KOSO HAMMEL DAHL

Technical Memo

Date: October 20, 2008

Re: Coal, Oil and Gas Power Plants – Severe Service Applications

Today's power plants require valves that can withstand significant pressure drops, high velocity in flow, and a range of high temperatures. The significant pressure drops and high velocity can result in erosion/cavitation that will damage most conventional trim designs. The Koso Hammel Dahl VeCTor™ trim is a radial flow multi-stage stacked disk trim designed with constant area ratios that provide a torturous path controlled pressure drop at each stage. Use of this design totally precludes the high velocity in compressible flow that creates noise or the critical pressure drops in liquid flow that creates cavitation. This product is offered as a linear, modified linear and modified equal percent flow characteristics. The disk stack is available in 316 SS, 410 SS and INCONEL®.

If the pressure drop or velocity is not as severe, or if there is flashing and erosion on the valve and trim, intolerable noise and vibration that is potentially destructive, the Flash-Flo® trim is the solution. The Flash-Flo® trim consists of a drilled hole cage with holes on opposing sides in order to break down the flow stream into smaller flow streams. These smaller flow steams are at high velocity and by impinging with each other, the energy is dissipated and the effects of cavitation are then minimized. This product is offered with both linear and equal percent flow characteristics.

As an alternative, the Q-Cage™ and Q-Cage™ Level 2 trims also an option. The Q-Cage™ trim is available with any flow characteristics. The Q-Cage™ trim is a drill hole cage design that utilized both the energy shift and mutual interference methods in compressible services for optimal noise reduction. This design can reduce noise generated by up to 20 dBA. In liquid (usually water) applications, it further limits the energy in each flow passage and also slightly reduces the valve pressure recovery, thereby further reducing the effects of cavitation damage. The Q-Cage™ Level 2 trim incorporates the Q-Cage™ trim with a modified plug skirt that allows up to another 10 dBA noise reduction by adding another pressure reducing stage to the trim. In this way, the Q-Cage™ Level 2 trim can handle higher energy levels, while providing lower noise generation and eliminating cavitation. Unlike other multi stage drilled hole trim, the KHD design is the only one where both stages are active, that is, the flow area of both stages varies with plug stroke. All other designs have only one active stage, the balance being static flow passages that are relatively useless at under 50% of valve capacity. For applications where the standard Q-Cage™ Level 2 trim in not adequate, KHD engineering can alter the trim in order to improve its effectiveness by customizing the area relationship between the first and second stage. By doing so, the pressure drop at the last stage is reduced, which is almost always the most crucial. This reduces the last stage flow velocity (recall that noise is proportional to velocity) in incompressible services and the critical pressure drop (where cavitation begins) in compressible service. This product is available with any flow characteristics.

These products are offered standard in a globe style valves ranging from 1 ½" to 16", ANSI class 150-2500 and angle style valves ranging from 1 ½" to 8 ", ANSI 150-2500. KHD valves are available in ASTM A216 gr WCB (Carbon Steel), A217 gr C5 (Chrome-Moly Steel) and A351 gr CF8M (316 Stainless Steel). Other materials including Monel©, Hastelloy© C and Alloy 20 are available upon request.

Below is a listing of the particular systems and the related valves that function within these systems and the KHD solutions.

The Condensate System

In a power plant there typically is a condensate system. The purpose of this system is to cool off the steam that has passed through the turbine in order to have it condensate and create a vacuum to increase the efficiency of the turbine. In doing so, the condensation is collected in a hot well and is pumped to the deaerator and also back into the condenser via two valves.

Condensate Recirculation Valve

The Condensate Recirculation Valve is an on-off valve that recycles the condensated water back to the condenser when needed. Because the pressure typically ranges between 300 psi and 600 psi and temperature from 100º to 150ºF, Koso Hammel Dahl recommends using a G110 series valve with VeCTor™ trim.

Deaerator Level Control Valve

The Deaerator Level Control Valve maintains a controlled flow level to the deaerator. Due to the fact that this valve is used throughout the process, from start-up thru operation, it sees a wide range of flows and temperatures. During start-up, there is a significant pressure drop that can cause cavitation that will damage most conventional trim design. For these cases, a high pressure valve such as a KHD V510 or V520 series valve with VeCTor™ trim is a perfect option.

The Feedwater System

A boiler feedwater system begins at the outlet of the deaerator and goes to the inlet of the boiler. The main purpose of this system is to provide feedwater to the boiler.

Boiler Feedwater Recirculation Valve

Boiler Feedwater Recirculation Valve is the valve that sees the most severe service conditions. This valve needs to be capable of taking extremely high pressure drops while reducing cavitation that would occur in most conventional trim designs due to flow velocity. The maximum pressure can be from 3,100- 5,500 psi with extreme pressure drops with result in cavitation or flashing. The Koso Hammel Dahl V510 or V520 series valve with VeCTor™ trim with a Class VI shutoff is ideal for this application. With the many turns within the path, the pressure is gradually dropped and the velocity is gradually reduced eliminating cavitation.

Boiler Feedwater Startup Valve

Boiler Feedwater Startup Valve can at times have the same severe pressure drops as those of the Boiler Feedwater Recirculation Valve. The difference between these valves is that the Boiler Feedwater Startup Valve does not see the high flow rates that the Boiler Feedwater Recirculation Valve does and does not require the same degree of cavitation protection. In these cases a V510 or V520 series valve with Q-Cage™ Level 2 trim or VeCTor™ trim with a Class VI shutoff can be used.

Boiler Feedwater Regulator Valve

Boiler Feedwater Regulator Valve is used to control the flow from the boiler feedwater pump to the heaters and boiler. During start up, as with the Boiler Feedwater Startup Valve, it haves the same severe pressure drops as the Boiler Feedwater Recirculation Valve but with reduced flows. Depending on the flow conditions, the VeCTor™ trim or the Q-Cage™ Level 2 trim with a Class VI shutoff are optimal solutions.

The boiler feedwater used in power plants is usually chemically treated to eliminate oxygen from the hot water which is potentially corrosive. These chemicals, however, make the use of alloy 6 on trim a problem as it will damage this metal. Koso Hammel Dahl offers 400 series stainless steel as our standard trim material eliminating the problem.

The Main Steam System

The Main Steam System consists from the boiler outlet through the turbine to the condenser of a power plant. This includes the steam superheater and the steam reheater.

Turbine Bypass Valve

Turbine Bypass Valve is used for quick startup, emergency conditions as well as for turbine maintenance. Depending on its location in the line, it could see high pressure drop to very low pressure drops. These valves are typically described as High Pressure Turbine Bypass valves and Low Pressure Turbine Bypass valves.

High Pressure Turbine Bypass Valve

The High Pressure Turbine Bypass Valve provides a pathway for high pressure and temperature steam from the inlet of the high pressure turbine to the steam reheater. This valve typically sees pressures from 2,800 psi to 4,500 psi with pressure drops from 2,600 to 4,500 psi. A V510 or V520 series valve with a VeCTor™ trim consisting of a high number of stages and tight shutoff should be used.

Low Pressure Turbine Bypass Valve

The Low Pressure Turbine Bypass Valve provides a pathway around the low pressure turbine and maintains the pressure and temperature when the high pressure bypass system is operational. This valve typically sees pressures of approximately 500 psi with pressure drops of 300 psi. A G110 or V510 series valve with a VeCTor™ trim consisting of a high number of stages and tight shutoff should be used.

Sootblower Valve

Sootblower Valve is used to control the sootblower header pressure. As the sootblower opens and closes, the flow varies considerably and as a result, a valve with high rangeability is necessary. In order to avoid shutting down the sootblower, a tight shutoff valve is required. The valve is usually run flow-to-close to avoid debris from damaging the seat. A 4500 lb rated valve with a VeCTor™ trim consisting of a high number of stages and tight shutoff is recommended.

Division Control Valve

Division Control Valve (also known as 501 Valve) handles the steam flow to load the turbine from the superheater. This valve can see over 2,000 psi inlet pressure and full pressure drop. For this application, Koso Hammel Dahl recommends a V510 or V520 series valve with a VeCTor™ trim consisting of a high number of stages.

Drum Pressure Control Valve

Drum Pressure Control Valve (also known as 502 Valve) handles steam bypass to the condenser, usually at startup. It is particularly important in plants that are not used for base load and therefore must be re-started often. The conditions vary from 2,000 psi water at 300ºF to 2,000 psi saturated steam at 650ºF. The pressure drop is very high as the downstream pressure is at vacuum and noise and vibration fatigue are the fundamental problem. The use of a V510 series valve with VeCTor™ trim consisting of a high number of stages and tight shutoff is the ideal solution.

The Heater Drain System

The Heater Drain System consists for two subsystems of heaters – the Low Pressure Heater system and the High Pressure system. In the Low Pressure Heater system, condensate from the condensate pump is heated by exhaust steam from the low pressure turbine is heated and returned to the deaerator. In the High Pressure Heater system, feedwater from the boiler feedwater pump is by extraction steam from the reheat section and returned to the boiler. At the higher pressure conditions, the feedwater is close to saturation.

Low pressure heater drain valve

Low pressure heater drain valve is used in the Low Pressure Heater. A G110 series valve with Q-Cage™ Level 2 trim is recommended. The body material should be Chrome-Moly (WC9) for greater protection against erosion due to flashing.

High pressure heater drain valve

High pressure heater drain valve is used in the High Pressure Heater. Given the high pressure that this system can have, a V510 or V520 series valve with Q-Cage™ Level 2 trim is recommended. The body material should be Chrome-Moly (WC9) for greater protection against erosion due to flashing.

Scrubber Slurry Handler and Ash Handling System

The Scrubber Slurry Handler System is used to remove sulfur dioxide and ash from the boiler. There are two methods of removing the sulfur dioxide gases and ash from the boilers, wet scrubbing and dry scrubbing. Depending on the process used, a sludge or slurry is produced that needs to be removed from the plant. In both cases, the content is erosive and corrosive.

The Ash Handling Valve is used to control the flow of the slurry or sludge being released into settling ponds. The typical flow is at approximately 150-300 GPM with a very low pressure drop of approximately 50 psi. The Koso Hammel Dahl V701 series valve is specifically designed to handle difficult services involving erosive fluids and slurries by using a venturi seat ring along with a streamlined body.