kentintrol

SEVERE SERVICE VALVE SOLUTIONS

KOSO

KOSO KENT INTROL SUPPLIES A DIVERSE RANGE OF PRECISION -MANUFACTURED CONTROL, CHOKE, AND ROTARY VALVES FOR OIL AND GAS, PETROCHEMICAL AND POWER INDUSTRIES – WORLDWIDE

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PRODUCT RANGE

TOP & BOTTOM-GUIDED CONTROL VALVES

Our range of high-performance top and bottom-guided control valves includes single and double-seated valves suitable for low and high-capacity applications, as well as three-way valves for mixing or splitting flows. Our control valves are designed to facilitate pressure drops at all stages of transportation in the oil, gas and power industries. All valves are refined by our engineers to suit the needs of each application and all service conditions.

CAGE-GUIDED CONTROL VALVES

The Series 1200/7200 range of cage-guided control valves is KKI's core product. The exceptional valves in this range combine high-integrity features, such as ASME VIII body/bonnet bolting design, a high flow capacity and a wide range of trim designs, from low-noise anti-cavitation to multi-stage trims. These valves are ideally suited to the critical service process control requirements of a wide range of industry applications.

SURFACE CHOKE VALVES

The KKI Series 73 surface choke valve offers a unique solution for the majority of choke applications in the oil and gas industry. The flexible valve design can incorporate many different trim and body material options to suit differing flow rates and in-service conditions. Thousands of KKI Series 73 surface chokes are installed around the world on projects for some of the world's leading oil and gas production companies.

ROTARY CONTROL VALVES

The Rotrol range of high-capacity butterfly valves has been developed to overcome the problems associated with control, cavitation and noise in conventional butterfly valve designs. Lighter in weight and more compact than globe valve alternatives, this innovative valve performs especially well in severe-service applications, where pressure drops tend to be high in the controlling position but where high-capacity throughputs at low pressure drops are also required.

SEVERE SERVICE SOLUTIONS

For more than 45 years, KKI has built up a reputation for delivering valve solutions for the most arduous service conditions. We have developed a range of advanced, high-quality severe service valve solutions for every type of problematic application, from high-pressure, high-temperature environments to sub-zero temperatures. Our valves are designed to combat the effects of cavitation, flashing, erosion, contaminated fluids, corrosion, high velocity, vibration, noise and energy dissipation.

INSTRUMENTS

KKI offers a wide selection of sophisticated instrumentation to support our comprehensive range of high-performance valves and actuators. The instruments we supply include pneumatic and electro-magnetic positioners, airsets, volume boosters and airlocks. All instruments are specified to deliver optimum performance for the service conditions and specific needs of each application. We also supply proprietary instruments to suit individual customer preferences.

ACTUATORS

Our range of robust, versatile and reliable pneumatic actuators includes the 'G', 'C' and 'D' Series models. These have been developed to meet the needs of all control valve applications, offering proven design and high reliability. They are used extensively for on-shore, offshore and power installations. In addition, we supply various proprietary actuators – such as electric, electro-hydraulic, pneumatic stepping and hydraulic stepping actuators – to meet customer requirements. All actuators can be supplied with hand-wheels and limit stop features.

TOP & BOTTOM-GUIDED CONTROL VALVES

SINGLE SEATED SERIES 10/71

DOUBLE SEATED SERIES 20

3-WAY MIXING AND DIVERTING SERIES 30

CAGE-GUIDED CONTROL VALVES

SERIES 1200/7200

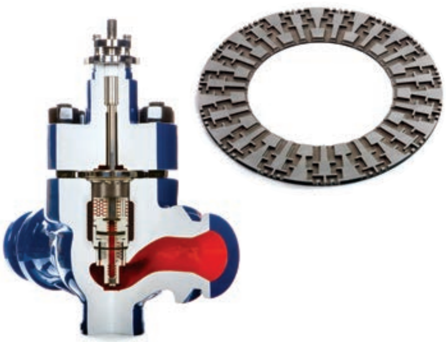
SURFACE CHOKE VALVES

SERIES 73

ROTARY CONTROL VALVES

SERIES 60

SEVERE SERVICE SOLUTIONS



INSTRUMENTS

ACTUATORS

SERIES G

SERIES C

SERIES D

SEVERE SERVICE VALVES

KKI have an unrivalled blend of proven expertise, innovative design technology and skilled engineering. This is the motivating force behind the development of the KKI range of high quality Severe Service Control Valves, Surface Choke Valves and Butterfly Valves. KKI has been manufacturing Severe Service Valves for over 45 years.

Whether it is for problematic applications relating to High Pressure, High Temperature, Sub Zero Temperatures, Cavitation, Flashing, Erosion, Solids Contaminated Fluids, Corrosion, High Velocity, Vibration, Noise or Energy Dissipation, KKI has proved it has the solutions. These issues are discussed in the following sections together with Case Studies, which present some of the solutions provided by KKI to handle potentially problematic applications. In addition to this KKI has the proven Koso Vector (velocity control) Labyrinth Disk Stack design in it's product portfolio.

Fig 01
Vector (velocity control)
Labyrinth disk stack trim design

OHSAS 18001 ISO/TS 29001 ISO 9001 ISO 14001
FPAL Verify Verified FPAL Registered

QUALITY MANUFACTURING

Maintaining the highest standards of quality throughout design, production and customer service is the cornerstone of Koso Kent Introl's philosophy. Our plant is accredited in accordance with Quality Management System ISO 9001 and Environmental Management System ISO 14001. In addition all products, where applicable, conform to ATEX, PED and all other applicable EU Directives and are CE marked accordingly.

The company's standard manufacturing experience includes NACE MR01.75, NORSOK, API 6A specifications and individual customer specifications. Our in-house inspection and testing facilities include hardness testing, NDE, PMI, gas and flow testing. Safety is the key element in everything we do, with all employees undergoing both general and specific Health and Safety training.

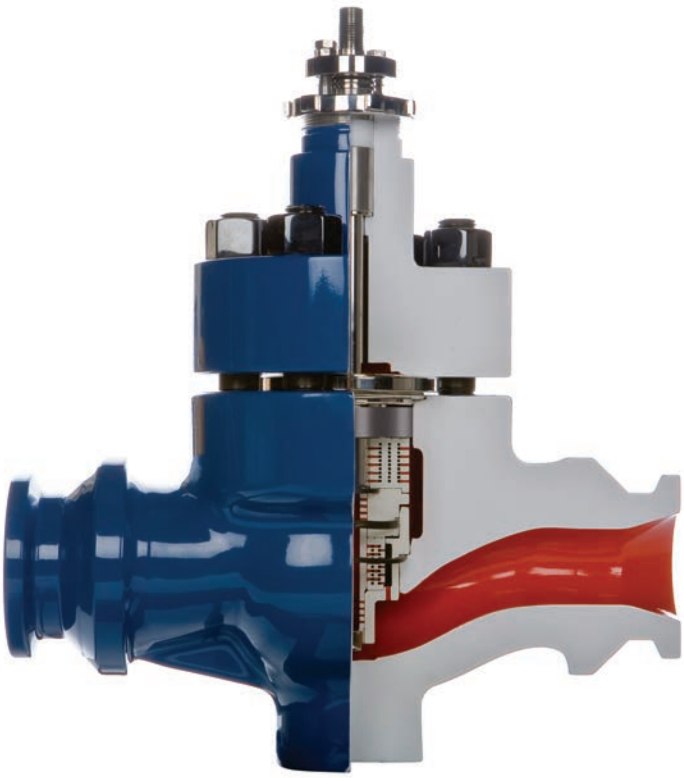


Fig 02
Turbotrol control valve

SEVERE SERVICE APPLICATIONS

There is level of "mystique" surrounding specific applications encountered in the control valve industry. Certain manufacturers try to differentiate themselves by specifying such applications as severe service. It should be noted that there is no definitive ruling as to what is and is not severe service. In reality it really depends on the severity of the operating conditions and on the importance of the valve to the operation of the plant.

KKI have over the years operated at the leading edge of the oil and gas industry and have as such encountered ever increasing demands in terms of pressure drop, contamination and increased flow rates.

In order to handle these arduous applications special selection criteria have been developed. Some applications that are frequently classified as "Severe Service" include:

- Anti Surge – Compressor Recycle
- Pipeline Surge Relief Control
- Centrifugal Pump Minimum Flow Re-circulation
- Over Board Dump
- Fire Water Deluge System
- Slug Catcher
- Vent to Flare
- Separator Level Control
- Boiler Feed Water
- Emergency Drains
- Super Heater Spray
- High Pressure High Temperature (HPHT)

The following is a list of some of the issues that are considered in assessing the severity of an application:

- High Noise
- Severe Vibration
- High Pressure Drop
- Cavitation
- Flashing
- High Velocity
- Contaminated Flow
- Erosive / Corrosive Medium
- Joules Thompson Effect

Fig 05
Cartridge trim with
Solid Tungsten Carbide Guide

The trims presented on this page are some examples of the Severe Service Trims available from Koso Kent Introl.

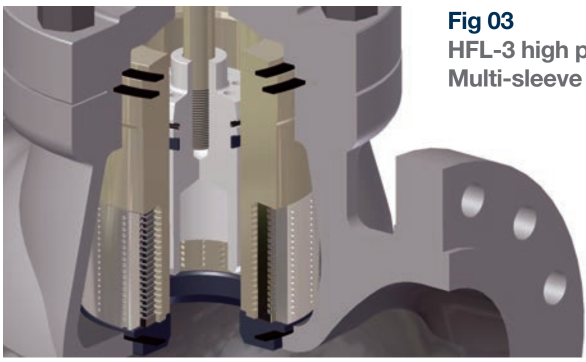
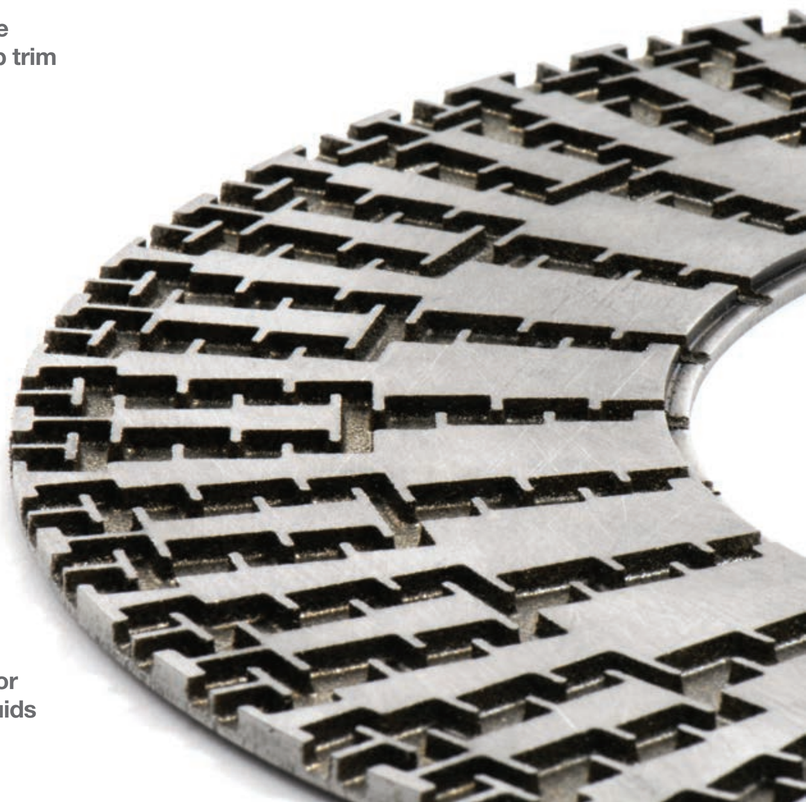


Fig 03
HFL-3 high performance
Multi-sleeve / Multi-step trim

Fig 04
Tungsten carbide plug for
heavily contaminated fluids

Fig 06
Vector 'D' disk – velocity control
Labyrinth trim design



ENGINEERING TOOLS

KKI is committed to providing fully analysed and tested valve product for the Severest Service Applications. Our expert engineering staff continually design, develop and test products to meet the ever-changing needs of the industry while supporting products that are already installed and operating throughout the world.

Our engineering staff utilise modern engineering tools, such as 3D Modelling, Finite Element Analysis, and CFD analysis to ensure that the products are designed to the highest level of integrity and reliability.

As a result of the continuous Research & Development and the utilisation of the most up to date Engineering Tools, the Severe Service Valves supplied by KKI are at the cutting edge of control and choke valve technology.

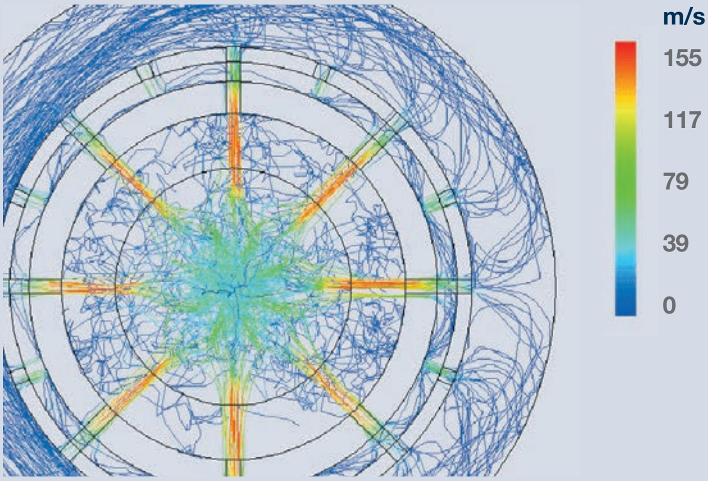
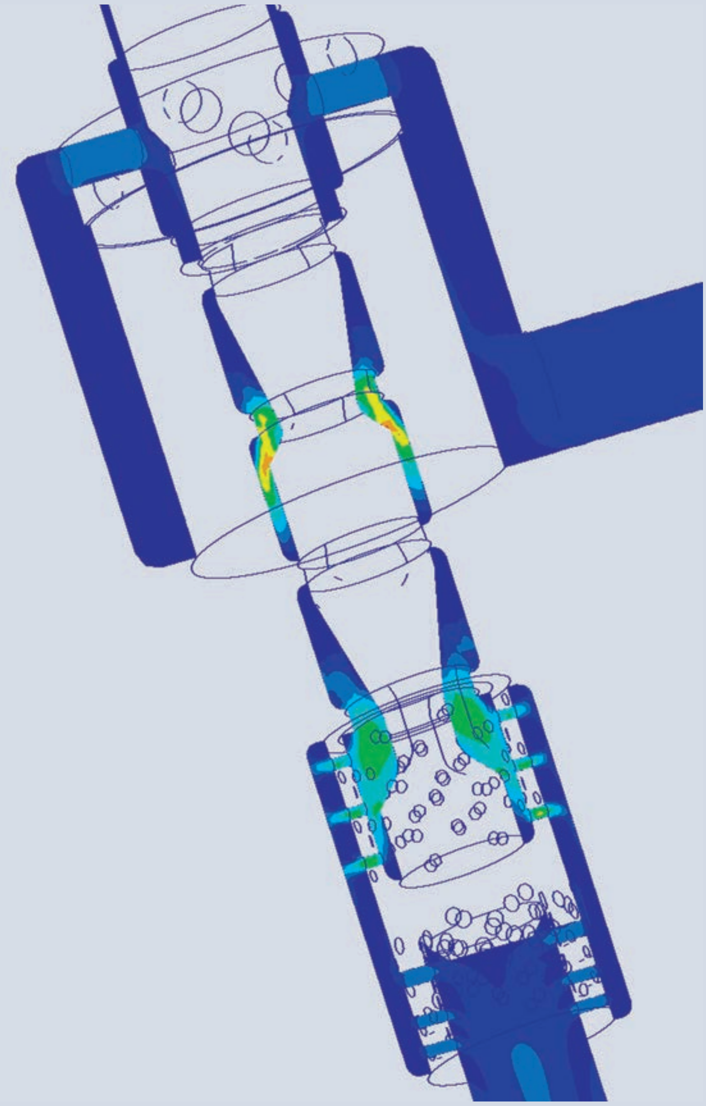


Fig 08
Plan view of a valve trim showing the sand particle trajectory

Fig 07
CFD analysis of 5 stage multi-spline



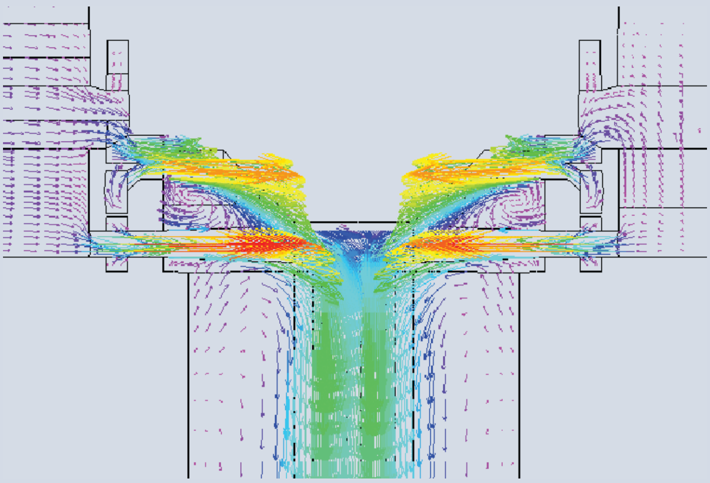


Fig 09
CFD analysis of a valve trim

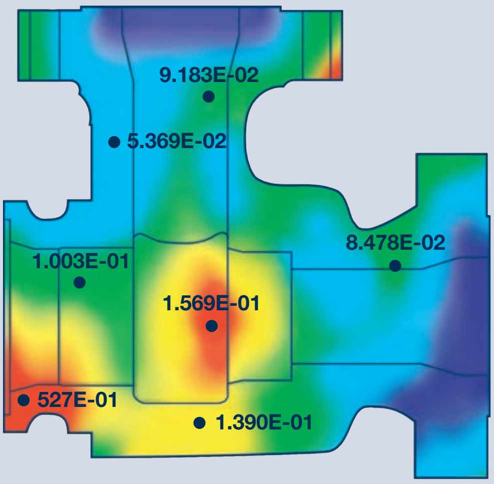


Fig 10
Choke body evaluation using Finite Element Analysis

CASE 1
SPECIALIST APPLICATION
MINIMUM FLOW PUMP RECIRCULATION VALVE

The trim in the adjacent photographs illustrates the extreme damage that high levels of cavitation can produce on pump minimum flow recirculation applications – it can literally tear a trim apart in minutes.

Either incorrect specification of the operating conditions or the incorrect design of trim are the underlying factors in such an application. In this particular instance the incorrect outlet pressure specified at 6 bar, was in fact atmospheric, resulting in this extreme level of erosion. The valve operated for only a few hours before it had to be taken out of service.

The original trim design incorporated 5 stages (10 turns) of pressure let-down, but the pressure drop apportionment did not eliminate cavitation, due to the much lower downstream pressure. In order to handle this pressure drop and eliminate cavitation, the trim design needed an additional 4 stages of let-down, giving a total of 14 turns within the existing valve body design, see HFL-9 Stage Anti-Cavitation trim.

The area increase through the trim resulted in lower pressure drops in the outlet stages of the trim and thereby eliminating cavitation, even though the outlet pressure was close to atmospheric. This design is a hybrid of the KKI Turbotrol valve that is used on similar applications and discussed in the following section.

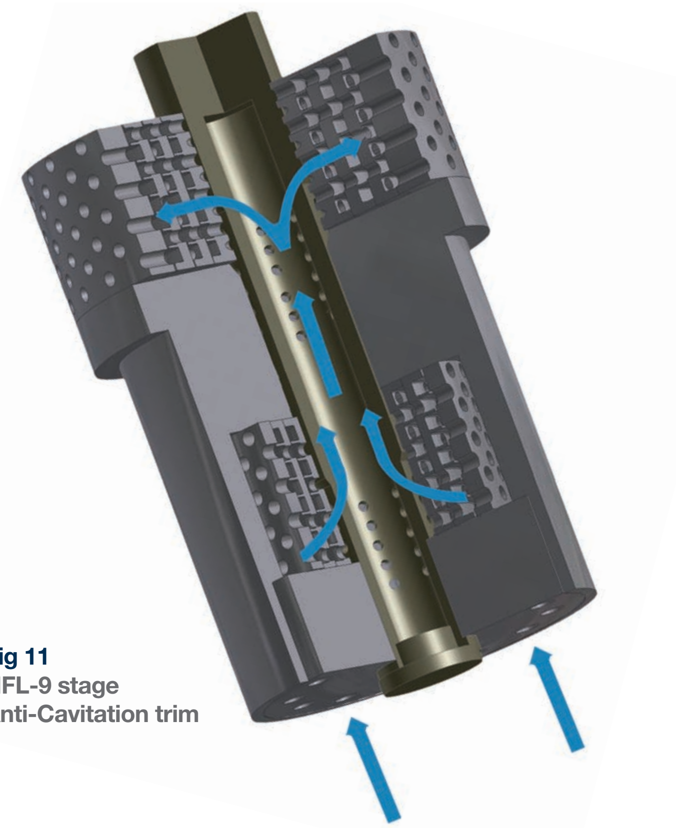
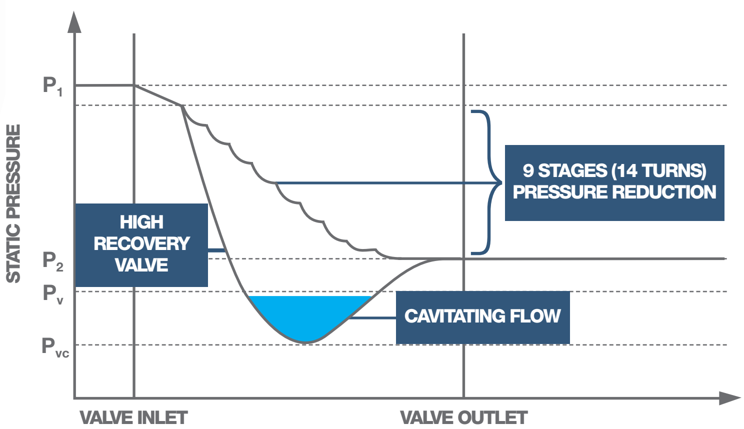


Fig 11
HFL-9 stage
Anti-Cavitation trim

Fig 12 and 13
Original trim with severe cavitation damage

Fig 14
Comparison between low and high recovery trim designs



CAVITATION EXPLAINED

Cavitation is the phenomenon that can occur in control valves on liquid duties. In its most severe form cavitation can destroy a control valve trim in a matter of hours. It is therefore important to control the level of cavitation when selecting a control valve.

Cavitation occurs on liquid applications when the fluid static pressure firstly reduces below the fluid vapour pressure (Pv) and subsequently rises (recovers) above the fluid vapour pressure. This results firstly in the creation of small vapour bubbles (cavities).

Subsequently these cavities collapse producing localised shock wave micro-jets. If these impact on the metallic surface of the valve then severe pitting and erosion damage can occur. A complete explanation of cavitation and the KKI method of calculating the Cavitation Index is given in the Technical Selection Manual TS 20 available at www.kentintrol.com

SERIES 51 & 57 TURBOTROL SEVERE SERVICE VALVES

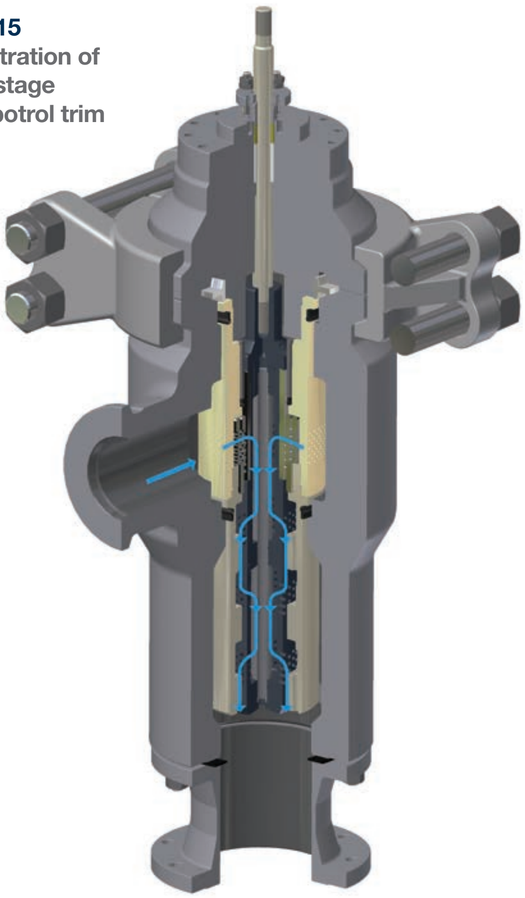
TURBOTROL VALVE DESIGN

The patented 'Turbotrol' valve design is utilised on very high-pressure drop liquid applications to eliminate the potentially erosive effects of cavitation. This design was first introduced by KKI in the mid 1980's and was specifically developed for minimum flow re-circulation pump protection. This design is typically employed on applications where the pressure drop requirement is in excess of 200 bar and the downstream pressure is close to Pv.

The design incorporates between 4 and 9 stages (9 and 14 turns). The flow is directed through a series of radial and axial flow paths, where the fluid is firstly split into many small flows and then recombines into an axial flow. This occurs repeatedly as it passes through the trim ensuring controlled dissipation of the fluid energy. The control of the velocity through the trim reduces the high wear rates normally associated with high pressure drop applications.

An additional feature of the Turbotrol is the plug seating face, which is protected from the effects of wire-drawing and erosion at low flows. A dead band is introduced adjacent to the seat, which ensures that the seating faces are positioned outside the high velocity turbulent flow streams prior to the flow stream holes being exposed.

Fig 15
Illustration of a 9 stage Turbotrol trim



TURBOTROL DESIGN SPECIFICATION

- Sizes – 1½" to 8" (40mm to 200mm)
- Ratings – ANSI 600 to 4,500 / API 3,000 to 15,000
- Design – ISO 10423 / API 6A / API 17D / ANSI B16.34 / ASME VIII
- Standards – PED / ATEX / NACE MR01.75 / ISO 15156 / NORSOK
- End Conns. – ISO 10423 / API 6A / API 17D / ANSI Flanges / Hub type connections
- Stages of let-down 4 to 9 (9 to 14 turns)

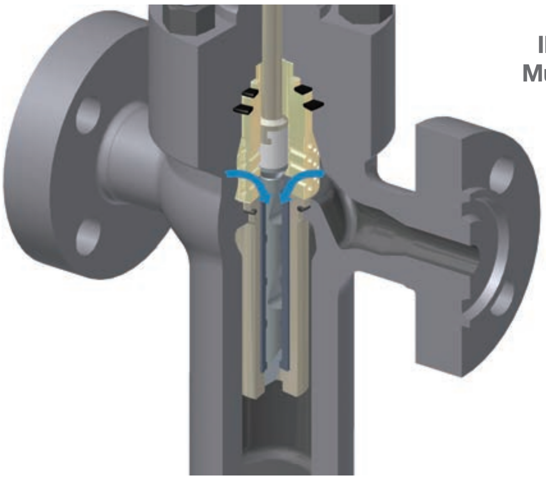


Fig 16
Illustration of a Multi-spline trim

MULTI-SPLINE TRIMS

The multi-spline trim is designed to extend the Turbotrol range for high-pressure drop liquid services for applications with low flow rate requirements. These trims are supplied in valve sizes up to 2" (50mm) diameter. In common with the larger Turbotrol trims, the flow sleeve and plug are constructed as an insert-able cartridge, with up to 5 stages of pressure drop to ensure that cavitation does not occur throughout the stated flow range.

The multi-spline trim option has an excellent rangeability. Rangeabilities in excess of 100 to 1 can be achieved due to the very precise fit of the plug within the seat. The standard trim material is generally Full Stellite Grade 6. However, there are also the options for tungsten carbide and advanced ceramic for pressure drops greater than 100 bar (1450 psi). Typical applications are low flow high-pressure drop services MEG Injection, Methanol Injection & other low flow requirements.

CASE 2 SPECIALIST APPLICATION FIRE WATER PROTECTION SYSTEM

The fire water system on offshore platforms, see fig 18, has proven to be an extremely onerous duty. KKI became involved in this application when a competitors Butterfly Valve suffered severe vibration, resulting in a failure of the system and causing a Health & Safety issue due to the fact that both the sprinkler and deluge system would not function correctly. On closer inspection of the valve, erosion (resulting from cavitation) of the vane, valve body and seating area was discovered.

On investigation it was noted that the valves were originally specified to be operating with an inlet pressure of 6 bar and a pressure drop of 1 bar. Following installation it was revealed that the operating pressure drop under test conditions was significantly higher. The pressure drop was actually 5 bar and the flow rate had increased from 250 to 340 m^3/hr. This meant that the existing Butterfly Valve had a calculated cavitation Index of + 2.0 bar, which is classified as "severe".

The photograph below shows the type of damage that occurred on this application. The majority of the damage was to the outer edge of the vane, there was also severe cavitation erosion damage to the valve body.

Fig 17
Cavitation damage to Butterfly valve

Fig 18 Fire Water System

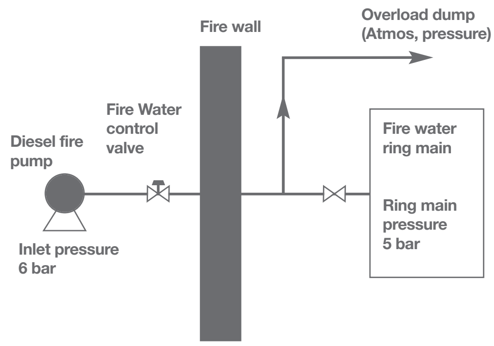
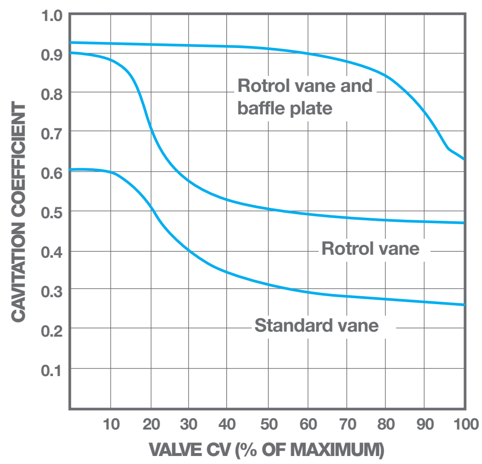


Fig 19 Pressure Recovery Comparison



Although it was clear that a larger globe type valve fitted with a low pressure recovery trim would be suitable for the operating pressures, the operator required a valve that would fit into the existing pipework configuration. KKI provided the Rotrol High Performance Butterfly Valve as the solution. This product had undergone extensive tests both on KKI's water test facility and at Brown Boveri Corporation (Baden) research facility. The special low recovery vane enables high-pressure drops to be handled without the onset of cavitation.

A comparison between the respective pressure recovery characteristics of a Standard Vane and a Rotrol vane is presented in Fig 19. The Cavitation Index (C_I) for the Rotrol valve under the most extreme condition was - 0.5 bar. The valve was installed and operated without the previous problems of cavitation and unstable control. This valve is now an accepted solution to what is still an onerous application.

ROTROL – SERIES 63 TO 66

THE ROTROL BUTTERFLY VALVE

The Rotrol Butterfly Valve range was developed to overcome the problems associated with control, cavitation and noise that would otherwise cause premature mechanical wear and failure of components on conventional Butterfly and Ball Valve designs.

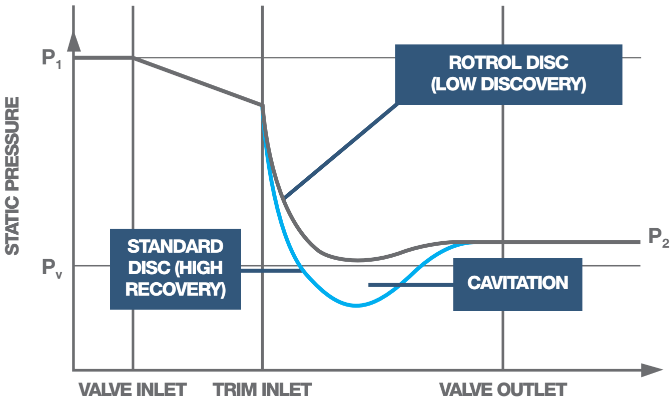


Fig 20
Comparison of pressure recovery between Low and High Recovery vane designs

The innovative design, refer to Fig 21, incorporates a profiled vane that has cowls on its leading and trailing edges. The cowls are drilled with a series of holes to allow flow to pass through the cowl.

Thus, at low valve openings when the cowls are most effective the flow passes through these holes, producing smaller turbulence scale and a similar low pressure recovery to that of a cage style trim, refer to Fig 20. This allows the valve to handle higher pressure drops and higher velocities without the onset of cavitation and noise.

This specialised valve performs exceptionally well in severe service applications with its variable resistance trim, where the pressure drop tends to be high in the controlling position but where high capacity through puts at low pressure drops are also required.

For applications that are particularly severe, an integral diffuser pack would be supplied, refer to Fig 21. The diffuser pack generally consist of one baffle plate fitted into the outlet of the valve body, but can consist of upto 3 baffle plates for the more extreme applications. The diffuser pack becomes effective when the flow rate through the valve increases.

Thus, as the valve opens beyond 30° open and the influence of the cowls on the flow is reduced, the baffle plates start to generate a back pressure. KKI will consider all valve openings when selecting the Rotrol valve and diffuser pack, to ensure cavitation is eliminated at all valve openings.

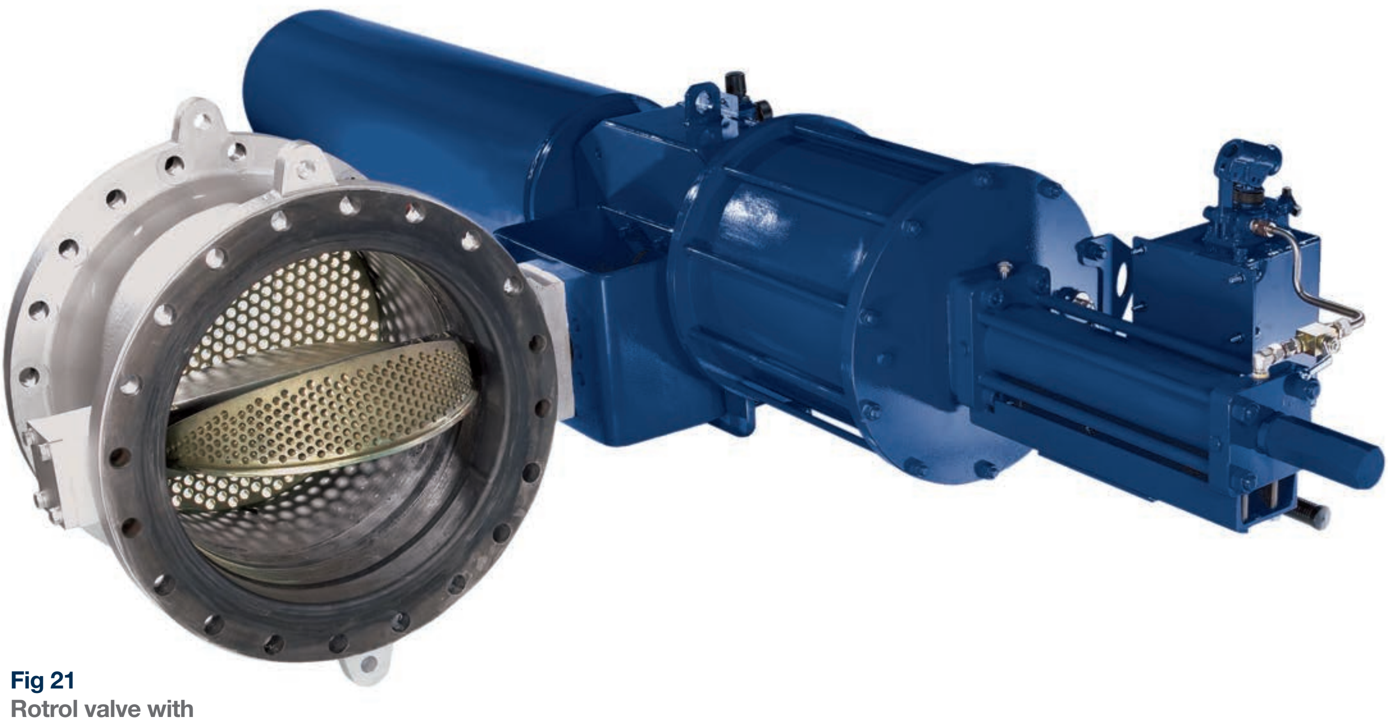


Fig 21
Rotrol valve with outlet baffle plate

CASE 3
SPECIALIST APPLICATION
SEPARATOR LEVEL CONTROL VALVES

In 1974 Koso Kent Introl supplied a number of control valves for a separator level control system schematic represented below in the Separator Level Control Schematic.

Fig 22
Separator level
control schematic

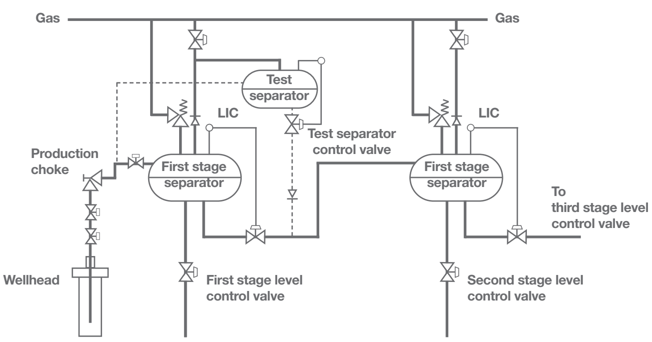
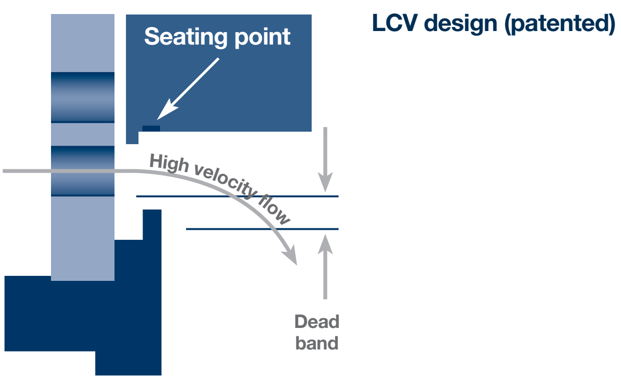


Fig 23 LCV design principle



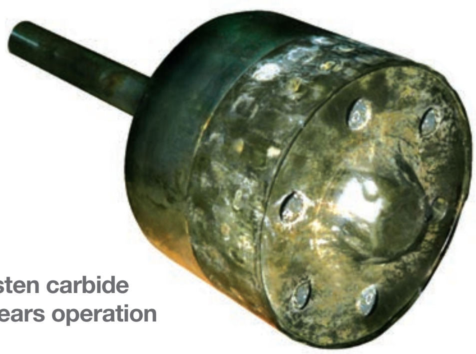


Fig 24
Patented solid tungsten carbide
LCV trim after two years operation

The original trim was a HFD cage guided design with an operating pressure drop of 100 bar (1450psi). In the early 1980's the client introduced water injection, the additional water cut resulted in the fluid being contaminated with sand. Within two weeks of operation of the valve, the trim was being severely eroded, due to the excess sand contamination.

Fig 25
Fully stellited cage guided trim after two weeks operation

Over the next two years KKI developed the LCV trim design, see Fig 23, by introducing various design enhancements to ensure that the trim would withstand the erosive nature of the medium. These enhancements included the introduction of a dead-band, sacrificial plug nose, a shrouded seat face arrangement and solid tungsten carbide for the main trim control elements.

The features of this design were patented and form the basis of the Koso Kent Introl Severe Service Choke Trim design as well as being an option within the globe control valve product range. The success of the trim design utilising tungsten carbide as presented in Fig 24 shows a relatively small amount of erosion to the sacrificial elements after two years operation.

This development lead KKI into the design and manufacture of their highly regarded choke valve product range.

SEVERE SERVICE SURFACE CHOKE VALVES

BE-SPOKE DESIGNED SEVERE SERVICE CHOKE VALVES

Koso Kent Introl has been supplying high technology surface choke valves since 1975. The design of the severe service trim incorporated in this valve was discussed in the previous section.

To date thousands of Kent Introl Series 73 surface chokes have been installed around the world on projects for some of the worlds leading oil and gas companies.

CHOKE DESIGN SPECIFICATION

Examples of be-spoke designs supplied by Koso Kent Introl are illustrated above, with special piping configurations, block valves and electro-hydraulic actuated units.

SIZES
1" to 16" (25mm to 400mm).

RATINGS
ANSI 600 to 4,500 / API 3,000 to 15,000.

DESIGN STANDARDS
ISO 10423 / API 6A / API 17D / ANSI B16.34 / ASME VIII

STANDARDS
PED / ATEX / NACE MR01.75 / ISO 15156 / NORSOK.

END CONNS
ISO 10423 / API 6A / API 17D / ANSI Flanges / Hub type connections. Other end connections available on request.

TRIM DESIGN
HF, LCV, Microspline, Multi-spline, Vector and various Multi-stage trim options. Other special trim configurations available on request.

ACTUATION
A wide range of actuator options are available, including manual, pneumatic spring opposed diaphragm, pneumatic piston, pneumatic stepping, hydraulic stepping, electric, and electro-hydraulic.

Fig 26
In-line choke with Hydraulic actuator

CASE 4
SPECIALIST APPLICATION
FLASHING SERVICE

KKI have a great deal of experience of supplying valves that operate on flashing fluids, both contaminated and un-contaminated. Flashing service applications range from relatively benign conditions, i.e. when the downstream pressure is just below the fluid vapour pressure, to severe, i.e. when the fluid is flashing at inlet to the valve and with pressure drops in excess of 20 bar.

Through experience of supplying valves into the most arduous conditions found, i.e. in the North Sea, where there is also sand contamination to contend with, KKI has over the last 20 years developed a successful selection criteria for these applications.

From the on-set, KKI used multi-stage trim designs on such applications, however, it soon became apparent that this resulted in premature failure of the valve trim. The reason for this was that as soon as there was any pressure drop in the trim, the fluid started to 'flash', i.e. since the fluid was no longer in equilibrium, some of the liquid was converted to vapour. The resultant two phase flow has a significantly higher specific volume than the single phase flow leading to higher velocities and higher erosion rates. Thus the respective flow paths in each stage of let-down will subsequently see higher velocities and higher erosion rates. For this reason KKI will generally offer single stage let-down, in hardened materials, for flashing service applications. On higher pressure drops tungsten carbide is utilised to reduce erosion rates.

Fig 28
Illustration of a Tungsten Carbide trim that replaced a competitors torturous path trim design

KKI have retro-fitted a large number of competitors valves operating on such duties with single stage tungsten carbide designs. On heavily contaminated services, the LCV trim design has been supplied. This protects both the control and seating surfaces on the valve plug and seat from the erosive flow.

The image below shows a competitors multi-stage trim that has suffered from flashing erosion damage. The illustration in Fig 28 presents a tungsten carbide trim designed to replace the Fig 27.

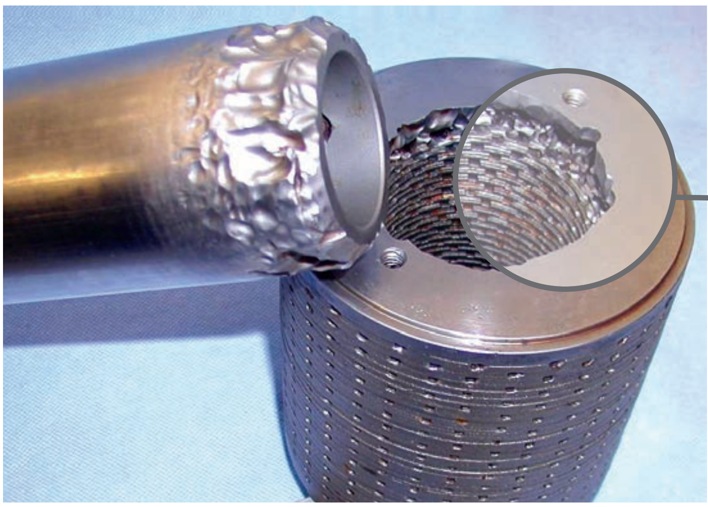


Fig 27
Competitor's torturous path trim design that failed on a Severe Service application due to contamination and Interstage flashing

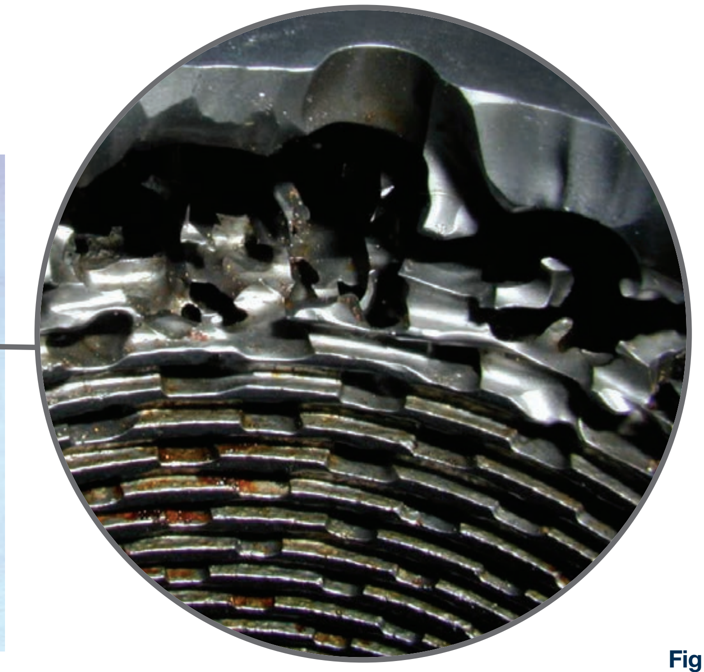


Fig 29
A competitors trim which has been replaced by a KKI tungsten carbide trim design

EROSION

When high velocity jets of liquid impinge against a solid surface some of the material will be eroded, the amount is dependant on the hardness and resilience of the material and on the impact velocity and angle of impact. The inclusions of abrasive particles in the liquid aggravate the erosive process.

High velocity jets of fluid emerging from the controlling orifices of the valve trim may result in the erosion of any surface on which they impinge and the effects of this will be enhanced if the fluid contains abrasive particles such as sand. High velocity jets of gas or vapour containing droplets of liquid can also produce severe erosion damage.

MATERIAL HARDNESS COEFFICIENTS

MATERIAL	β
Inconel (cladding)	175
Stainless 316	223
Stellite No 6	304
Stainless 17/4PH	334
Stainless 420	407
Tungsten Carbide	801

V = volume of material eroded mm3/mm2
u = velocity of fluid jet m/sec
ρ = density of fluid kg/m3
t = duration hours
β = coefficient depending on material hardness (refer to adjacent table)
θ = angle of incidence of a jet with surface degree (min. for use in the equation = 20°)

EROSION DUE TO CLEAN FLUIDS

As with cavitation, predictive calculations are difficult because there are so many variables affecting the rate of erosion.

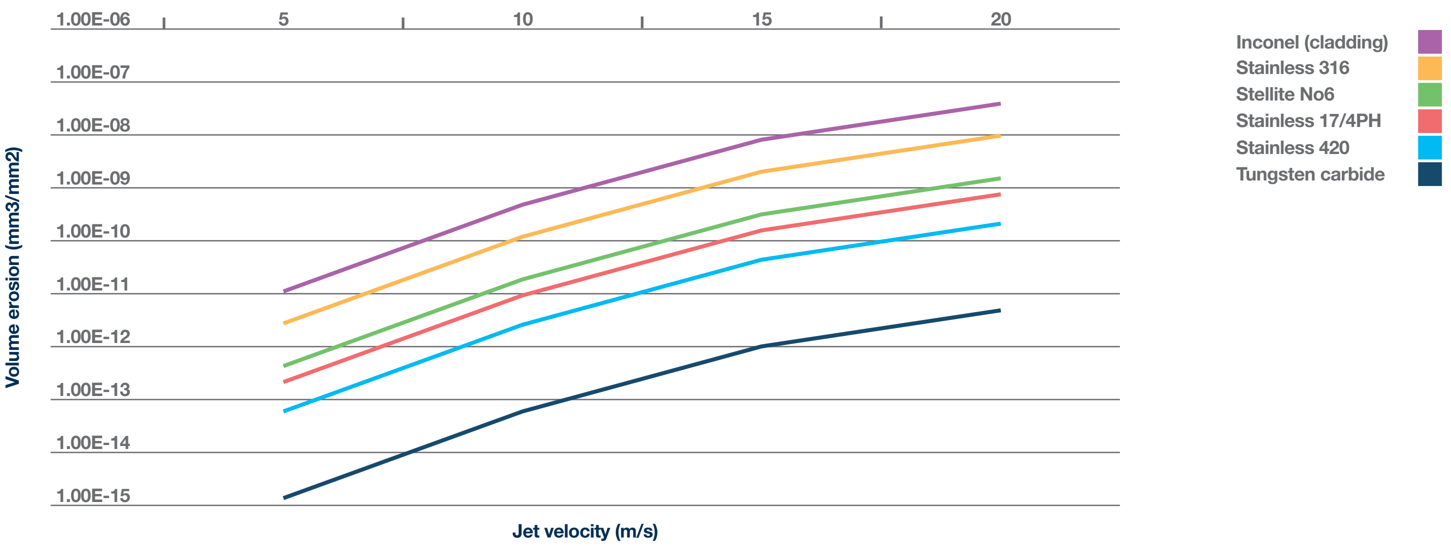
Research at universities and within the industry has produced some proposals and arguably the most user friendly of these from the valve applications engineers viewpoint is from the work carried out by M.M. Salama, E.S. Ventakesh and E. Rabinowicz.

The graph below relates erosion rate versus velocity for different material grades. This shows the significant improvements that can be made by utilising stellite or tungsten carbide on potentially erosive services.

$$V = f\,(u, \rho, \beta, t, \theta)$$

EROSION RATES FOR VARIOUS MATERIAL GRADES

Three years predicted erosion for clean liquids with an SG of 1 and an incidence angle of 90 Degrees



AERODYNAMIC NOISE

The control of this noise generation has been a major undertaking over many years. Over this period KKI have undertaken a number of Research Projects in order to gain a better understanding of this process.

Aerodynamic noise generation is attributed to the presence of high turbulence levels and shock waves in the valve, downstream of the flow restriction. The high levels of turbulence are a result of dissipating high levels of energy by throttling the flow. The turbulence energy is converted by a non-linear process into internal and acoustic energy, and subsequently the acoustic energy is propagated downstream with a small percentage being transmitted through the pipe wall and into the surroundings as acoustic sound waves.

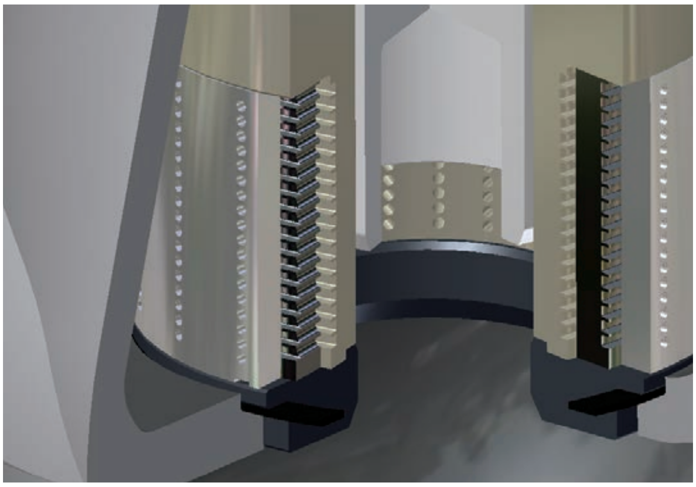


Fig 30 HFQ class low noise trim

Aerodynamically generated noise usually seems to emanate from a point in the downstream pipe-work approximately 1 to 2 pipe diameters from the exit of the valve. This distance is related to the pipe-work configuration and outlet flow velocity.

KKI has been providing solutions for high noise level applications since the 1960's. The development of these trims has advanced considerably with the aid of experimental research programmes and more recently Computational Fluid Dynamics.

KKI undertook an extensive research program during the 1980's into Aerodynamic noise generation within control valves. This resulted in the successful introduction of the low noise trim designs referred to as HFQ1 and HFQ2. These complemented the already proven HFD (Double Stage) and HFT (Triple Stage) trim designs previously used for low noise applications.

The preferred flow direction is "under" the plug for the HFQ trim design. This enables the optimum flow area increase as the flow passes through each stage of the trim. The result is a very low trim exit velocity and very high levels of noise attenuation. The flow geometry means that the process fluid enters the cage radially and passes through the subsequent sleeves in a torturous path resulting in high frictional and impingement losses. Shock wave formation is controlled by jet impingement on the sleeves, this has been shown to have a major (advantageous) bearing on the noise generation process.

The KKI family of HF trims (HF, HFD, HFT, HFQ1 & HFQ2) provide high levels of dynamic attenuation (upto 40dBA), whilst avoiding the problems of erosion and vibration.

Fig 31
5 stage (9 turns) low noise trim design

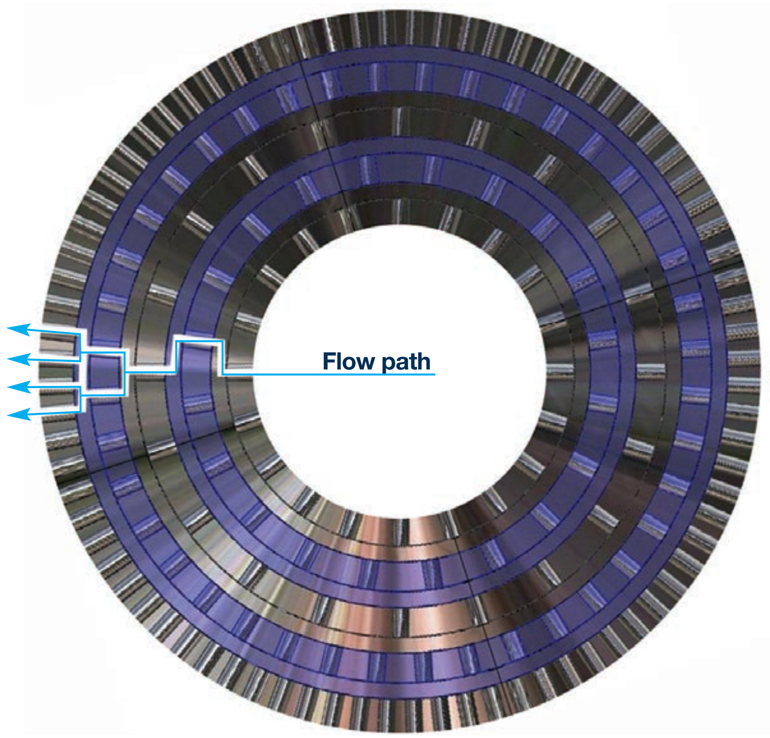


Fig 32
Plan view of a HFQ2 low noise trim

SILENCERS

In solving aerodynamic noise generation problems it must also be recognised that there is a need to control downstream velocities, otherwise high pipeline velocities can produce secondary noise which could be significantly higher than that produced by the valve trim.

It is generally accepted that to achieve a low noise solution, the downstream velocity should be restricted to less than 0.3 times the fluid sonic velocity. This coincides with the velocity at which compressibility effects start to become noticeable. In order to address this problem KKI utilise down stream silencers, these take the form of a taper pipe fitted with a number of baffle plates (circular plates with a number of drilled holes).

These are used to produce a back-pressure to the valve and are selected so that the velocity from the trim exit to the valve outlet is less than 0.3 times sonic velocity (0.3 mach).

Fig 33
Baffle plate

In utilising baffles the correct allocation of pressure drop to the trim and each baffle stage is important. At least 30% of the total pressure drop should be allocated to the valve trim, the remainder divided through the various pressure drop stages.

If a number of baffles are required, then it is advisable to allocate the pressure drop in diminishing magnitudes as they are located further away from the valve inlet, so that the last baffle takes the lowest pressure drop.

In selecting these devices it is necessary to ensure that the trim silencer system operates effectively over the full range of operating conditions. This approach has been used successfully by KKI for in excess of 30 years.

Certain valve manufacturers will endeavour to exclude the use of battle plates as dynamic attenuators because of the commercial advantage it provides against larger valve solutions. However, there is no valid technical reason why silencers/baffles should not be used, on the proviso that all operating conditions have been considered in their selection.

Fig 34
Control valve c/w taper pipe and baffle pack

CASE 5
SPECIALIST APPLICATION
SURGE CONTROL (INCOMPRESSIBLE FLUIDS)

If there is a sudden closure of a valve or a trip out of a pump, either at the start or the end of pipeline or at an intermediary pump station, the flow at that point will be brought to rest or significantly reduced. The fluid upstream and down stream is not "aware" of this stoppage and continues to flow under its mass momentum.

The fluid upstream is compressed causing a pressure surge and downstream there will be a rarefaction in pressure, which will encourage reverse flow. Pressure surges and reverse flows are extremely dangerous causing damage to pumps and possible to fracture to the pipeline. A surge on a long pipeline operating at a normal pressure of 17.5 bar can generate a transient pressure of 96 bar if uncontrolled.

EXAMPLE OF SEVERE SERVICE SURGE CONTROL APPLICATION

The customer was experiencing severe vibration due to cavitation with a competitors control valve.

KKI were asked to a provide a trial valve that would eliminate all the cavitation, provide stable control while the valve would be subjected to extremely high velocities and the valve had to fit into the existing space on the pumping station.

Seven Stages of pressure drop were used to ensure that the pressure of the medium did not drop below the vapour pressure, thus preventing cavitation and eliminating both the noise and vibration that were previously being experienced with one of our competitors valves.

Great care was also taken to control the velocity through the valve. Although the valve was described as a 16" angle design, the trim components and size were the same as used on a 24" valve.

Prior to shipment to Alaska the valve was fully tested in house for confirmation of both the CV and flow characteristic.

After successful extensive customer trials Koso Kent Introl received an initial order for 36 Anti-surge Pipeline Control Valves, each one specifically designed around the flow conditions of each individual pump. KKI subsequently received and delivered a further order for 10 more units.

In 2009 the valves continue to function satisfactorily with minimum service requirements.

Fig 35
Alaska pipeline Anti-surge Severe Service control valves

CASE 6
SPECIALIST APPLICATION
COMPRESSOR RE-CYCLE/ ANTI-SURGE CONTROL VALVES (COMPRESSIBLE FLUIDS)

Although all control valve applications are sized considering all the operating conditions and ensuring adequate valve openings for control, the anti-surge does require particular attention.

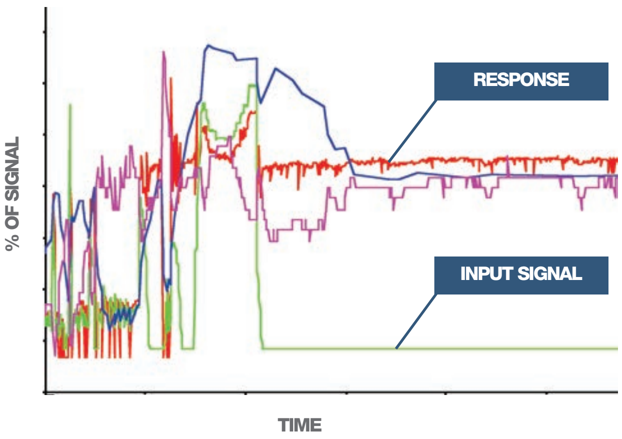


Fig 36 Eratic response due to vibration

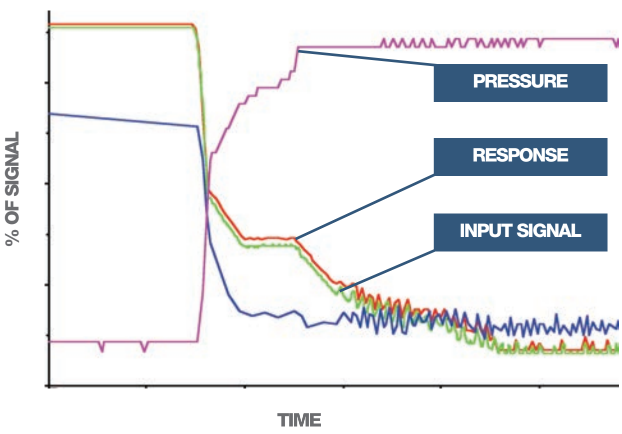


Fig 37 Trace after modification

Usually, the valve specification states the exact requirements, i.e. the maximum range of the valve design Cv. These are specified to ensure that when the valve is brought into service it can control the flow so that the compressor does not move towards a surge condition.

An additional requirement for this application is for the valve to respond quickly under either a trip or modulating condition. This requires a sophisticated instrumentation configuration utilising volume booster and trip valves. These have to be set up to ensure a stable control in operation.

Another problem that has to be considered on this particular application is vibration, many valve manufacturers have over the years encountered such problems on this particular application. One of the main contributors to this is the adverse piping configurations that are created in an attempt to minimise the footprint of the plant. This together with adverse operating conditions, i.e. high pressure drop can result in problematic vibration problems. In order to counter this KKI apply a specific set of rules in the selection of the valve for this application.

The graphs shown in Figs 36 and 37 present traces of the actual valve opening conditions during a re-cycle operation. Under most of the operational range the valve control remained stable. However, under certain instances the response of the valve was eratic as shown in Fig 36. The green and red lines are the input (instrument signal) and output (valve position) of the device. This shows that although the input signal (green) is requesting the valve to close, the valve actually remains open as shown by the red trace. Corresponding with this occurrence was a sudden increase in SPL. This was not aerodynamic noise generation, it was a result of high vibration levels at a discrete frequency due to fluid induced resonance.

Numerous attempts at resolving the problem only partly resolved the issue. This was largely due to the unpredictable nature of the problem. A complete review of the process was undertaken, and various modifications to the trim design and guiding were incorporated into the replacement trim design. The valve was put back into service and retested. In order to verify the performance of the modification a slight sinusoidal signal was incorporated into the input signal, Fig 37 represents the results obtained from this test. The excellent correlation between the input signal and output signal indicate how the modifications have improved the control system. Several other problem re-cycle applications were resolved using the same design philosophy.

VECTOR LABYRINTH TRIMS

KKI supply the Koso VeCTor Severe Service Labyrinth Trims. These trims extend the capability of KKI to offer trim designs for the most severe operating conditions now found in the various industries served.

KKI are in the enviable position of being able to supply the most appropriate design for the specified application whether high pressure drop cavitating, high pressure drop flashing or high pressure drop gas application, this proven trim design delivers accurate control, long life, free from cavitation, erosion, vibration and noise problems.

The design has evolved through many decades of experience in solving severe service applications where durability, reliability, repeatability and accurate / precise control are required. The advanced design velocity control trim prevents generation of noise and / or cavitation at the source.

The typical applications that the Koso Vector Labyrinth trim has been supplied on are basically the same as listed on page 3 of this document, and include compressor re-cycle, turbine by-pass and pump recirculation.

The Koso Vector Labyrinth trims limit harmful flow velocities by separating the flow into smaller individual channels, and then stage the full pressure drop across multiple turns in the fluid path. This is the basic principle of the HFL trim design, however, on the Vector designs the allowed pressure drops are significantly lower, leading to much lower velocities that are well within any threshold for erosion for the majority of trim materials.

In addition to the Vector D Labyrinth trim shown in Fig 40 Koso has also developed the Vector M Multi-step trim, shown below. This gives a smooth and continuous increasing flow over the full travel of the valve. This eliminates the inherent stepped flow that occurs in most stacked disc designs, see Fig 38.

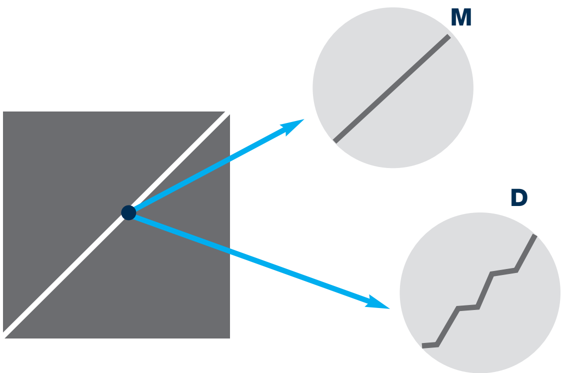


Fig 38
Flow characteristic comparison between D and M Vector

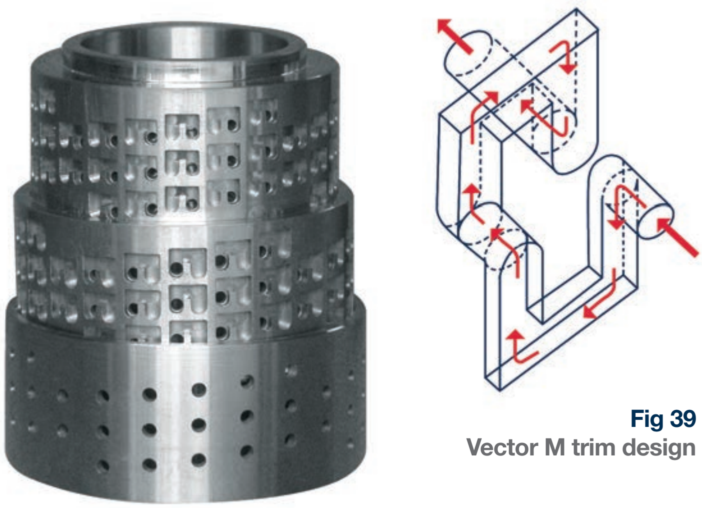


Fig 39
Vector M trim design

Fig 40
Vector D Labyrinth disc

PERFORMANCE TESTING

KKI continually tests their products to ensure that the units meet the ever-changing requirements of the specific Industry that the units will be used in.

Some of the tests that are carried out include the following:

- Flow Testing – To verify valve size and the trim characteristic
- Bend Testing – To verify the end loads
- High Temperature Testing – To verify suitability at elevated operating temperatures
- Noise Testing – To confirm our noise prediction techniques
- API 6A / 17D Testing – To ensure the products are in accordance with the standards
- Vibration Analysis – To verify the stability of the valve under high-energy applications
- Erosion Qualification & CFD reports – To provide an indication of the life expectancy of a valve trim
- Cryogenic / Low Temperature test – to verify Control Valve operation at sub zero temperatures
- Life Cycle Testing – To simulate and verify the life expectancy of the valve components
- Trim Impact Testing – To verify that the trim will not collapse when hit by large solid contaminants travelling at high velocity
- Emission Testing – To prove that the valve integrity is suitable to prevent leakage to the atmosphere.

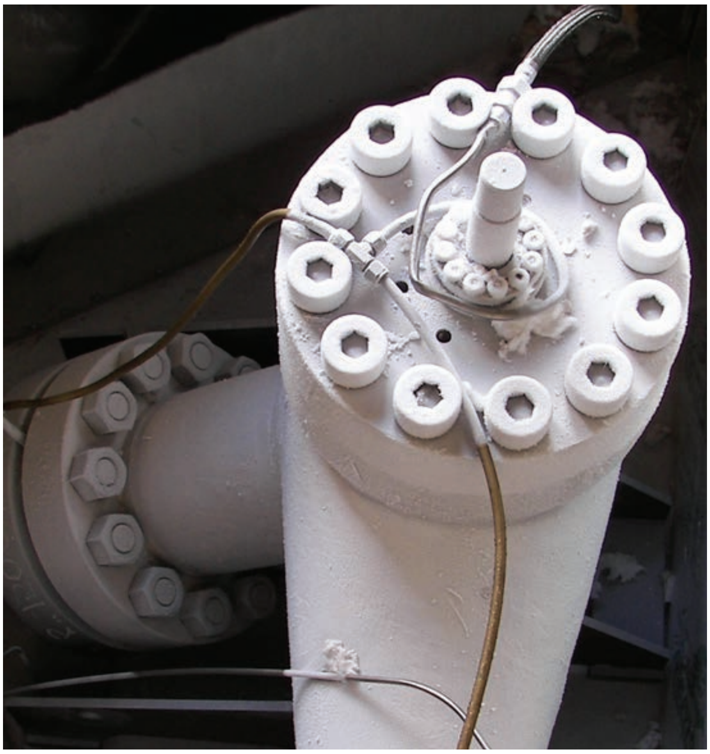


Fig 42
Choke valve during cryogenic testing

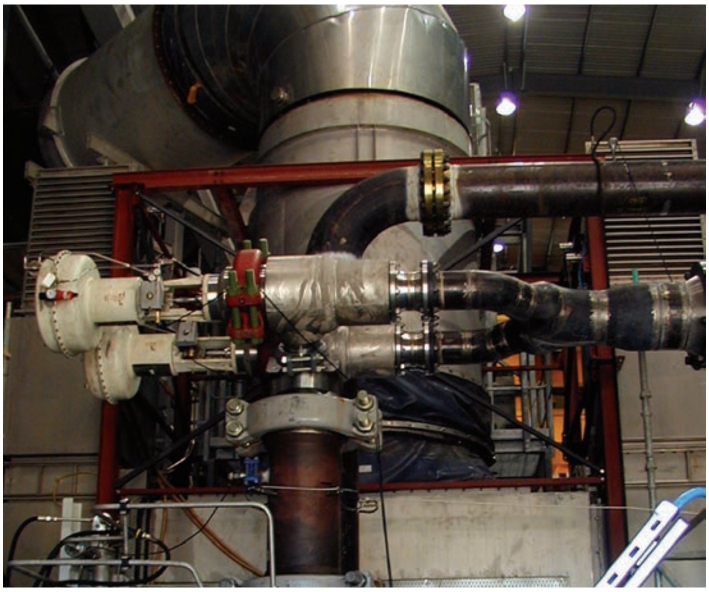


Fig 41
Turbotrol valve on 480 bar test loop – undergoing FAT

Fig 43
Control valve during flow testing

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