KOSO HAMMEL DAHL

Severe Service Products for Noise, Cavitation, Erosion, Corrosion Control Products and Other Severe Service Applications

Manufactured by KOSO HAMMEL DAHL in the USA

NOISE

GENERAL THEORY

Noise is unwanted sound that propagates through air and is characterized by amplitude, frequency and duration. We hear sound energy over a narrow frequency band from 60 Hz to 20k Hz, but the ear is most sensitive to sound in the 500 to 5000 Hz range.

Sound is measured in decibels or dB which is a log function. As a result, it takes a doubling of energy to provide a 3 dB increase in sound pressure level, and it takes an increase of 6 dB to make a perceptual difference to an observer. The A weighting filter network, designated as dBA, has been designed to approximate the frequency distribution of a healthy young human and is normally used as an overall indicator of noise amplitude. *See Figure 1, Reference 1.* OSHA laws indicate that a sound level, using the A weighted network, of 85 to 90 dBA is considered hazardous to human hearing when exposed to over the duration of a typical workday.

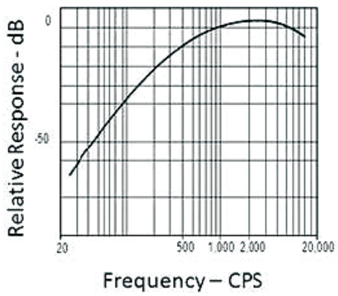

Figure1, Ref. 1 - A weighting filter network

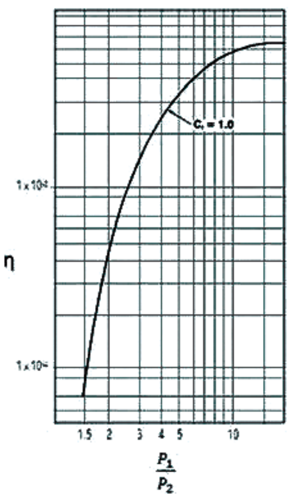

Figure 2, Ref. 2 - Acoustical Efficiency

In control valves, aerodynamic noise is a function of the energy conversion in the throttling process. This can be approximated by the difference in potential energy between the inlet and outlet of the valve. This function, usually denoted by the Greek letter (eta, η), is called the acoustical efficiency function. It is simply the fraction of the energy lost in the system that is converted to noise. This function is highly dependent on the fluid velocity, and for subsonic flow, is proportional to the flow velocity to the 8th power. For control valves, flow velocity is directly related to the valve pressure ratio P_1/P_2. At this point, the acoustical efficiency is about 0.1%, meaning that 0.1% of the energy lost to heat, vibration, etc. during the throttling process is actually converted to noise. Above the choked pressure ratio, the acoustical efficiency remains almost constant, since the flow is already choked (i.e., sonic). *See Figure 2, Reference 2.*

APPLICATIONS AND SOLUTIONS

NOISE CONTROL - COMPRESSIBLE FLUIDS

There are three generally accepted methods used to deal with valve noise. They are explained below:

- Reducing the flow velocity.
- Increasing the dominant frequency of the generated noise.
- Increasing the path noise reduction, commonly called transmission loss.

Often one or more of these methods are used together to provide the level of noise control required. Note that, of those listed, only the first method actually reduces the amount of noise generated, the latter two methods just reduce the noise observed outside the system. A brief explanation of each follows:

Flow velocity: This method seeks to minimize the noise created in the throttling process by providing low velocity through the trim, gradually reducing pressure so that high flow velocities are not developed. Since the efficiency of conversion of energy (η) is directly related to flow velocity to the eighth power, by keeping the flow velocity as far below sonic as possible, the efficiency of the transfer of flow energy to noise is minimized. *See Figure 2.* At Koso Hammel Dahl, this is done using multi staging, either with drilled cages (Flash Flo®, Q-Cage™ and Q-Cage™ Level 2 trim) or a stack of disks (VeCTor™ trim), machined to provide tortuous flow passages within the disks. These tortuous paths reduce the energy gradually so that high velocities, and therefore its related noise, are never attained. *See Figure 3.* Note that the small size of the fluid openings also shifts the sound energy to higher frequencies as discussed below. *See Reference 2.*

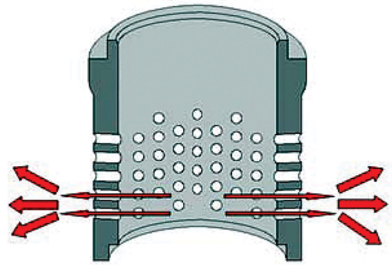

Figure 3 - Multi-path trim, noise reduction

Increasing the dominant frequency: Noise is created with a peak frequency that is determined by the size of the flow passages, given by the term **Fp=SV/D**. Here the Fp is the peak frequency, S is the Strouhal number, V is the fluid velocity and D is the characteristic diameter of the flow passage. Since the sound energy drops off rapidly on either side of the peak frequency, the goal here is to push the sound energy to a point in the frequency distribution where it is above both the human sensitivity and the A weighted spectrum. In addition, noise in the high frequency ranges is quickly attenuated in air, piping and within the turbulence of the valve itself. The engineers at KHD use this method for both the stacked disk method and the drilled hole cage method. In addition, for the drilled hole cages, the engineers at KHD have also used the relationship between the holes to provide interference between the flow streams to further reduce the noise generated. *See Reference 3.*

Path noise reduction: Noise can be reduced by increasing the resistance to the re-transmission of the noise to the surrounding environment, called pipe transmission loss. This can be achieved by:

- Adding thermal insulation to the piping. Thermal insulation, if installed correctly, will usually also substantially reduce noise emission, especially at high frequencies.
- Increasing wall thickness. Noise will be reduced by the transmission through thicker and denser materials.
- Larger piping systems. The larger the piping system, the lower the modal frequency, the higher the transmission loss, especially if high frequency noise is generated as you would find in drilled cages or disk stack trim designs. *See Reference 4.*

Other considerations: There are other factors that must be considered or the gains made in the trim design can be lost. These are as follows:

- **Flow direction:** KHD low noise solutions for compressible service almost always are used in the flow-to-open mode. In this way, the design is compatible with the normally expanding area in the trim within the valve body. This has the effect of preventing secondary generated noise.
- **Valve outlet velocity:** All low noise applications require great care in sizing the valve to prevent regenerated noise at the valve outlet. This can be caused by high exit velocities if the valve body is too small. In general, for low noise applications, the outlet velocity should not exceed 0.33 Mach. Most sizing calculation systems will

make notations if this velocity is excessive. However, the min pipe size can be determined from the formula.

- **Static downstream devices:** It is also possible to shift the high pressure ratio (i.e., critical or sonic) to a static downstream device. In this application, a multi-stage device is mounted at the terminal end of the pipe, sometimes connected to a silencer. For applications where the flow rate is relatively constant, such as atmospheric dump, this method can reduce the cost of noise compliance substantially by allowing the use of a smaller valve and downstream piping as well as reducing the noise control required from the valve trim.

English Units

steam

$$D = 0.119\sqrt{\frac{W(1-0.0007T_{sh})}{P_2}}$$

gas

$$D = 0.0054\sqrt{\frac{Q\sqrt{GT}}{P_2}}$$

where D is the nominal pipe size (in/mm)
W is the flow rate (lb/hr)
T_{sh} is the steam superheat (°F)
P_2 is the downstream pressure (psia)
G is the specific gravity
Q is the gas flow rate (SCFH)

CAVITATION

GENERAL THEORY

Cavitation is caused by the fluid pressure dropping below the fluid vapor pressure, followed by a return of the fluid pressure above the fluid vapor pressure. For example, upstream of the valve, the fluid pressure, and therefore the potential energy, is high. As the fluid travels through the valve, the velocity increases and the pressure decreases in accordance with Bernoulli's law. If the pressure drops below the fluid vapor pressure, vapor bubbles form in the fluid. This is called flashing, and can be erosive in nature and must be dealt with. However, as the fluid slows downstream of the valve seat, the pressure will rebound, sometimes only slightly depending on the design of the valve. If this fluid pressure rebounds to a point above the vapor pressure, then the vapor bubbles formed will collapse, actually implode. This implosion will create very high local loads on any metal surfaces near the implosion. *See Figure 4.* These forces applied to the metal surfaces are so great that they will very quickly destroy the valve.

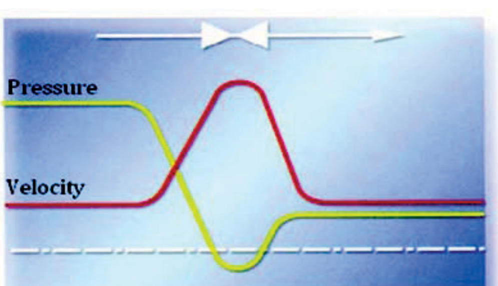

Figure 4 - Cavitating Service

Although noise from cavitating applications can be estimated, they are actually of no importance. A cavitating valve must be dealt with to eliminate the source of the cavitation by design to avoid damage to the valve.

APPLICATIONS AND SOLUTIONS

CAVITATION CONTROL

Cavitation control can take any or all of the three forms noted below:

Energy dissipation: In this method, the flow is directed toward the center of the valve trim, where cavitation energy is dissipated on the fluid itself. Because of the potential for damage, this method is only applicable to very low energy levels. Examples of this method include using standard trim with the flow over the plug or using a valve style with low pressure recovery (high coefficient such as a globe valve instead of a ball or butterfly valve).

Energy limiting: This method, always used in conjunction with the "energy dissipation" method noted above, uses small flow passages to limit the cavitation energy in each flow passage. This method can be used in somewhat higher energy systems as that noted above, but is still limited in use. Examples of this method would include Flash-Flo™ trim, which both operates flow over and reduces the energy in the flow stream. In addition, the Q-Cage™ trim, using a drilled hole cage trim, running flow over, further limits the energy in the flow stream

Multi-staging: In this method, the pressure is gradually reduced into multiple discrete pressure drops or stages to limit the flow velocity in the trim, so that the fluid pressure never falls below the vapor pressure. In this manner, the vapor bubbles are not generated in the flow stream, which eliminates the trim destruction resulting from the implosions caused by cavitation. Examples of this method include the Q-Cage™ Level 2 trims, which combine the energy limiting feature and the multi-staging feature, although to only two active stages. For more severe applications, the disk stack method (VeCTor™ trim) can provide any number of stages to solve the most difficult applications, combining the energy limiting feature and any number of stages as required. Note that, on any multi-stage trim, the last stage is the most critical, since the vapor pressure will be closest to the fluid pressure at that point. It is important to use a well designed trim even with multi-staging to prevent cavitation damage. These methods will usually be operated flow over just to ensure that no damage occurs at the valve body walls. *See Figure 5 and 6.*

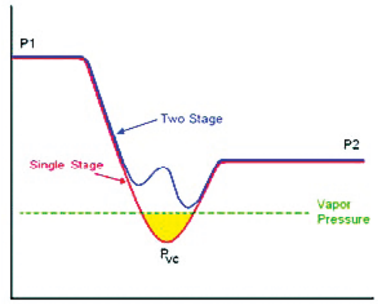

Figure 5 - Multiple Stage Pressure Drop and Velocity Control

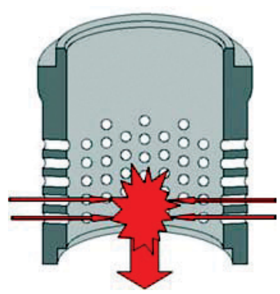

Figure 6 - Multiple Stage Pressure Drop and Velocity Control

FLASHING SERVICE

Flashing service occurs when the fluid pressure falls below the vapor pressure and does not recover above the vapor pressure. That is, the downstream pressure is below the vapor pressure of the fluid. These applications can also create damage to the valve due to local high velocities. Fortunately they can be controlled by flow the fluid over the plug and using an energy limiting design trim.

EROSION SERVICE

GENERAL THEORY

As fluid passes through a control valve, the law of continuity requires that the fluid accelerates as the valve passage sizes are reduced. This means that the flow velocity increases as it passes through the throttling section of the valve and peaks at what is called the vena contracta, usually just downstream of the valve trim. If foreign material is entrained in the fluid, or the fluid is otherwise abrasive, those areas of the valve can be subjected to extreme damage. Typically, these areas include the valve plug, seat and any component downstream of the valve seat. Of course, velocity control would be the obvious method to reduce this damage. However, the abrasive characteristics of the fluid seldom permit this application. Instead, the valve components that can be impacted will need to be treated with specialized materials to prevent the damage. These materials can be applied to the surface of the seat, plug or even the entire valve body if required.

APPLICATIONS AND SOLUTIONS

Thermal spray: These coatings can be tungsten or ceramic for wear or sacrificial such as zinc or aluminum. They are usually applied with a high velocity method and do not form an atomic bond with the base metal. However, they are very effective and have a return on investment due to increased longevity of valve and/or part lifespan.

Fusion coatings: These are similar to those noted above but are heated to form a molecular bond with the base metal. They have a low porosity and good resistance to gouging. The fusing is accomplished at very high temps, above 2000 °F.

Weld overlays: This is perhaps the most common type of hard facing, usually involving materials like stellite and related materials. They are applied by hand or automated using welding equipment, can be touched up re-applied and applied to almost any thickness. They have high adhesion to the base metal and present a non-porous surface.

Laser applications: These involve many of the same treatments listed above. However, since they are applied with a laser, the coated part never heats up (i.e., lasers generate high heat but to very small local areas).

PRODUCTS AND HARDWARE

Flash-Flo® Trim

In cases where 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 streams 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. *See Figure 7.*

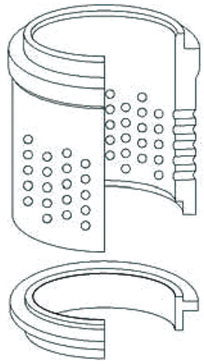

Figure 7 - Flash-Flo® Trim

Q-Cage™ Trim

As an alternative, 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, noted above *(see Reference 2 and 3)*. 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. *See Figure 8.*

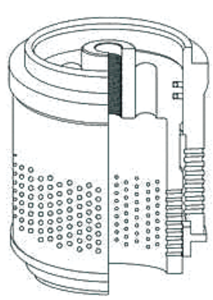

Figure 8 - Q-Cage™ and Q-Cage™ Level 2 Trim

Q-Cage™ Level 2 Trim

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 is 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) incompressible services and the critical pressure drop (where cavitation begins) in incompressible service. This product is available with any flow characteristics. *See Figure 8.*

VeCTor™ Trim

The VeCTor™ trim is a radial flow multi-stage stacked disk trim designed with constant area ratios that provide a tortuous 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 with a linear, modified linear and modified equal percent flow characteristics. *See Figure 9.*

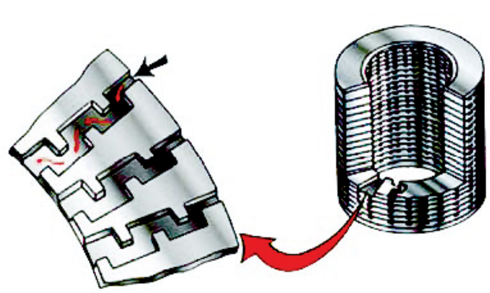

Figure 9 - VeCTor™ Trim

Diffusers and Attenuator Plates

In addition to the valve and trim options mentioned above, Hammel Dahl also can provide diffusers and attenuator plates for those gas and steam applications where the pressure drop is extremely high. The diffuser or attenuator plate are used downstream of the valve to reduce the pressure drop on the valve. Since the system's pressure drop is divided between the valve and the diffuser/plate, a desirable outlet flow velocity of the system can be achieved. Depending on the pressure range required for the application, a one-stage or two-stage diffuser can be provided.

Baffle and Orifice Plates

In liquid applications where the pressure drop is extremely high and can cause cavitation and noise in even specialized anti-cavitation trim, baffle and orifice plates can be used to reduce the pressure drop across the valve. These plates can be used both upstream as well as downstream of the valve. Baffle plates are plates with multiple holes used to restrict the flow upstream of the valve to provide a reduction on the pressure drop of the valve. Orifice plates are plates with only one hole used either upstream or downstream of the valve. Upstream of the valve, the orifice plate acts similar to the baffle plate. Downstream, it creates a back-up of the pressure and reducing the pressure drop on the valve.

TYPICAL APPLICATIONS BY INDUSTRY

CHEMICAL

Aggressive Chemicals (Exotic Alloy Valves)

Today's chemical plants must safely handle some of the most aggressive chemicals known to mankind. The Koso Hammel Dahl Model G120, Single-Seated, Top Guided Globe Valve was designed in conjunction with some of the leading chemical companies and features an "all-metal" construction. The entire body structure, including the body-to-bonnet gasket, is made of metals that are suited for the process media. KHD routinely produces these valves in Hastelloy B & C for acetic, hydrochloric and nitric acids, Alloy 20 for Chlorine service, titanium and zirconium for sulfuric acid and sodium compounds. *See Figure 10, G120 Series Globe Valve, Contoured Trim, Live-Loaded Packing.*

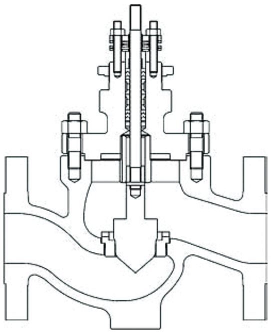

Figure 10 - G120 Series Globe Valve, Contoured Trim, Live-Loaded Packing.

Many applications require exotic alloy valves to be delivered on a short manufacturing cycle. KHD continues to supply exotic alloy valves and high pressure class valves utilizing wrought block body style valves. In many cases this cuts the delivery time in half and provides a much more rugged body structure. *See Figure 11, 10000 psig Block Valve.*

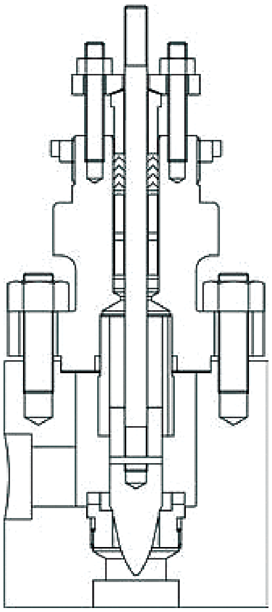

Figure 11 - 10,000 psig Block Valve

Hazardous Chemicals (Bellows Sealed Valves)

Development of hazardous chemical valves began in earnest with World War II when Koso Hammel Dahl became a primary supplier to the United States war effort and supplied special bellows sealed valves to the Rocky Flats Project (Gas Weapons) and Oak Ridge (Manhattan Project). In the following decades KHD continued to supply bellows sealed valves to uranium processing sites at Hanford, WA and Savannah River, SC and for the radioactive waste systems of today's nuclear power plants. *See Figure 7, G120 Series Globe Valve, Contoured, Bellows Sealed Bonnet.*

Hazardous medias are most often encountered in the ANSI Class 150-600 valves, but special applications may require larger valves with higher pressure classes. Koso Hammel Dahl has an extensive history of supplying high pressure class bellows sealed valves to the power and chemical industries. *See Figure 13, Special Class 2500 Bellows Sealed Bonnet.*

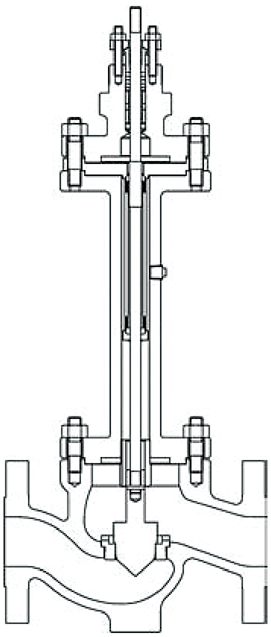

Figure 12 - G120 Series Globe Valve, Contoured Trim, Bellows Sealed Bonnet.

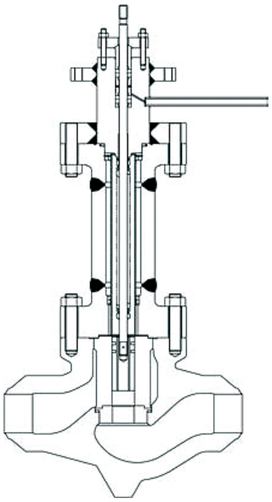

Figure 13 - Special Class 2500 Bellows Sealed Bonnet

Coal Gasification (Integrated Gasification Combined Cycle)

The IGCC process is an extremely versatile and clean process for converting a wide variety of carbon-containing feedstocks into a synthesis gas, or "syngas", composed primarily of carbon monoxide and hydrogen. This syngas is a valuable raw material that can be used to replace oil and natural gas in many applications including the production of electric power. A wide variety of abundant domestic feedstocks can be used for gasification including coal and lignite, petroleum residues such as petcoke, biomass such as switch grass and recycled waste products from manufacturing facilities and landfills.

POWER GENERATION

The first and the longest running commercial coal gasifier in the U.S. was built in 1983 to produce chemicals from coal and has operated reliably with on-stream availability of 98-99%. The most difficult applications in this facility are the hot acetic acid lines for which Koso Hammel Dahl provided cage trim (G110) and top-guided (G120) globe valves made of 100% Hastelloy C material. *See Figure 14, Globe Valve, Hastelloy C, Dual Seal Bonnet.*

Coal, Oil and Gas Power Plants (Feedwater systems)

Today's power plants require valves that can withstand significant pressure drops, high velocity of flow, and a range of temperature. Below are descriptions of the crucial valves within the plants.

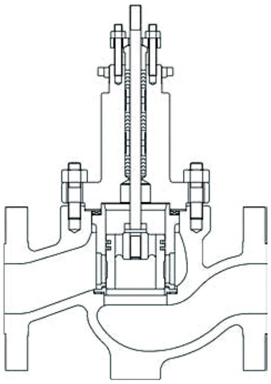

Figure 14 - Globe Valve, Hastelloy C, Dual Seal Bonnet

Condensate Pump Recirculation Valve

These valves are used to recirculate flow from the condensate pumps to the condenser to prevent the pumps from overheating at low flow rates. The inlet pressure is typically in the 300-600 psi range and the temperature is in the 100-150°F range, while downstream pressure is in the condenser so it can be at vacuum. As a result, the service has a high potential for cavitation. This application calls for a G110 globe valve with VeCTor™ trim and tight shutoff. The VeCTor™ trim is a multi-stage trim designed to prevent cavitation and erosion by utilizing various disks containing paths with multiple stages that provide controlled pressure and velocity reduction. *See Figure 15, Globe Valve VeCTor™ Trim.*

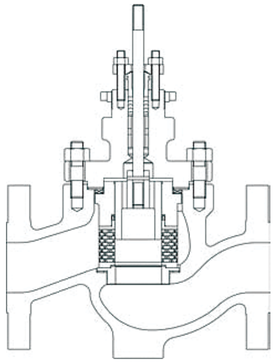

Figure 15 - Globe Valve, VeCTor™ Trim

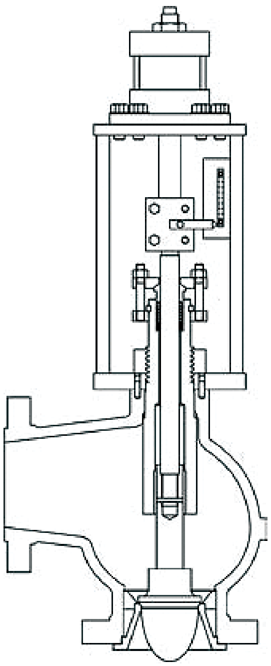

Figure 16 - V701
Venturi Seat Angle Valve

De-aerator Control Valve
These valves maintain the level in the aerator and therefore typically have high pressure drop at low flow and less pressure drop as flow is increased. The G110 series cage guided globe valves with VeCTor™ trim help control the pressure drops. The VeCTor™ trim, in these cases, would be designed with a large number of turns for severe cavitation protection at low flow and incrementally fewer turns or stages for less protection with increasing valve stroke.

Boiler Feedpump Recirculation Valve
This is usually the most severe service application in the feedwater system. This valve returns flow from the feedpump outlet to the condenser when the system is in low demand to protect the feedpump from damage it may incur at very low flow rates. As a result, it has a very high inlet pressure of 3000 psi or more, yet, since it is usually closed, it must shut off absolutely tight. Any leakage across the seat will quickly damage the seat at these high pressures. As a result, these are typically globe or angle valves, 1500 or 2500 lb class, with VeCTor™ trim, often with 24 stages, and very tight Class VI shutoff, and soft seats.

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 its standard trim material eliminating the problem.

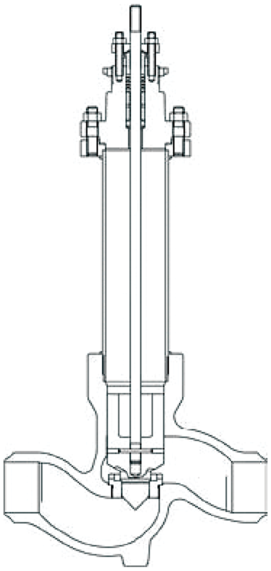

Figure 17 - V817
Cryogenic Globe Valve
with Standard Trim.

Division Control Valve (also known as 501 Valve)
This valve handles the steam flow to load the turbine and can see over 2000 psi inlet pressure and full drop. For this application, Koso Hammel Dahl recommends a 1500 lb or 2500 lb rated globe valve with a VeCTor™ trim with a high number of stages.

Drum Pressure Control Valve (also known as 502 Valve)
This 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 2000 psi water at 300°F to 2000 psi saturated steam at 650°F. The downstream pressure is of course the condenser pressure, so the pressure drop is very high and noise and vibration fatigue are the fundamental problem. This is typically a 1500 lb globe valve with VeCTor™ trim with a high number of stages and tight shutoff.

Sootblower Control Valve
This is a modulating application to control the sootblower header pressure. As a result, high range ability is required as well as a tight shutoff. The valve is usually run flow-to-close to avoid debris from damaging the seat. A 4500 lb rated globe valve with a VeCTor™ trim with a high number of stages and tight shutoff is recommended.

Hydro-Electric (Hoover Dam to the Yangtze)
Koso Hammel Dahl has provided critical service sluice isolation bypass valves for Hydro-Electric Dams from Hoover Dam to the Yangtze River Project. The main sluice valves are 30 ft diameter hydraulically powered ball valves that are closed when maintenance must be performed in the turbine pits. Once the main sluice valves are closed the pits are drained and maintenance is performed in a safe, dry environment.

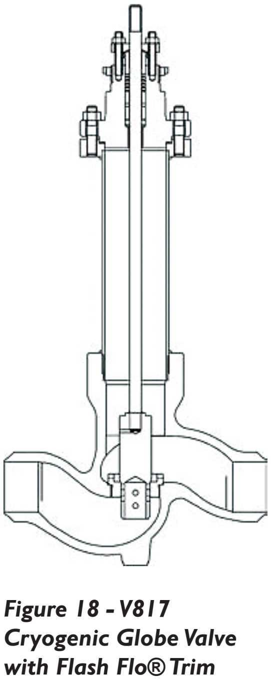

Figure 18 - V817
Cryogenic Globe Valve
with Flash Flo® Trim

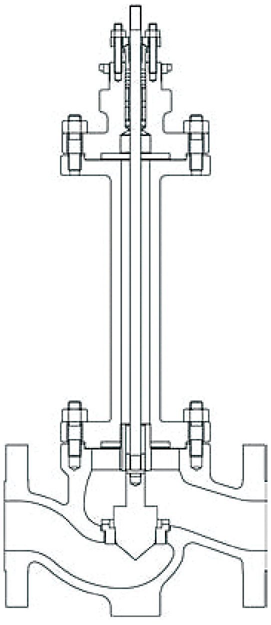

Figure 19 - G120 Series
Globe Valve with ULT
Bonnet Extension

Sluice Isolation Valve
The differential pressure across these large main sluice valves creates a "hydraulic lock" that locks the valves in the closed position. To release the "hydraulic lock" the turbine pits must be flooded using the Koso Hammel Dahl Model V701 re-flood valves in the high pressure bypass line around the main sluice valves. These are 6-16 inch, solid plug valves that are capable of passing dirt and river debris without causing a failure of operation. The flow direction is "flow-over" the plug and provides inherent "fail-safe" closure of the valve when maintenance is being performed in the turbine pits. The actuator is a hydraulic piston that is operated from the main sluice system. *See Figure 16.*

INDUSTRIAL GAS

GAS SEPARATION APPLICATIONS

Cryogenics – Cold Box Valves
The present day cryogenic product lines have their roots in the early space program when Koso Hammel Dahl supplied 1-8 inch, ANSI Class 2500 cryogenic oxygen and hydrogen fuel supply valves to the rocket test stands at the Stennis Space Center, Cape Canaveral and Areojet General in the Mojave Desert. From that early beginning KHD became the world leader in the supply of cryogenic valves for the air and petroleum gas separation industries.

The KHD Model V817 "Cold Box" valve is used in the main cryogenic separation tower (cold box) where it is installed horizontally through the tower wall and imbedded in the tower insulation. The V817 cold box valve is an all-welded structure with a long extension neck that allows the trim to be removed without removing the valve from the cold box. *See Figure 17, V817 Cryogenic Globe Valve with Standard Trim.*

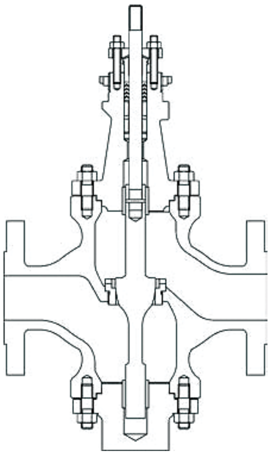

Figure 20 - V802 Single-Seated Top & Bottom Guide Globe Valve

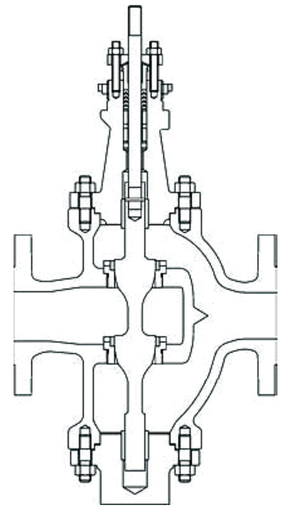

Figure 21 - V800 Top and Bottom Guided Double-Seated Globe Valve

Cryogenic Globe Valve with Standard Trim

One exclusive option provided with Koso Hammel Dahl V817's is the anti-cavitation trim known as Flash Flo®. This trim is required for cryogenic valves exposed to high pressure differentials and cavitating conditions. These applications are known as "JT" valves for the well known Joules-Thompson Effect they perform in the system. *See Figure 18, V817 Cryogenic Globe Valve with Flash Flo® Trim.*

Cryogenics – Pipeline Valves

Cryogenic fluids are transported through heavily insulated pipelines, and the control valves installed in these piping systems must meet unique and specific requirements. The Koso Hammel Dahl Model G120 "Cryogenic Pipeline" valve includes 316 stainless steel bodies and trim, Teflon (PTFE) or Graphite seals and packing, and Kel-F (PCTFE) soft seats. A standard feature of the G120 Series is a longer length Ultra Low Temperature bonnet (ULT) that meets national and international standards. When the Ultra Low Temperature bonnet option is selected the body fasteners are converted to special Low Temperature bolting materials. *See Figure 19, G120 Series Valve with ULT Bonnet Extension.*

OIL AND GAS

OIL REFINING AND TRANSPORT

Petroleum refining and transportation industries demand globe valve with high C_V values that are inherently "fire-safe" and in many cases can handle dirt and debris in the media. The Koso Hammel Dahl Model V802/V803 Single-Seated Top & Bottom Guide Globe Valves are available in 1-12 inch body size and are specifically designed and produced to meet refining industry standards.

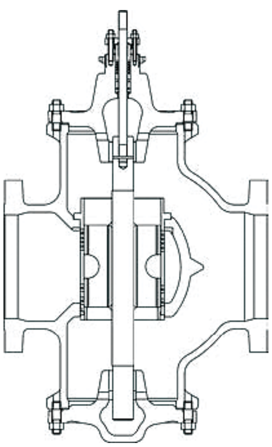

Figure 22 - V800 Globe Valve with Flash Flo® Trim

The large pipeline sizes and the possibility of entrained particles rule out many standard valves such as cage trim valves. *See Figure 20, V802 Single-Seated Top & Bottom Guide Globe Valve.*

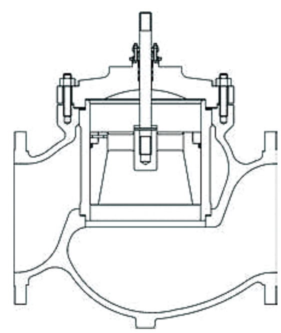

Figure 23 - G110's 10 & 12 inch, Monel Fire Suppression Valves

Pipeline Valves

Today's pipelines are larger in diameter and operate at higher pressures than those of the past. While many of the pipeline isolation valves are rotary valves the high pressure control valves at the pumping stations are high-flow balanced globe valves. For these applications the KHD Model V800/V801 Double-Seated, Top & Bottom Guided Valves with a balanced plug design are available in 1-24 inch body sizes. *See Figure 21, V800 Top and Bottom Guided Double Seated Globe Valve.*

Very often the pump recirculation valves at each station encounter cavitation while handling lighter weight fluids such as gasoline or jet fuel. One exclusive option provided with KHD V817's is the anti-cavitation trim known as Flash Flo®. This trim style has been a standard KHD pipeline option since the 1960's and has been used in pipelines throughout North America. *See Figure 22, V800 Series Valve with Flash Flo® Trim.*

Platform Valves

The marine environment of oil platforms exposes valves to hostile marine conditions and requires valves of special construction and specific materials. The moisture, salt spray and corrosion create some of the most significant challenges for control valves that must operate in the case of extreme emergency. *See Figure 23, G110's 10 & 12 inch, Monel Fire Suppression Valves.*

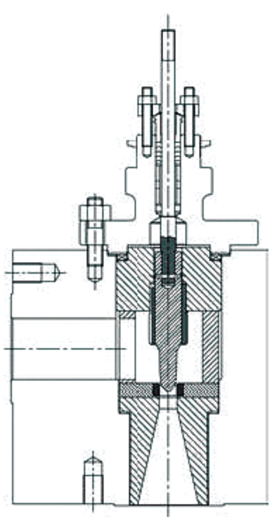

Figure 24 - Forged Block Valve

MINING AND MINERALS

Bauxite Mining/Alumina Processing

The processing of bauxite ore into alumina grit is one of the most abrasive processes in today's mining industry and the Koso Hammel Dahl Model V701 has been the premier slurry valve since the 1950's. This design features an enlarged body bowl that decreases the flow velocity by 50% while maintaining a smooth flow transition from the inlet down over the plug to the outlet. The venturi—which covers the entire outlet—and the trim set are made of abrasive resistant material such as Chrome-Iron, Stellite or Tungsten Carbide. For severe applications the entire body interior can be coated with Stellite or Colmonoy hard facing. *See Figure 25, V701 18 x 20 Digester Tail Valve.*

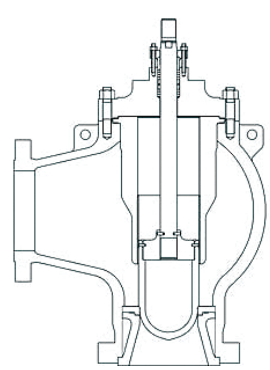

Figure 25 - V701 18×22 Digester Tail Valve

KHD can also provide block valve with special face-to-face dimension for any application. *See Figure 24, Forged Block Valve.*

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3. Optimizing Valve Jet Size and Spacing Reduces Valve Noise, Control Engineering.
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