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TURBINE BYPASS NOISE RELATED ISSUES WITH AIR COOLED CONDENSERS

As new combined cycle power plants continue to sprout up around the country, noise related issues with the turbine bypass system are becoming more and more common. This mainly occurs in applications that dump directly to the condenser. In most new constructions, these are the LP and HRH (Hot Reheat) applications.

Many of the initial combined cycle plants utilized water cooled condensers. Noise becomes a major concern as the condenser wall is typically constructed of thin materials compared to that of the turbine bypass valves. For the majority of the applications, the noise is addressed using noise attenuating trim in the turbine bypass valve and a downstream sparger or diffuser inserted into the condenser.

Because of the increased construction of power plants, the availability for cooling water is decreasing. To combat this, air cooled condensers are being used more often. However, with this technology comes a few more concerns.

Figure 1 shows a turbine bypass valve in an air cooled condenser arrangement. The steam is dumped into a main steam duct that then distributes the steam over the forced draft fans. This steam duct is a very large thin wall (typically ½") piece of pipe. Because of this a large amount of noise will be transmitted through the pipe wall into the external environment causing high vibration and subsequent noise.

To eliminate the noise, the turbine bypass valve must be used in combination again with the downstream sparger. Because the use of air cooled condensers is fairly new to the combined cycle market, the need for spargers was overlooked on many initial designs. Recent experiences have shown that the noise generated in these thin-walled ducts is great enough to cause a plant not to meet noise guarantees.

A properly sized turbine bypass valve used with air cooled condensers must take into account a number of factors. The first is the noise generated by the control valve itself. Noise is generated as the majority of the system pressure drop is taken inside of the control valve.

The next noise formation mechanism that must be accounted for is the sparger. A small pressure drop occurs at this point, but the noise must be tightly controlled as the flow dumps into the condenser duct.

Finally, as multiple turbine bypass valves are used in the majority of the most recent power plant designs, the noise from each separate valve and sparger combination must be taken into account.

Fisher has been conducting numerous tests in our Marshalltown flow lab focusing on noise and air cooled condensers. Since only a small amount of area can be inserted into the condenser duct, research focusing on sparger outlet jet interaction has been conducted. Additional testing includes the effect of the outlet steam impinging on the condenser duct wall and how the noise radiates through the entire radial area of the condenser duct.

Additional research is planned for the upcoming winter months focusing on detailed noise prediction that combines both valve and sparger noise. This will also include the impact of the outlet steam on the condenser duct itself. Look for additional information in an upcoming edition of the Severe Service Journal.

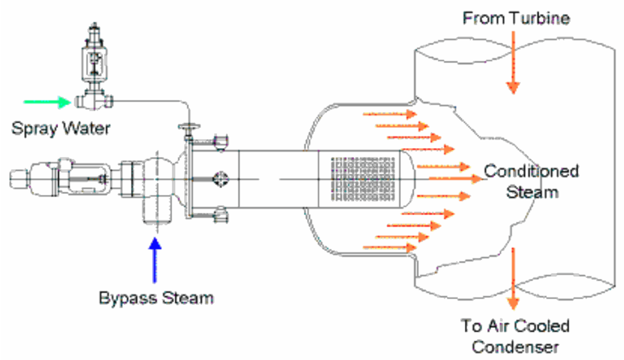

Figure 1: Air Cooled Condenser Arrangement

FREQUENCY SHIFTING: ARE THERE PROBLEMS?

A recent number of inquiries have been received in the Marshalltown Severe Service Group pertaining to control valve noise spectrums. This has been focused on gas transmission applications experiencing interference problems with their flow measurement devices, namely ultrasonic flow meters. Research into the matter has found that the ultrasonic flow meters being used are operating at the same frequencies being emitted by the control valve noise abatement trim.

Why does this happen? The majority of noise abatement trims work using many of the same principles. One of these
principles is to shift the noise being emitted by a valve trim into a range that is inaudible to human beings. This is accomplished by using many tiny holes as in the Whisper III trim offerings. This results in three major benefits: greater noise transmission loss, noise peak shifted out of audible range, and lower fatigue stress in the pipe. Keep in mind that smaller holes create smaller jet diameters, which shift the peak frequency higher resulting in higher transmission losses.

The only problem with this fundamental is that the peak frequency can get so high as to interfere with the ultrasonic flow measurement device. And product flow that can not be measured is flow not making money.

So what is the solution? Unfortunately, there is no quick and easy answer to this question. The best approach is to examine the system up front. Before any items are purchased, a peak frequency and noise spectrum can be created utilizing existing process data. Fisher has the ability to create the “haystack” of noise spectrums using both sound power and sound pressure levels.

Based off of these calculations, an ultrasonic flow meter that operates in a range that will not be impacted by the valve noise emissions can be selected. By examining the system up front, it may be possible to install the ultrasonic flow meter upstream of the control valve. This will ensure that the high frequencies emitted by the noise abatement trim will not interfere with the ultrasonic flow meter.

If a system is currently in place and having problems, these same calculations can still be made. Results however, may show the need for a noise abatement trim that controls valve noise by a different method or an ultrasonic meter that operates in another range.

Shifting frequencies higher has many benefits that far outweigh the downsides such as interference with ultrasonic flow meters. This fundamental works well when employed in today’s noise abatement trims and will continue to be a tool to fight valve noise. This just emphasizes why it is important to look at the entire system prior to selecting a control valve for a given application.

DST IN WATER INJECTION APPLICATION STILL GOING

In 1997, Fisher won an order for several water injection recycle valves at an oil production facility. These valves are used to recycle produced water to be injected into the ground around the pumping system.

In many cases, the water carries entrained particulate such as sand, residual hydrocarbons and numerous inorganic species. Couple this with inlet pressures that approach 4500 psig in many applications, it becomes difficult to address the application properly.
Because of the entrained particulate conventional drilled hole or stacked disk anti-cavitation trims are susceptible to plugging in a short amount of time. With this in mind, Dirty Service Trim (DST) was used for this application to address flowing particulate, erosion and cavitation.

Figure 2 shows the trim after it was removed recently for the first time since the 1997 installation. The trim has a large amount of buildup, but still was able to pass the required amount of flow during operation.

Figure 2: DST Trim After Four Years of Service

The trim set was inspected for any damage to the internal components with none being found. The trim was then cleaned and prepared for reinstallation in the valve bodies. Figure 3 shows the same valve trim after cleaning.

Figure 3: DST Trim Prior to Reinstallation

The DST solution has proven itself many times over in this application. Many vendors will claim to be able to address the problem using stacked disk anti-cavitation trims. Looking at Figure 2, it’s very doubtful this will occur.