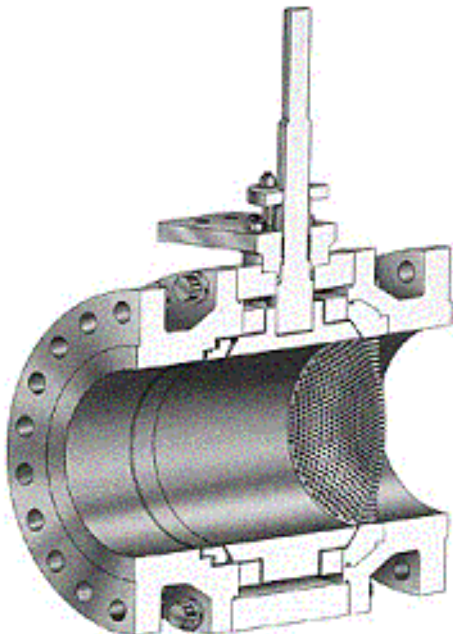


Figure 2: Cross Section of V260 with Hydrodome

Fisher worked with Plantation personnel and in a two days shipped a Hydrodome to the site. Once the Hydrodome was received, the local Fisher Service Company technicians removed the existing valve body, performed the minor machining to accept the new part and delivered the valve back to the site the same day.

Once the valve with Hydrodome was installed, the cavitation and vibration problems were eliminated. Because of this solution, another Fisher V260 control valve in parallel is being retrofitted with the Hydrodome solution to ensure that the same problem does not occur again.

SOLUTION ADDRESSES LOW LIFT VALVE NOISE AT GAS TRANSMISSION STATION

During evenings and weekends, the required gas supply in many gas transmission stations drops substantially from normal operation. Controllability in control valves can be drastically affected at these conditions, as the valves are required to throttle below their minimum controlling point. Excessive valve noise is another common issue experienced at these operating positions. Both of these issues have plagued the gas transmission industry for years. The following example discusses the problems noted above and a new solution available to address both control and noise related issues with gas transmission valves.

One 16" valve and three 12" valves were installed at a gas distribution station in Mons, Belgium. After less than one month of operation, the owner began to receive complaints about excessive noise emitting from the station during the evenings.

In order to address the cause of the noise, it was necessary to determine at what point in the valve travel the noise was occurring. A spectrum noise analyzer found that the valve experienced a strong peak of 780 Hz at less than 10 percent travel. At this point, the valve was generating 117 dBA of noise as measured at a point one meter away.

Two situations were identified as potential causes of the noise. One is related to pressure imbalances that can occur on the top and bottom of a standard,

balanced valve plug. The varying forces cause the valve plug to move into the area of lowest pressure creating an axial, or up and down motion. Due to pulsations in the flow stream, this motion can create a loud harmonic oscillation and drastically affect controllability because of plug instability.

Another suspected cause for the noise was clearance flow vibration. Clearance flow vibration occurs at low valve travels as flow past the valve plug and cage wall exerts a radial, or side-to-side force on the valve plug causing it to move like a clapper on a bell. As expected, this can generate a large amount of noise.

Once the valves were torn down, the cause of the problem was realized immediately. As can be seen in Figure 3, the radial forces acting on the valve plug were great enough to leave an impression of the cage on the lower portion of the valve plug. The noise caused by the plug vibration was the source of the complaints received by the owner. _



Figure 3: Cage Impression on Valve Plug due to Radial Plug Vibration

To eliminate any possible issues with controllability due to axial motion at low valve lifts, Fisher developed the anti-vibration spoked valve plug. This design reacts to transient pressure changes and pulsations in the fluid better than standard balanced constructions by changing the natural frequency of the plug assembly. Now, any pressure changes that occur in the fluid are quickly registered from the bottom side of the plug to the top side due to less restriction thus equalizing the forces.

To address the radial forces acting on the valve plug and the subsequent noise generated, a lower metal piston ring is installed into a machined groove at the lower end of the valve plug. This ring effectively blocks any flow that can move between the plug and cage and eliminates any associated vibration. By controlling the clearance flow, the overall turndown of the valve can also be increased to levels greater than 150:1.

After the new plug was installed into the valves, the measured noise was 74 dBA at ten percent travel and less. Once this issue was solved, several more units were purchased for other sites.

Numerous other gas companies have since used this solution to provide better control and to address noise at low valve travels. Coupling this solution with an open noise prediction standard such as IEC 60534-8-3 can assure the end user that the solution they are receiving will meet their requirements and not create additional problems after installation.