For Process Automation

GENERAL CATALOG

CONTROL VALVES

ACTUATORS

INSTRUMENTS

FA • SYSTEMS

CHEMICAL PUMPS

PRODUCTION

KOSO

Since its establishment, the KOSO group has developed a diverse range of high-quality control valves of diversified types, greatly contributing to the implementation of process automation (PA) in various industries.

In 1976, KOSO started to develop, manufacture, and sell automation systems utilizing the abundant experience and know-how earned by that time. Today, even stronger from strategic acquisitions, KOSO is able to offer a complete line of automation systems, including sensors, controllers, and computers.

KOSO stands ready to meet every customer need with the best products available as they strive to equip themselves with the total automation systems of the next century.

AUTOMATION SYSTEMS

JAPAN

Nihon KOSO Co., Ltd.
Tokyo KOSO Co., Ltd.
KOSO Service Co., Ltd.
KOSO Engineering Co., Ltd.
KOSO Co., Ltd.
Nihon KOSO Fuji Co., Ltd.
Herutu Electronics Co., Ltd.
Toyo Steel Belt Ind. Co., Ltd.
Tokyo Okazaki Ind. Co., Ltd.
Shinkosha Co., Ltd.
Tensho Printing Co., Ltd.
Soto Seisakusho Co., Ltd.

OUTSIDE JAPAN

KOSO America, Inc. [Rexa]
KOSO M-Mac International, Inc.
PACIFIC Seismic Products, Inc.
KOSO Kent Introl Ltd.
KOSO Controls Asia Pte. Ltd.
KOSO Fluid Controls Private Ltd.
Kent Introl Private Ltd.

JOINT ENTERPRISES

KOSO - AACI (Anshan) Co., Ltd.
Hangzhou Hangyang KOSO Pump & Valve Co., Ltd.

TECHNOLOGY TRANSFER

Anshan Automation Control Instrument Co., Ltd.
Tianjin No. 4 Instrument Factory
I.M.I Bailey Birkett Ltd.

REP. AGREEMENTS

Ronan Engineering Company
Adalet-PLM
Sor Inc.
Drallim Controls, Ltd.

KOSO

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Corporate History

The creativity of youth is the key that can open the door to a wonderful future for mankind. At Nihon KOSO Co., Ltd., we believe that youthful power and “creativity” represent our corporate character. These are the two foundations upon which we have built our company into what it is today. With the beginning of this new century, our dreams continue to expand endlessly. At Nihon KOSO, we aspire to achieve the possibilities of the future as we exceed the expectations of the present.

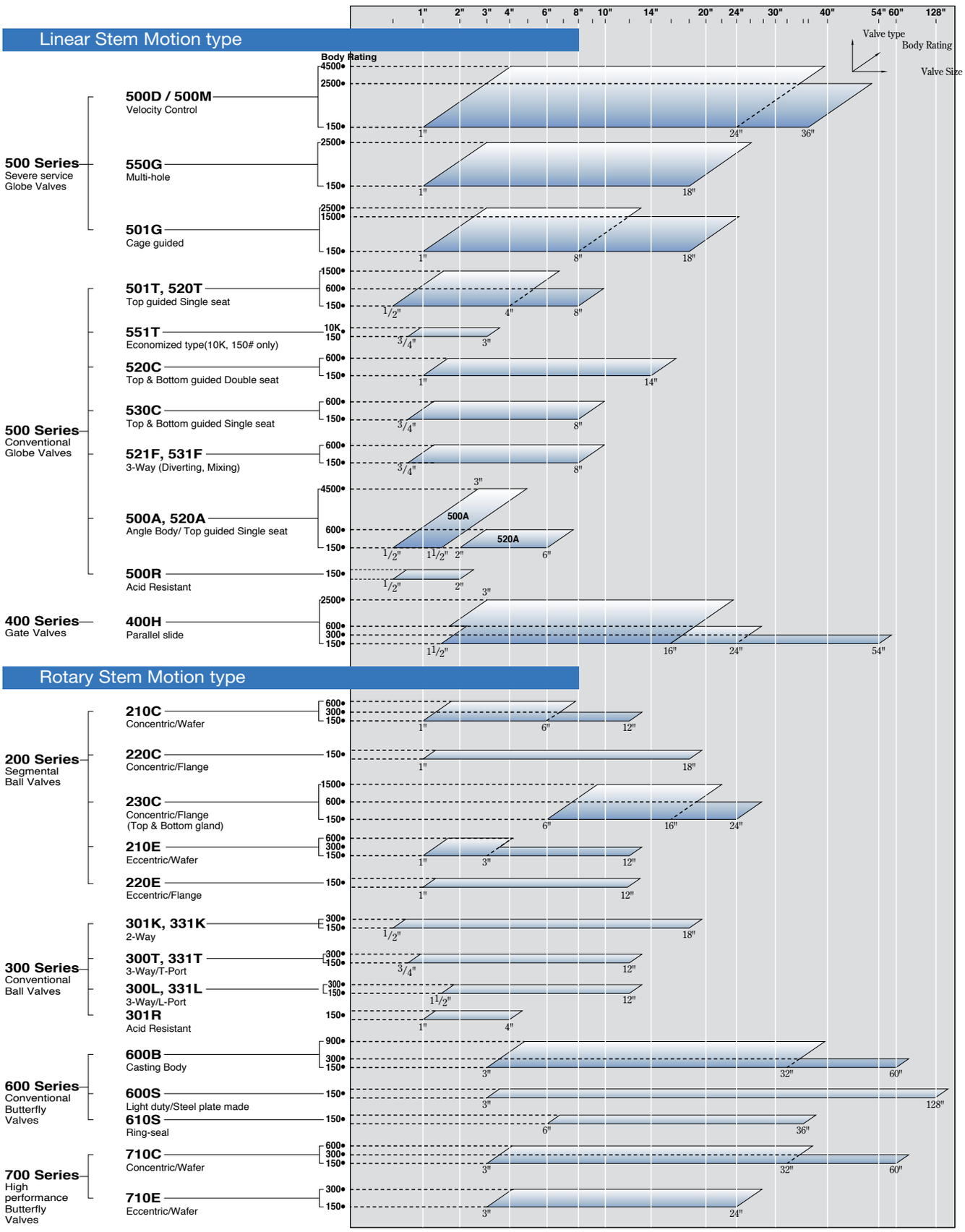
Year.Month	
1965.11	Starts business as control valve manufacturer
1966. 8	Establishes Nihon KOSO Industry Co., Ltd.(Manufacturing division)
1971. 6	Establishes Tokyo KOSO Co., Ltd.
1974.11	Acquires KHK (The High Pressure Gas Safety Institute of Japan) certification
1976. 3	Establishes KOSO Engineering Co., Ltd.
12	Establishes KOSO Service Co., Ltd.
1977. 2	Establishes Nihon KOSO Co., Ltd. (Sales division)
1978. 5	Establishes KOSO International, Inc.(U.S.A.)
1979. 3	Acquires A.P.I. certification
5	Establishes Korea Controls Co., Ltd. (as a joint enterprise)
9	Starts technology transfer negotiation with China National Technology Import & Export Corp.
1980. 4	Establishes KOSO Co., Ltd.
1982.11	Signs rep. agreement with Ronan Engineering Company of U.S.A. for sales to Japanese market
11	Acquires interest in Souto Seisakusho Co., Ltd.
1984. 5	Introduces IBM factory automation system
1985. 2	Signs agreement with I.M.I Baley Birkett Ltd. of U.K. for technology transfer
4	Signs agreement with Anshan Instrument Co. of China for technology transfer
1986. 3	Signs agreement with Control Components Inc. of U.S.A. for a mutual technology transfer
5	Diagnosing Chinese business for technology renovation. (JAPAN-CHINA NATIONAL PROJECT)
1987. 5	Acquires UNDERWRITERS LABORATORIES INC. certification
12	Signs agreement with Wuxi Instrument Valve Co., Ltd. of China for technology transfer
1988. 8	Establishes Korea KOSO Engineering Co., Ltd. (Korea)
1989. 5	Establishes Wuxi KOSO Control valve Co., Ltd. (as a joint enterprise) (China)
6	Establishes KOSO-AACI (Anshan) Co., Ltd. (as a joint enterprise)(China)
10	Signs rep. agreement with Adalet-Plm of U.S.A. for sales to Japanese market
1990. 1	Establishes Pacific Seismic Product, Inc. (U.S.A.)
5	Establishes Toren Co., Ltd.
1991. 3	Signs agreement with Tianjin No. 4 Instrument Factory of China for technology transfer
4	Signs rep. agreement with SOR Inc. of U.S.A. for sales to Japanese market
7	Acquires Herutu Electronics Co., Ltd.
1992. 3	Acquires Toyo Steel Belt Ind. Co., Ltd.
4	Signs rep. agreement with Drallim Controls Ltd. of U.K. for sales to Japanese market
1993. 5	Establishes KOSO Controls Asia Pte. Ltd. (Singapore)
5	Acquires the ownership of Korea Controls Co., Ltd. (Korea)
5	Establishes KOSO Control Engineering (Wuxi) Co., Ltd. (China)
8	Acquires Rexa Inc. of U.S.A. (Changes Rexa’s name to KOSO America, Inc.)
9	Acquires Shinkosha Co., Ltd.
1994. 6	Acquires ISO 9001 certification
1995. 9	Acquires Sigma Electric Works Co., Ltd
1996.10	Establishes KOSO Control Engineering Co., Ltd. (China)
2000. 1	Acquires Tokyo Okazaki Industries Co., Ltd.
7	Korea Controls Co., Ltd. changes its Korean name to KOSO
2001. 2	Merges Nihon KOSO Co., Ltd.(Manufacturing division)with KOSO Service Co., Ltd.
6	Establishes KOSO Fluid Controls Private Ltd. (India)
2002. 1	Acquires Tensho Printing Co., Ltd.
2	Establishes Hangzhou Hangyang KOSO Pump & Valve Co., Ltd.
3	Establishes SP Laboratory Co., Ltd.
4	Establishes Wuxi KOSO Valve casting Co., Ltd.
7	Acquires the assets of Hammel Dahl globe control valves line
2005. 6	TOREN Co., Ltd. Changes its name to Nihon KOSO Fuji Co., Ltd.
6	Acquires the assets of Kent Introl products line
6	Establishes KOSO Kent Introl Ltd. (U.K.)
6	Establishes Kent Introl Private Ltd. (India)

KOSO

KOSO PRODUCTS FOR AUTOMATION SYSTEMS

- PROCESS CONTROL SYSTEMS
  - CONTROL SYSTEMS
  - SENSOR - INSTRUMENTS
  - WIRELESS SIGNAL TRANSMISSION SYSTEMS
  - CONTROL VALVES & ACTUATORS
    - SEVERE SERVICE CONTROL VALVES
    - GENERAL SERVICE CONTROL VALVES
    - ACTUATORS
    - ACCESSORIES
    - DESUPERHEATERS
- FACTORY AUTOMATION SYSTEMS
  - SYSTEM DESIGN - CONTROL PANELS
  - AUTOMATED MACHINES
  - STAINLESS STEEL BELTS
  - WIRELESS COMMUNICATIONS & CONTROLS
  - OTHERS
- PROLONGATION OF VALVES SYSTEMS LIFE TIME
  - NET SYSTEMS FOR CUSTOMER SATISFACTION CENTERS
  - DEVELOPMENT OF LONG-LIFE VALVES & ACTUATORS
- IT - MULTI-MEDIA & OTHERS

KOSO CONTROL VALVE RANGES



20 INCH SEVERE SERVICE VALVES 600# ANSI

20 INCH SEVERE SERVICE VALVES

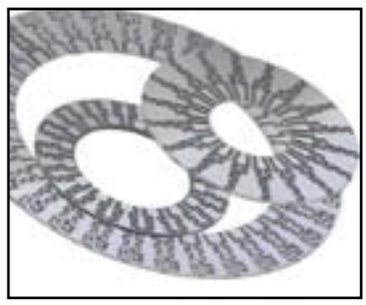
VECTOR™ SERIES SEVERE SERVICE GLOBE VALVES

KOSO VECTOR™

500M: VECTOR™ M trim

500D: VECTOR™ D trim

500J: VECTOR™ J trim



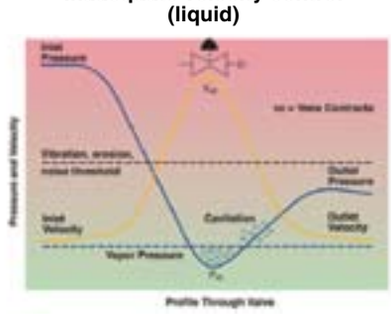
In severe services with high temperature and high differential pressure, KOSO's multi-stage VECTOR™ trim promises accurate control and long life, free from cavitation erosion and noise problems, whether the fluid is compressive or non-compressive. This Series is multi-advantageous in that its improved performance and durability allows maintenance cost reduction and system simplification. Since such ancillaries as diffusers and silencers are not necessary and equipment cost can be reduced. With 500M, 500D and 500J VECTOR™ trim choices, depending on the fluid condition, the most suitable model can be selected by comparing features.

6300LA/540M

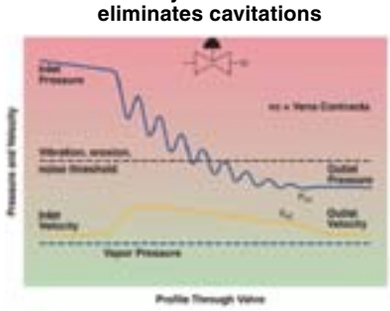
5200LA/530M

510M

Inadequate velocity control (liquid)



Velocity control valve eliminates cavitations



Specifications

		500M Globe/Angle	500D Globe/Angle	500J Globe/Angle
	Body type / Body Styles			
	Body size	1" (25A) ~ 36" (900A)	1" (25A) ~ 36" (900A)	1" (25A) ~ 18" (450A)
	Body rating	ANSI Class 150 ~ 4500 · JIS10K ~ 63K	ANSI Class 150 ~ 4500 · JIS10K ~ 63K	ANSI Class 150 ~ 2500 · JIS10K ~ 63K
	Fluid temperature	-196 ~ +565°C (-320 ~ +1050°F)		
	Connections	Flanges (RF, RTJ), Butt Weld, Socket Weld, Integral Flanges (RF, RTJ)		
	Body materials	SCPH2 / WCB, SCPH21 / WC6, SCPL1 / LCB, SCS13A / CF8, SCS14A / CF8M, A105, F11, F22, etc…		
	Trim materials	SUS410/410SS, SUS316, INCONEL, F11(STELLITED) etc…		
	Rangeabillty	50:1 ~ 20:1		
	Flow characteristics	Linear, Modified Linear, Eq% Modified Eq%		
Leakage	Metal seat	ANSI Class IV, V or MSS-SP-61		
Leakage	Soft seat	ANSI Class VI		
	Trim Levels	Up to Level 24	Up to Level 40	Up to Level 8
	Actuator combination	5200LA: Pneumatic Diaphragm Actuator 6300LA: Pneumatic Cylinder Actuator 3500LB,3600LB: Solid State Electronic Actuator 3800LA: Microprocessor REXA Actuator		

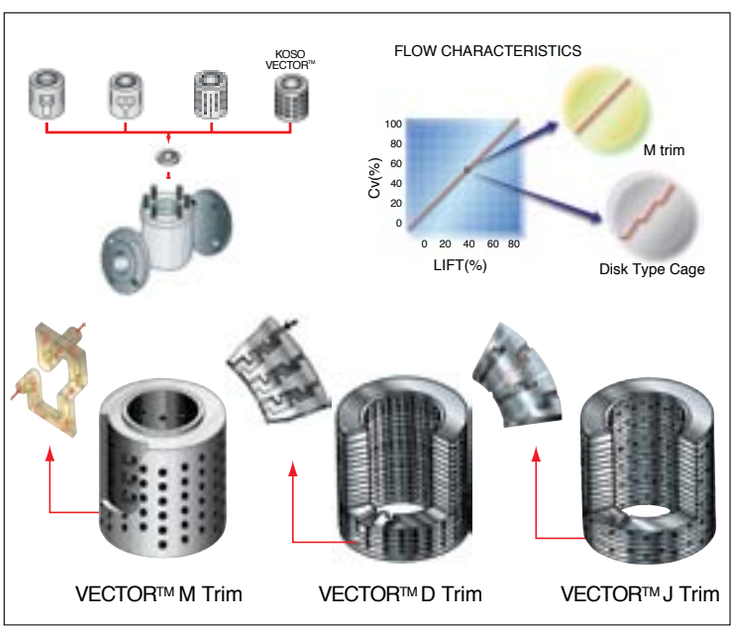
500 SERIES SEVERE SERVICE GLOBE VALVES

501G: Cage Guided Control Valves

550G: Multi-hole Cage Guided Control Valves

The 501G series is our latest cage guide control valve with large Cv value, and dynamic stability. It is suitable for a variety of heavy duty services. This series is characterized by pressure balanced type trim for high pressure drops.

The 550G series provides control valves that meet low noise and anti-cavitation requirements by incorporating multi-hole type cages, instead of the standard cages, in the 501G series cage guided control valves. All the parts except the multi-hole cage are interchangeable with the parts of the 501G series. For severe fluid conditions that cannot be covered by this series, you can choose from KOSO's VECTOR™ velocity control trim options.



6300LA/501G

5200LA/550G

Specifications

	Body type:Style	550G : Globe type 560G : Angle type	501G : Globe type 511G : Angle type
	Body size	1" (25A) ~ 18" (450A)	1" (25A) ~ 18" (450A)
	Body rating	ANSI Class 150 ~ 2500 · JIS 10K ~ 63K	ANSI Class 150 ~ 2500 · JIS 10K ~ 63K
	Fluid temperature	-196 ~ +538°C, (-320 ~ +1000°F)	-196 ~ +538°C, (-320 ~ +1000°F)
	Connections	Flanges (RF,RTJ), Butt Weld, Socket Weld, etc.	
	Body materials	SCPH2 / WCB, SCPH21 / WC6, SCPL1 / LCB,SCS13A / CF8, SCS14A / CF8M, etc.	
	Trim materials	SUS410/410SS, SUS630/SCS24, SUS316/CF8M, etc.	
	Rangeability	20:1 ~ 5:1	50:1 ~ 20:1
	Flow characteristics	Linear, Modified Linear, Modified Eq%	Linear, Eq%
Leakage	Metal seat	ANSI Class IV,V or MSS-SP-61	
	Soft seat	ANSI Class VI	
	Actuator combination	5200LA:Pneumatic Diaphragm Actuator 6300LA:Pneumatic Cylinder Actuator 3500LB,3620LA:Solid State Electronic Actuator 3800LA:Microprocessor Actuator	

500 SERIES CONVENTIONAL GLOBE VALVES

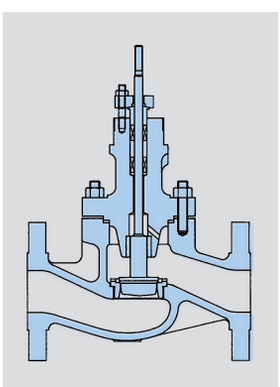
501T: Top Guided Single Seat Globe Valves

551T: Top Guided Single Seat Globe Valves/JIS10K and ANSI class 150 only

520T: Small Plug Single Seat Globe Valves

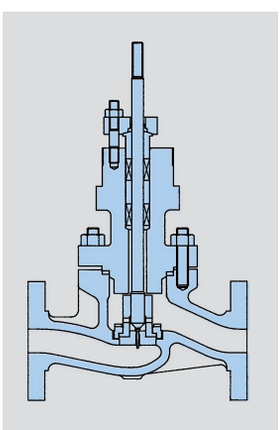
KOSO top-guided control valves are compact and simple structured. They are usable in a broad scope of applications, including all cavitation-free liquid services as well as steam and gas services that meet noise regulations. Aiming at quick delivery and low prices, the 551T model is limited to JIS 10K, ANSI (JPI) 150 lbs. with no optional features. The 520T model covers minimum flow applications, with its small plug, specially designed for durability.

5200LA/501T



501T

5200LA/551T



520T

Specifications

Body type		501T : Globe type 511T : Angle type	551T : Globe type —	520T : Globe type —
Body size		1/2" (5A) ~ 8" (200A)	3/4" (20A) ~ 3" (80A)	1/2" (15A) ~ 1" (25A)
Plug size		1/8" (6A) ~ 8" (200A)	1/4" (8A) ~ 3" (80A)	1/64" (1A) ~ 1/16" (3A)
Body rating		ANSI Class 150 ~ 1500 · JIS 10K ~ 63K	ANSI Class 150 · JIS 10K	ANSI Class 150 ~ 600 · JIS 10K ~ 40K
Fluid temperature		-196 ~ +538°C (-320 ~ +1000F°)	-5 ~ +200°C (-23 ~ +392F°)	-45 ~ +538°C (-49 ~ +1000F°)
Connections		Flanges (RF,RTJ), Butt Weld, Socket Weld.		
Body materials		SCPH2 / WCB, SCPH21 / WC6, SCPL1 / LCB, SCS13A / CF8, SCS14A / CF8M, etc.		
Trim materials		SUS316, SUS316+Stellite, SUS316+TFE etc.		SUS316+Stellite
Rangeability		50:1 ~ 30:1		6.8 ~ 8.8
Flow characteristics		Linear, Eq%, On-Off	Modified Eq%	Needle flow
Leakage	Metal seat	ANSI Class IV		
	Soft seat	ANSI Class VI		—
Actuator combination		5200LA:Pneumatic Diaphragm Actuator 6300LA:Pneumatic Cylinder Actuator 3500LB, 3600LB:Solid State Electronic Actuator 3800LA:Microprocessor Actuator		

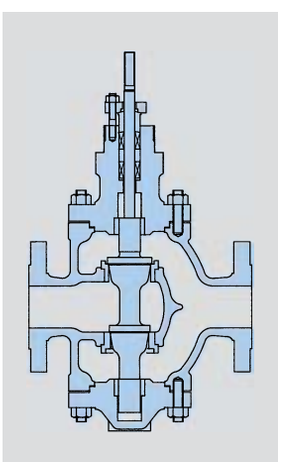
500 SERIES CONVENTIONAL GLOBE VALVES

520C: Top and Bottom Guided Double Seated Globe Valves

530C: Top and Bottom Guided Single Seated Globe Valves

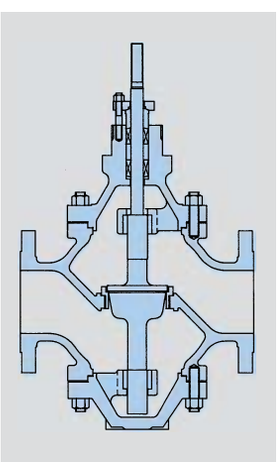
These series represent typical conventional top and bottom guided control valves. Supported above and below the plug, they easily deal with vibration-prone conditions, high temperature services and special material combinations, which makes them well-suited for a wide range of applications.

5200LA/520C



520C

5200LA/530C



530C

Specifications

		520C	530C
Body type		520C	530C
Body size		1" (25A) ~ 14" (350A)	3/4" (20A) ~ 8" (200A)
Body rating		ANSI Class 150 ~ 600 · JIS 10K ~ 40K	
Fluid temperature		-196 ~ +538°C (-320 ~ +1000°F)	
Connections		Flanges (RF,RTJ), Butt Weld, Socket Weld.	
Body materials		SCPH2 / WCB, SCPH21 / WC6, SCPL1 / LCB, SCS13A / CF8, SCS14A / CF8M etc.	
Trim materials		SUS316, SUS316+Stellite	
Rangeability		30:1	
Flow characteristics		Eq%, Linear, On-Off Q-Port	
	P-port plug	ANSI Class II	ANSI Class IV
	Q-port plug	—	Rated Cv × 0.001%
Actuator combination		5200LA: Pneumatic Diaphragm Actuator 6300LA: Pneumatic Cylinder Actuator 3500LB, 3600LB: Solid State Electronic Actuator 3800LA: Microprocessor Actuator	

500 SERIES CONVENTIONAL GLOBE VALVES

521F: 3-Way Diverting Globe Valves

531F: 3-Way Mixing Globe Valves

Diverting valves that divide the into two directions and mixing valves that converge two flows into one are available.

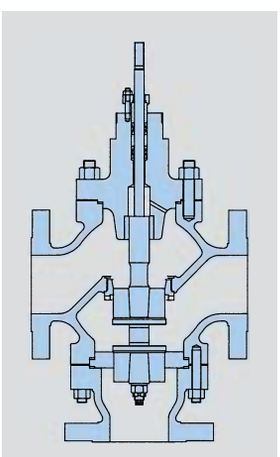
For valve size 2.5 in. (65A) or under, 531F (mixing type) can also be used as a diverting valve with no functional problem.

500A: Top Guided Single Seated Angle Valves /Forging Body

520A: Top Guided Single Seated Angle Valves/Casting Body

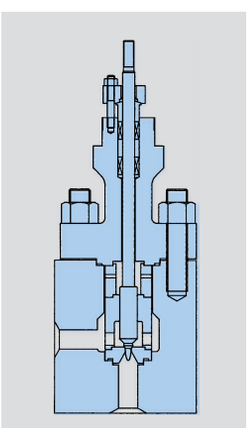
With this series, slurry-containing fluids, high viscosity fluids, flashing fluids or super high differential pressure fluids can be handled easily.

520LA/521F . 531F



531F

5200LA/520A



500A

Specifications

Body type	521F · 531F	520A	500A
Body size	3/4" (20A) ~ 8" (200A)	2" (50A) ~ 6" (150A)	1/2" (15A) ~ 1 1/2" (40A)
Body rating	ANSI Class 150 ~ 600 · JIS 10K ~ 40K	ANSI Class 150 ~ 600 · JIS 10K ~ 40K	ANSI Class 150 ~ 4500 · JIS 10K ~ 63K
Fluid temperature	-45 ~ +300°C (-49 ~ +572°F)	-45 ~ +300°C (-49 ~ +572°F)	-196 ~ +538°C (-320 ~ +1000°F)
Connections	Flanged(RF)	Flanged(RF, RTJ)	Integral Flanged (RF,RTJ) Socket Weld
Body materials	SCPH2 / WCB, SCS13A / CF8, SCS14A / CF8M		A105, F11, F22, SUS316 etc.
Trim materials	SCS14A / CF8M, SCS24	SUS316, SUS316+Stellite	SUS316, SUS316+Stellite
Rangeability	30:1	30:1	30:1 ~ 10:1
Flow characteristics	Linear, ON-Off	Eq%, Linear	
Seat leakage	ANSI Class III	ANSI Class IV	
Actuator combination	5200LA: Pneumatic Diaphragm Actuator 6300LA: Pneumatic Cylinder Actuator 3500LB, 3600LB: Solid State Electronic Actuator 3800LA: Microprocessor Actuator		

500 SERIES CONVENTIONAL GLOBE VALVES

500R: Acid Resistant Type Globe Valves

This series provides globe style control valves for controlling corrosive and/or poisonous fluids. Body parts are made of pure teflon and gland parts are completely sealed by a bellow seal bonnet made of pure teflon. The valve body is covered by cast iron or stainless steel which is resistant to external shock.

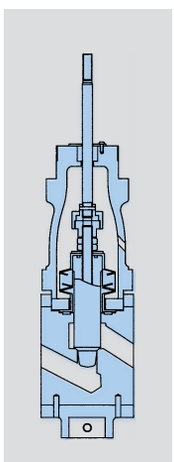
500S: Small Flow Control Valves

This valve series is compact size, light weight, and high-performance.

It is suitable to service controlling very small flows like in test plants, laboratories, etc.

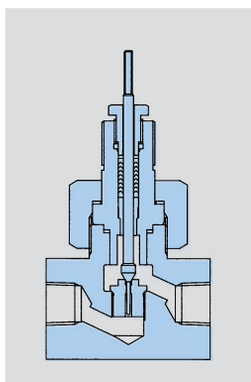
The valve body is designed to withstand up to 300Kgf/cm2G pressure.

5200LA/500R



500R

5800LA/500S



500S

Specifications

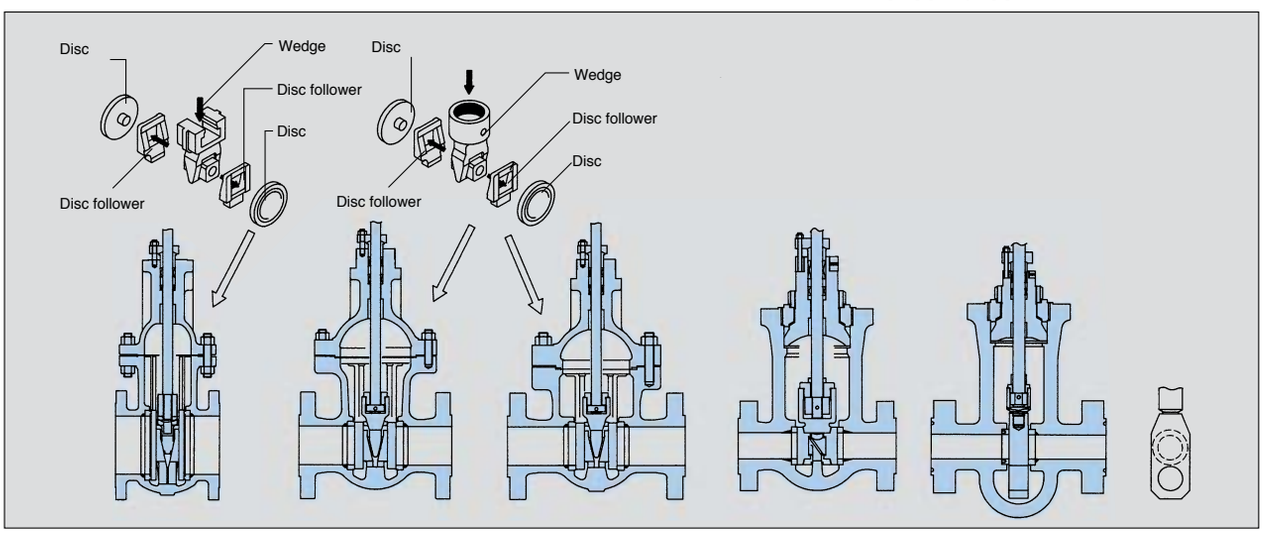
Body type	500R	500S
Body size	1/2" (15A) ~ 2" (50A)	1/2" (15A) ~ 3/4" (20A)
Body rating	JIS 10K Equivalent	ANSI Class 150 ~ 2500 · JIS 10K ~ 63K
Fluid temperature	0 ~ +150°C (-32 ~ +302°F)	–196 ~ +500°C (–320 ~ +932°F)
Connections	Wafer : 3/4 or Less, MFR Std : 1" or More	PT, NPT, Socket Weld
Body materials	Pure Teflon / Cover : FC250, SS400, SUS304	SUS316 SUS316, Other Alloy Steel
Trim materials	Pure Teflon	SUS316, Other Alloy Steel
Rangeability	30:1 ~ 15:1	30:1 ~ 10:1
Flow characteristics	Eq%, Linear	Eq%, Linear
Seat leakage	ANSI Class VI	ANSI Class IV
Actuator combination	5200 LA:Pneumatic Diaphragm Actuator 3500LB, 3600LB:Solid State Electronic Actuator	5800LA:Pneumatic Actuator

400 SERIES GATE VALVES

400H: Parallel slide valves

Parallel gate slide valves have KOSO's own design/construction to achieve superior metal-to-metal sealing performance. The excellent shut-off performance, brought about by the metal-to-metal sealing, makes it well-suited to a variety of severe service, including emergency shut-off/opening at extremely low or high temperature applications.

6100LA/400H



Class 150 Class 300 Class 600 Class 900/1500 Class 2500

Specifications

Body class	150/300	600	900/1500	2500
Body size	$1\frac{1}{2}$" (40A) ~ 54"(1350A)	$1\frac{1}{2}$" (40A) ~ 24" (600A)	3" (80A) ~ 16" (400A)	3" (80A) ~ 16" (400A)
Body rating	ANSI Class 150 / 300 JIS 10K ~ 30K	ANSI Class 600 JIS 40K	ANSI Class 900 / 1500 JIS 63K	ANSI Class 2500
Fluid temperature	-196 ~ +538°C (-320 ~ +1000°F)			
Connections	Flanged (RF, RTJ), Butt Weld, Socket Weld.			
Body materials	SCPH2 / WCB, SCPH21 / WC6, SCPL1 / LCB, SCS13A / CF8, SCS14A / CF8M etc.			
Disc materials	A105 / Stellited, SCM435 / Stellited, SUS304 / Stellited, SUS316 / Stellited			
Seat materials				
Rangeability	Standard type / 20:1 ~ 15:1 V-Orifice type / 30:1 ~ 20:1			
Flow characteristics	Approximate Linear			
Seat leakage	Rated Cv × 0.000001%			ANSI Class V
Actuator combination	5200LA: Pneumatic Diaphragm Actuator 6100LA: Pneumatic Cylinder Actuator Electric Motor Actuator(Limitorque, Rotork, Seibu, etc.)			

200 SERIES SEGMENTAL BALL VALVES

210C: Concentric segmental ball valves

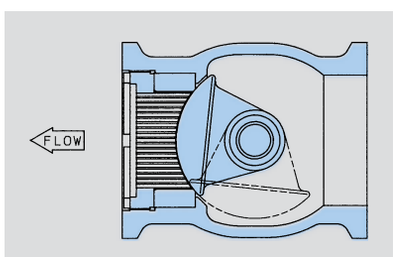
This series is a concentric segmental ball valve for modulating applications. A V-notch cut at disc makes rangeability larger and creates a shearing effect by disc and seal ring. Therefore, suitable to large rangeability service and/or control of fluids with entrained particles and/or slurry.

230C: Concentric segmental ball valves

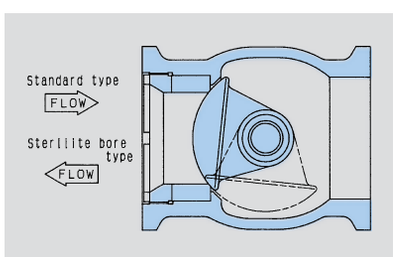
This series is the same as the 210C series except that the stem penetrates the body and is supported by double gland packing. The stem's blow out force is set off in this construction making it suitable for heavier services such as high pressure, high temperature service because of the heat expansion insulated stem design.

6300RB/210C

3620R/210C



210C ANTI-CAVITATION TYPE



210C CONCENTRIC TYPE

6400RB/230C

Specifications

		210C	220C	230C
	Body type			
	Body size	1"(25A) ~ 12"(300A)	1"(25A) ~ 18"(450A)	6"(150A) ~ 24"(600A)
	Body rating	ANSI Class 150 ~ 600 · JIS 10K ~ 40K	JIS 10K	ANSI Class 150 ~ 1500 · JIS 20K ~ 63K
	Fluid temperature	-45 ~ +500°C (-49 ~ +932°F)	-45 ~ +500°C (-49 ~ +932°F)	-45 ~ +650°C (-49 ~ +1202°F)
	Connections	Wafer type	Flanged(RF)	Flanged(RF, RTJ)
	Body materials	SCPH2/WCB, SCS13A/CF8, SCS14A/CF8M. etc.		
	Disc materials	SCS14A		SCS13A, SCS14A
	Disc treatment	Chrome plated or Stellited		
	Seal ring materials	R.TFE, SUS316		SUS304, 316
	Rangeability	500:1 ~ 100:1		100:1
	Flow characteristics	Approximate Eq% (Inherent Characteristic)		
Leakage	Metal seat	L Type seat : Reted Cv × 0.001% / H Type seat : Rated Cv × 0.25%		
Leakage	Soft seat	ANSI Class VI		
	Actuator combination	6300RB, 6400RB, 6500RA, 7300RA:Pneumatic Cylinder Actuator 3500RB, 3600RB:Solid State Electronic Actuator 3400RB:Electric Motor Actuator		

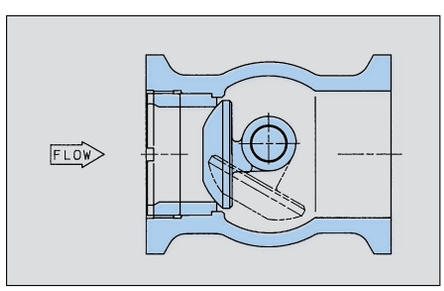
200 SERIES SEGMENTAL BALL VALVES

210E: Eccentric Segmental Ball Valves

This series of eccentric segmental ball valves is designed for modulating applications. Compared to a globe valve, the ball valve body is compact, light weight, and yet it offers large Cv value, large rangeability and can be converted to reduce bore type (60, 40% reduced) by changing only seal ring.

6300RB/210E

5200RA/210E



210E ECCENTRIC TYPE

Specifications

		210E	220E
	Body type		
	Body size	1" (25A) ~ 12" (300A)	1"(25A) ~ 12" (300A)
	Body rating	ANSI Class 150 ~ 600 · JIS 10K ~ 40K	ANSI Class 150 ~ 300 · JIS 10K ~ 20K
	Fluid temperature	-45 ~ +400°C (-49 ~ +752°F)	-45 ~ +400°C (-49 ~ +752°F)
	Connections	Wafer type	Flanged (RF)
	Body materials	SCPH2 / WCB, SCS13A / CF8, SCS14A / CF8M, etc.	
	Disc materials	SCS14A	
	Disc treatment	Chrome plated or Stellited	
	Seal ring materials	R.TFE, SUS316 / Stellited, SUS630	
	Rangeability	100:1	
	Flow characteristics	Approximate Linear (Inherent Characteristic)	
Leakage	Metal seat	ANSI Class IV	
	Soft seat	ANSI Class VI	
	Actuator combination	6300RB, 6500RA, 7300RA: Pneumatic Cylinder Actuator 5200RA: Pneumatic Diaphragm Actuator 3600RB: Solid State Electronic Actuator	

300 SERIES CONVENTIONAL BALL VALVES

301K: Straight Through Ball Valves

310K: Straight Through Ball Valves

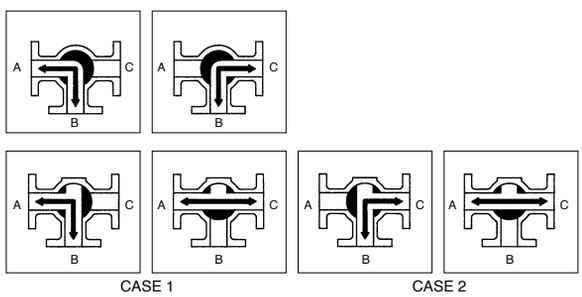
332K: Straight Through Ball Valves

331L: L port 3-way ball valves

331T: T-port 3-way ball valves

301R: Acid resistant ball valves

When totally opened a ball valve has the same bore as the pipeline and it's fluid resistance is negligible. For this reason, this automatic valve is best suited for on-off service, controlling various types of liquid, gas and slurry.



This series have teflon or polyvinyliden fluoride internal parts. This series has teflon or polyvinyliden fluoride internal parts. This model has excellent acid or corrosive fluid resistance. Outside of the internal parts is guarded by cast iron or stainless steel covers.

7300RB/301K

6300RB/332K

6300RA/331T

6300RB/301R

Specifications

Body type	301K	332K	331L · 331T	301R
Full bore size	1/2" (15A) ~ 16" (400A)	1/2" (15A) ~ 8"(200A)	1 1/2" (40A) ~ 12" (200A)	1" (25A) ~ 2 1/2" (65A)
Reduced bore size	4" × 3" ~ 18" × 16"	—	6" × 4" ~ 12" × 10"	3" × 2 1/2" ~ 4" × 3"
Jacketted valve size	11/2" × 1/2" × 1/2" ~ 10" × 8" × 6"	—	—	—
Body rating	150# ~ 600# · 10K ~ 40K	ANSI Class 150 ~ ANSI Class 300 · JIS 10K ~ 20K		ANSI Class 150 · JIS 10K
Fluid temperature	-45 ~ +250°C (-49 ~ +482°F)	-20 ~ +230°C (-4 ~ +446°F)	-20 ~ +200°C (-4 ~ +392°F)	-10 ~ +100°C (-14 ~ +212°F)
Connections	Flanged (RF)			Wafer Tapped
Body materials	SCPH2 / WCB, SCSBA / CF8, SCS14A / CF8M	SCPH2 / WCB, SCS14A / CF8M		PVDF / FCD or SCS13A
Ball materials	SUS316 / SCS14A, SCS13A Buffing	SUS316 / SCS14A Buffing	SCS14A / CF8M Buffing	PVDF
Seal ring materials	Pure Teflon, Reinforced Teflon			PTFE
Seat leakage	Tight shut off			
Actuator combination	6300RB, 6500RA, 7300RA : Pneumatic Cylinder Actuator 3200RA, 3300RA, 3400RB : Electric Motor Actuator			

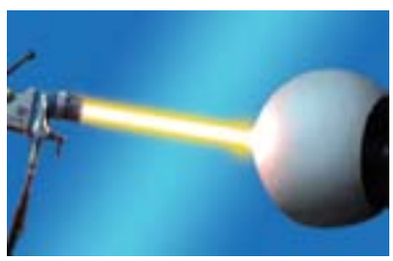
300 SERIES METAL SEATED BALL VALVES

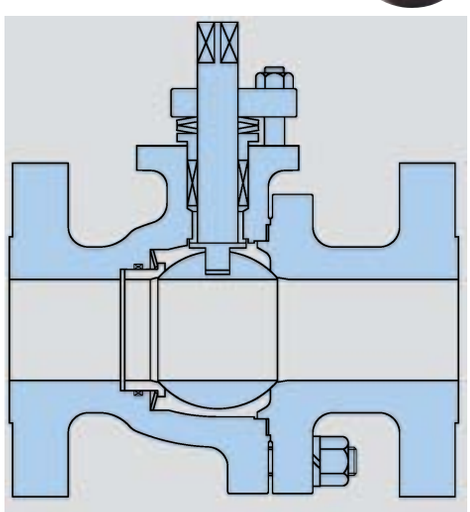
300W: Metal Seated Ball Valves

This ball valve series provides zero-leakage in several service applications with high temperature and/or high pressure. The ball and seat are hard coated with chrome carbide or tungsten carbide using Koso's HVOF coating system to provide high erosion and abrasion resistance. They are mate-lapped based on our own technique to ensure 100% sealing. Live loading also ensures zero emissions.

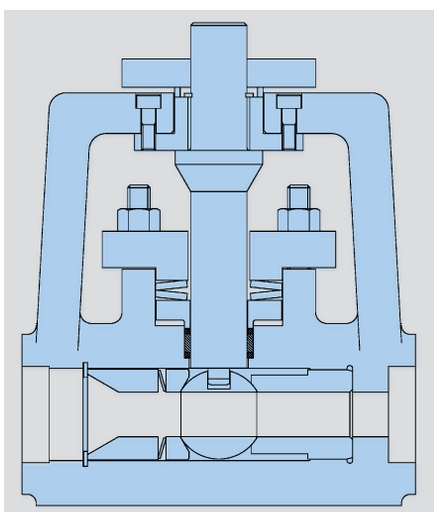
The ball never leaves the seat and wipes contaminants away. This self-cleaning action prevents interference and damage from contaminants. Therefore, this valve is suitable for the slurry service the abrasive services.

This flexible valve design be easily adapted to the flow characteristics of the service condition by simply changing the ball window shape.





300W



310W

Specifications

	Body Type	300W	310W
	Body Size	1" (25A) ~ 24" (600A)	1/2" (15A) ~ 1" (25A)
	Body Rating	ANSI Class 150 ~ 600 / JIS 10K ~ 40K	ANSI Class 600 / 900 / 1500 / 2500 / 2500 Special Class
	Fluid Temperature	-45 ~ 538°C (-49 ~ +1000°F)	-45°C ~ 600°C (-49 ~ +1112°F)
	Connections	Flanged (RF)	Socket Weld, Butt Weld / Flange RF (ANSI Class 600)
	Body Materials	SCPH2 / WCB, SCS13A / CF8, SCS14A /CF8M. etc.	A105/A182-F11 / A182-F22/A182-F91
	Ball/Seat Materials	SUS316 / SUS410	410SS / INCONEL
	Ball Treatment	TungstenCarbide / Chrome Carbide / Self-Fluxing Alloy	TungstenCarbide / Chrome Carbide
	Seat Treatment	TungstenCarbide / Chrome Carbide / Stellited	TungstenCarbide / Chrome Carbide
Leakage	Metal seat	0	0
	Structure	Floating / Trunnion	Floating

700 SERIES HIGH PERFORMANCE BUTTERFLY VALVES

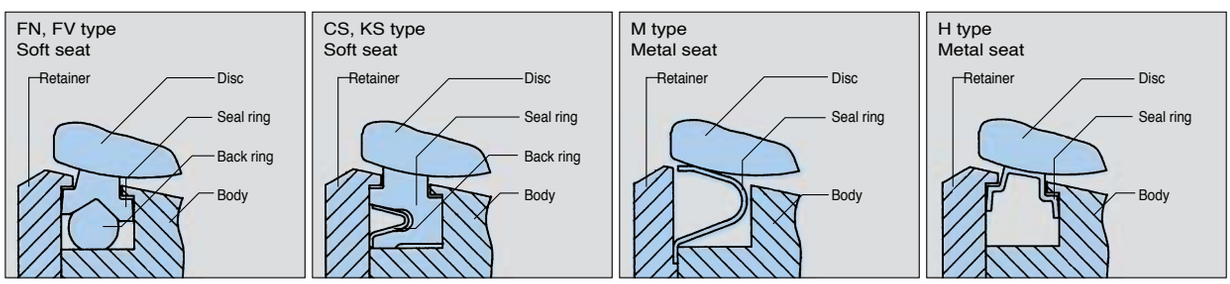
710C: Concentric PARA-SEAL C Valves

710E: Concentric PARA-SEAL E Valves

720E: Eccentric PARA-SEAL Valves

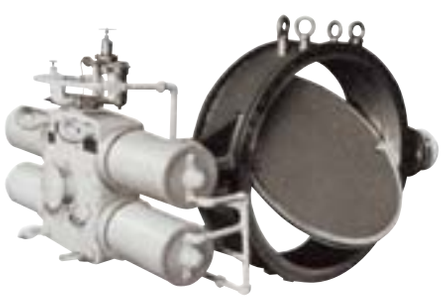
This PARA-SEAL valve is a high performance butterfly valve of high durability and high seating performance. It has several different seal ring constructions suitable for a variety of service applications.

Seal-ring Construction



6300RB/710E

5200RA/710E



6400RB/710C

3620R/710E

6300RB/710E

Specifications

Body type	710E		720E		710C	
Body size	3" (80A) ~ 24" (600A)				3" (80A) ~ 60" (1500A)	
Body rating	ANSI Class 150 ~ 300 · JIS 10K ~ 20K					
Fluid temperature	-196 ~ +500°C (-320 ~ +1000°F)				-196 ~ +600°C (-320 ~ +1200°F)	
Connections	Wafer type		Flanged (RF)		Wafer type	
Body materials	SCPH2 / WCB, SCS13A / CF8, SCS14A / CF8M, etc.					
Disc materials	SCPH2 / WCB, SCS13A / CF8, SCS14A / CF8M, etc.					
Disc treatment	Chrome plated or Stellited					
Rangeability	60° Opning / 25:1, 90° Opning / 50:1					
Flow characteristics	Approximate Eq% (Inherent Characteristic)					
Seal ring type	FN	FV	CS	KS	M	H
Seal ring materials	R. TFE	R. TFE	R. TFE	Kel-F	SUS316	SUS316, 630
Back ring materials	NBR	VITON	SUS316	SUS316	-	-
Seat Leakage	ANSI Class VI				Rated Cv × 0.01 ~ 0.00001%	
Actuator combination	6300RB, 6400RB, 6500RA, 7300RA: Pneumatic Cylinder Actuator 3500RB, 3600RB: Solid State Electronic Actuator 5200RA: Pneumatic Diaphragm Actuator					

600 SERIES CONVENTIONAL BUTTERFLY VALVES

600B: Butterfly Valves/Casting Body type

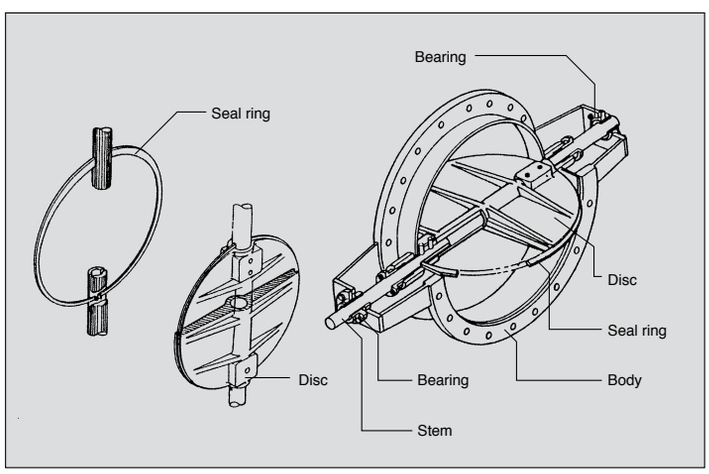
600S: Butterfly Valves/Fabricated Body type

610S: RING-SEAL type Butterfly Valves

This butterfly valve design features a metal seal ring with a cut-end which is set around the disc. This construction allows for low seating force and better shut off performance. It also provides more resistance against very high operating temperatures. The seat ring's thermal expansion with fluid temperature fluctuation makes the valve best suited to high-temperature fluid applications.

6300RA/600B

6300RA/600S



610S

Specifications

		600B	600S	610S
	Body type			
	Body size	3" (80A) ~ 60" (1500A)	3" (80A) ~ 128" (3200A)	6" (150A) ~ 36" (900A)
	Body rating	ANSI Class 150 ~ 900 · JIS 5K ~ 63K	ANSI Class 125 · JIS 2K ~ 10K	ANSI Class 125 · JIS 2K ~ 10K
	Fluid temperature	-45 ~ +600°C (-49 ~ +1112°F)		-45 ~ +750°C (-49 ~ +1382°F)
	Connections	Wafer type	Flanged (RF)	
	Body materials	SCPH2 / WCB, SCS13A / CF8, SCS14A / CF8M, etc.	SS400, SUS304, SUS316, etc.	SUS304, SUS316, etc.
	Disc materials			SCS14A / CF8M
	Rangeability	60°Opening / 15:1	90°Opening / 30:1	100:1 ~ 150:1
	Flow characteristics	Approximate Eq% (Inherent Characteristics)		
	Seal ring materials	—	—	SUS316 or Inconel
Seat Leakage	Standard	90° Cv × 2.5 ~ 0.5%	90° Cv × 5.0 ~ 1.5%	90° Cv × 0.25 ~ 0.1%
	15° seal	—	90° Cv × 0.5 ~ 0.2%	—
	Back seat	—	90° Cv × 2.0 ~ 1.0%	—
	Actuator combinations	6300RB, 6500RA, 7300RA: Pneumatic Cylinder Actuator 3500RB, 3600RB: Solid State Electronic Actuator 5200TA: Pneumatic Diaphragm Actuator		

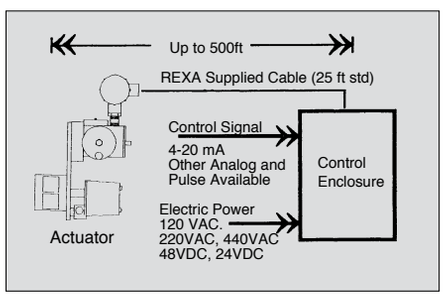
3000 SERIES ELECTRO-HYDRAULIC ACTUATORS

REXA Microprocessor Controlled Actuators

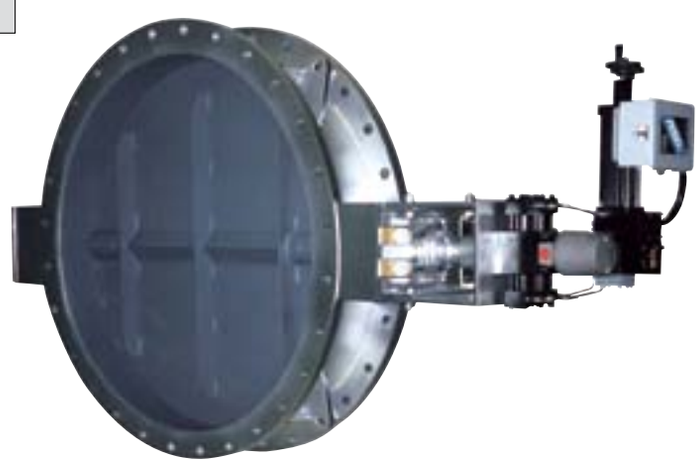
HIGH POWER·HIGH SPEED·HIGH PERFORMANCE ACTUATOR

This series of actuators represents the next generation of intelligent digital actuators. These are milti-function hybrid process control devices incorporating computer functions to fully utilize the advantages of both electric and hydraulic types, i.e., high speed and large output.

Major components are: digital motor, gear pump and electronic circuit. Unique hydraulic Flow Match System (patented) controlled by direct digital signals secures stabilized high speed response and high accuracy action. The actuators feature a fail safe upon power loss. Furthermore, two kinds of power modules provide redundancy and high power to enhance electric safety. With this series, we are closer than ever to the concept of “maintenance free.”



3800LA



3800RA

Specifications

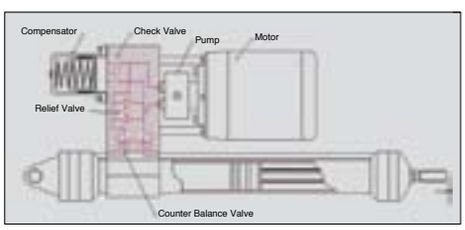
Type	Linear Stem Motion Type	Rotary Stem Motion Type	Crank Arm Motion Type
	3800LA	3800RA	3800DA
Max. output	533787 N	11300 N·m	11300 N·m
Power source	AC100V 50/60 HZ / Options: AC120V, AC220V, AC440V, DC48V, DC24V		
Max. stroke/angle	550mm	90°	
Control signal	4 ~ 20mA DC, Direct-digital, Pulse, Two position, Manual(up/down push-button)		
Environment temp.	Actuator: –30 ~ +70°C(–60 ~ +140°F) ,Option 93°C(185°F) / CONTOROL ENCLOSURE; –40 ~ +60°C(–80 ~ +120°F)		
Deadband	0.05%(minimum) Selectable at the PCP between 0.05% and 5.0% of calibrated signal span		
Positioning accuracy	< 0.15% of full stroke		
Linearity	< 0.05% of full stroke		
Repeatability	< 0.10% of full stroke		
Enclosure type	NEMA 4×(STD), FM approved Class 1, Div.2, Groups A, B, C & D and NEMA 4×		
Options	Spring return type, Position Transmitter, Limit Switches, Manual Override.		

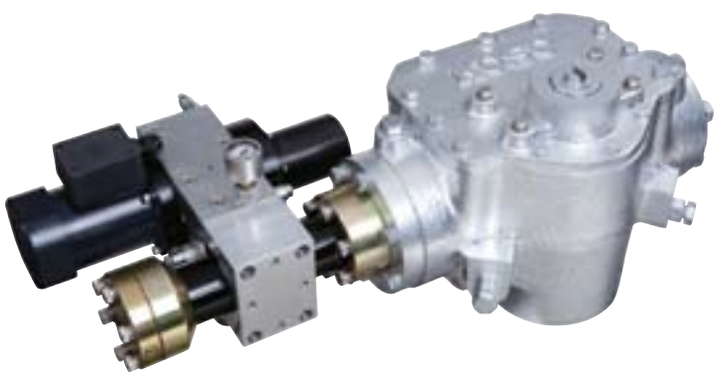
4800 SERIES ELECTRO-HYDRAULIC ACTUATORS

4800: Electro-Hydraulic Actuators

M-MAC

The M-MAC series is the electro-hydraulic actuator which combines the power of hydraulics, the reliability of solid state electronics and the flexibility of user-configured control. It features a compact design, and all the major components of a hydraulic system are packaged with a stand alone modular actuator, which provides excellent value. Simply install, then hook up to the appropriate electric power source. M-MAC series also allows for precise positioning independent of load variation. The motor only operates when motion is required and it achieves the power consumption. The dedicated controller allows the user to set the desired actuator operation parameters.





4800RA

4800LA

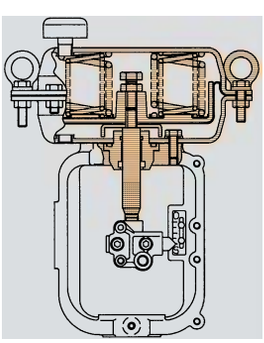
Specifications

Type	Linear Stem Motion Type	Rotary Stem Motion Type	Crank Arm Motion Type
	4800LA	4800RA	4800DA
Max. output	110,000 N	20,000 N·m	10,000 N·m
Power source	AC100, 200V 50/60 HZ / Options: AC120V, AC220V, AC440V		
Max. stroke/angle	150mm	90°	
Control signal	4 ~ 20mA DC, Direct-digital, Two position, Manual(up/down push-button)		
Environment temp.	Actuator: −10 ~ +60°C(−20 ~ +120°F) / CONTOROL ENCLOSURE: −10 ~ +50°C(−20 ~ +100°F)		
Positioning accuracy	< 0.1% of full stroke		
Enclosure type	Weather / Explosion Proof		
Options	Spring return type, Manual Handpump, Accumulator		

5000 SERIES PNEUMATIC DIAPHRAGM ACTUATORS

5200: Pneumatic Diaphragm Actuators

This series provides high performance, high power multi-spring diaphragm actuators that are compact and light-weight. Receiving pneumatic or electric signals, the unit balances the force created when the diaphragm is air-pressured through positioner and the force of compressed spring, so that the output shaft is controlled and placed at a set position. Control of position by pneumatic signals (20~100Kpa) directly applied on the diaphragm is also possible. In combination with KOSO's positioner the 5200 pneumatic diaphragm actuators provide high accuracy position control.



5200LA

5200LA

526LLA

5200RA

Specifications

		Linear Stem Motion Type					Rotary Stem Motion Type			
	Type	5221LA	5227LA	5235LA	524SLA 524LLA	526SLA 526LLA	5221RA	5227RA	5235RA	524LRA
	Actuator size	218	270	350	450	650	218	270	350	450
MAX Output	N	2185	3648	4315	7453	16475	—	—	—	—
	N·m	—	—	—	—	—	46.4	116.2	183.2	553.7
	Air supply KPa	140, 300, 340		140, 300		300	300, 340		300	
	Spring range KPa	20 ~ 100, 80 ~ 200, 120 ~ 300		20 ~ 100, 80 ~ 200		80 ~ 200	80 ~ 200, 120 ~ 300		80 ~ 200	
	Max. stroke/angle	20mm	30mm	40mm	80mm	110mm	60 °			
	Action	Direct Action or Reverse Action								
	Environment temp.	Standard type: -10 ~ +70°C (-20 ~ +140°F), Low temp.service: -40 ~ +40°C (-80 ~ +80°F), High Temp.service: 0 ~ +100°C (0 ~ +200°F)								
	Options	Manual handle, Limit SW, Positioner, Air filter regulator etc.								

6000 SERIES PNEUMATIC CYLINDER ACTUATORS

Linear Stem Motion type

6100LA: Pneumatic Cylinder Actuators (1 piston type)

6200LA: Pneumatic Cylinder Actuators (2 piston type)

Valve stem and actuator output shaft connection is inside the cylinder.

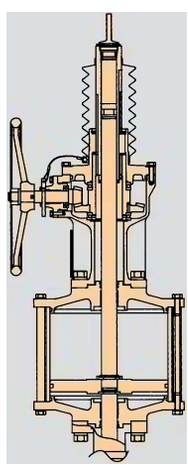
6300LA: Pneumatic Cylinder Actuators (1 piston type)

Valve stem and actuator output shaft connection is outside the cylinder in-yoke.

6100LA with side handle

6200LA with top-side handle

6300LA without handle



6300LA with top-side handle

Specifications

6100LA, 6200LA	Double Acting type						
Type code	6110LA	6116LA	6128LA	6136LA	6141LA	6154LA	6254LA
Size	100	160	280	360	415	540	540×2
Output N at 500KPa	3430	9310	29890	45570	62220	106820	213640
Max. stroke - mm	60	210	310	610	810	810	1360

6300LA	Double Acting type					Spring Return type		
Type code	6315LA	6320LA	6330LA	6345LA	6360LA	6330LA	6345LA	6360LA
Size	150	200	300	450	600	300	450	600
Output N at 500KPa	7938	14308	32242	73010	129850	7644	17248	30576
Max. stroke - mm	210	210	210	410	410	210	210	210
Air supply	Double Acting : 300 ~ 500 KPa Spring Return : 500 KPa							

6000 SERIES PNEUMATIC CYLINDER ACTUATORS

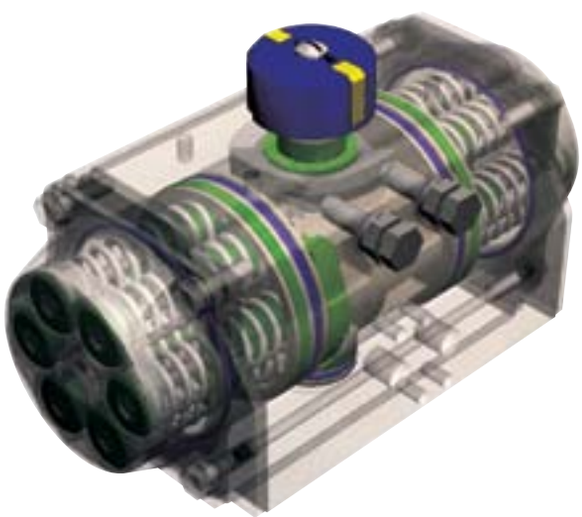
Rotary Stem Motion type

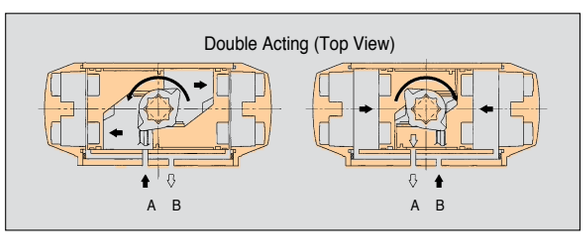
6300RB: Pneumatic Cylinder Actuators

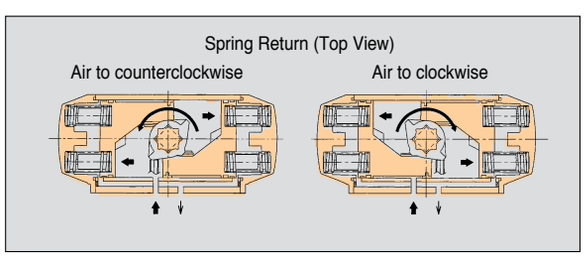
Small Torque Cylinder

2 Piston Rack & Pinion Pneumatic Actuator

Output Shaft Rotating angle/90° or 60°







Specifications

6300RB	Double Acting type												
Type code	63B0RB	63B1RB	63B2RB	63BARB	63B3RB	63BBRB	63B4RB	63BCRB	63B5RB	63BDRB	63B6RB	63BERB	63B7RB
Size	AT050	AT100	AT200	AT250	AT300	AT350	AT400	AT450	AT500	AT550	AT600	AT650	AT700
Output N·m at 500KPa	16.6	29.3	58.2	91.5	133	215	277	435	567	766	1064	1787	2594
6300RB	Spring Return type												
Type code	63B0RB	63B1RB	63B2RB	63BARB	63B3RB	63BBRB	63B4RB	63BCRB	63B5RB	63BDRB	63B6RB	63BERB	63B7RB
Size	AT050	AT100	AT200	AT250	AT300	AT350	AT400	AT450	AT500	AT550	AT600	AT650	AT700
Output N·m at 500KPa	6.7	11.1	22.1	36.7	50.7	82	105	165	224	292	425	721	992
Air supply	Double Acting:300 ~ 500 KPa Spring Return: 300, 400, 500 KPa												
Action	Direct Action or Reverse Action												
Environment temp.	Standard type: -20 ~ +60°C (-4 ~ +140°F), Low temp.service:-50 ~ +60°C (-58 ~ +140°F), High Temp.service:0 ~ +100°C (-32 ~ +212°F)												
Options	Manual handwheel, Limit Switch, Positioner, Air filter regulator, Speed controller, Lock Valve, Lock up Valve, Solenoid Valve etc.												

6000, 7000 SERIES PNEUMATIC CYLINDER ACTUATORS Rotary Stem Motion type

7300RB: Pneumatic Cylinder Actuators

Middle Torque Cylinder

2 Piston Rack & Pinion Pneumatic Actuator

Output Shaft Rotating angle/90° or 60°

6500RA: Pneumatic Cylinder Actuators

Middle Torque Cylinder

2 Piston Scotch Yoke type Pneumatic Actuator

Output Shaft Rotating angle/90° or 60°

6400RB: Pneumatic Cylinder Actuators

Large Torque Cylinder

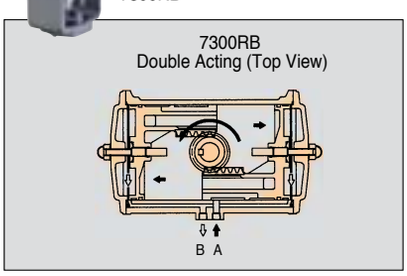
4 Piston Scotch Yoke type Pneumatic Actuator

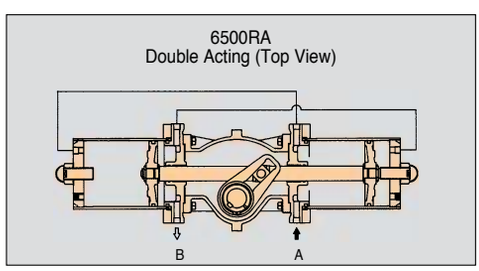
Output Shaft Rotating angle/90° or 60°

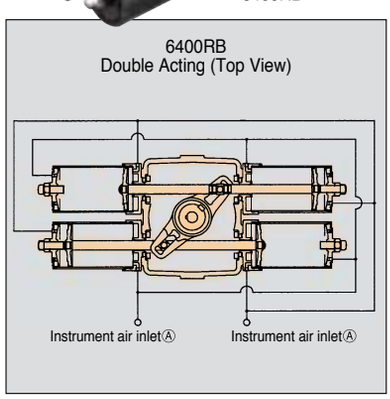

7300RB

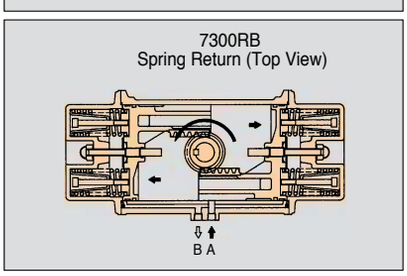

6500RA

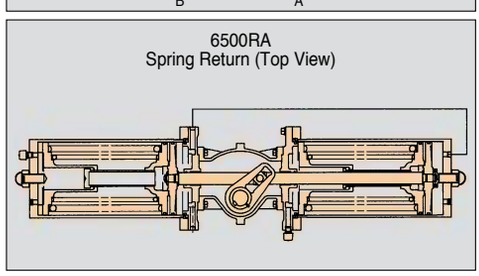

6400RB











Specifications

7300RB	Double Acting type				Spring Return type			
Type code	7317RB	7323RB	7328RB	7337RB	7317RB	7323RB	7328RB	7337RB
Size	170	235	280	375	170	235	280	375
Output N·m at 500KPa	637	1712	2962	6987	212	589	995	2332

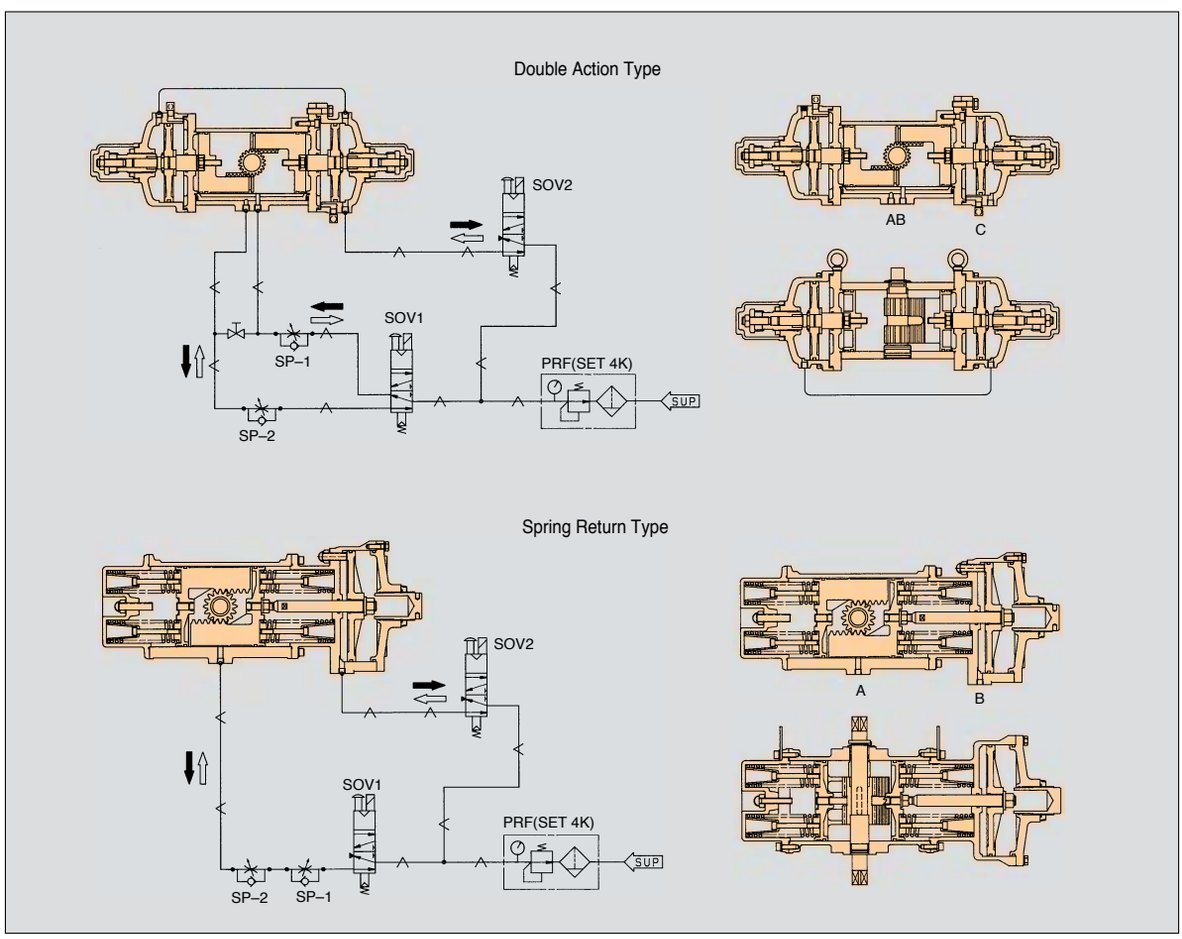
6500RA, 6400RB	6500RA						6400RB	
	Double Acting type			Spring Return type			Double Acting type	
Type code	6517RA	6520RA	6528RA	6520RA	6528RA	6536RA	6420RB	6428RB
Size	170	200	280	200	280	360	200	280
Output N·m at 500KPa	1850	3200	7500	907	2231	4413	9370	20500
Air supply	Double Acting : 300 ~ 500 KPa Spring Return : 300, 400, 500 KPa							
Action	Direct Action or Reverse Action							
Environment temp.	Standard type: -20 ~ +60°C (-40 ~ +120°F), Low temp.service: -50 ~ +60°C (-10 ~ +120°F), High Temp.service: 0 ~ +100°C (0 ~ +200°F)							
Options	Manual handwheel, Limit Switch, Positioner, Air filter regulator, Speed controller, Lock Valve, Lock up Valve, Solenoid Valve etc.							

6000, 7000 SERIES PNEUMATIC CYLINDER ACTUATORS **Rotary Stem Motion type**

7900RA: 2 Step Action type Pneumatic Cylinder Actuators

Output Shaft Rotating angle/90°

2 Piston Rack & Pinion Pneumatic Actuator



Specifications

7900RA		Double Acting type					Spring Return type				
	Type code	79B3RA	79B4RA	7917RA	7923RA	7928RA	79B3RA	79B4RA	7917RA	7923RA	7928RA
	Size	AT300	AT400	170	230	280	AT300	AT400	170	230	280
Output	N·m AT 400 KPa	106	222	510	1370	2370	40.5	84	170	455	796
	N·m AT 500 KPa	133	277	637	1712	2960	50.7	105	212	569	995
	Air supply	Double Acting : 300 ~ 500 KPa Spring Return : 300, 400, 500 KPa									
	Action	Direct Action or Reverse Action									
	Environment temp.	Standard type:-20 ~ +60°C (-4 ~ +140°F), Low temp.service:-50 ~ +60°C (-58 ~ +140°F), High Temp.service:0 ~ +100°C (-32 ~ +212°F)									
	Options	Manual handwheel, Speed controller, Solenoid Valve,Air filter regulator etc.									

ACCESSORIES FOR PNEUMATIC ACTUATORS

EP800: Electro-Pneumatic Positioner

This series is for positioning of pneumatic actuator operated control valves. The input signal 4~20mA DC is changed to air pressure. Accurate positioning is achieved by having valve position feedback from the valve stem.

PP800: Pneumatic-Pneumatic Positioner

Same series as EP800 but with a pneumatic signal (20~100Kpa). Also double acting and single acting types are available.

PRF300: Airfilter-Regulator

For regulating instrument air.
CL-420: Lock Valves
CL-523: Used for shut off, switching, or locking of instrumental air circuit (air relay).

EPA800
EPB800
EPC800

PPA800
PPC800

CL-523

CL-420

PRF400

PRF300

Specifications

Type	EPA800 for single acting	EPC800 for double acting	EPB800 5200LAfor 5200LA actuator
Input signal / Characteriatic	4 ~ 20, 4 ~ 12, 12 ~ 20 mA DC / Linear		
Air supply	140 ~ 700 KPa		
Type	Single acting type	Double Acting type	
Linearity/Hysteresis	±1.0% / 0.5%	±1.5% / 0.8%	
Response level/Repeatability	0.1% / 0.2%	0.2% / 0.3%	
Air consumption	Output air pressure(50%) 5 Nl/min. at Sup. 140 KPa [gaug]	Output air pressure(50%) 15 Nl/min. at Sup. 400 KPa [gaug]	
Max. capacity	Output atomosphere 175 Nl/min. at Sup. 140 KPa [gaug]	Output atomosphere 400 Nl/min. at Sup. 400 KPa [gaug]	
Enclosure	Weather proof type, Explosion proof type Intrisically safe explosion proof type		
Air/Electric wiring connection	Rc. $^1/_4$ / G$^1/_2$		
Environment temp.	Standard type: –20~+60°C (-4~+140°F), Low temp.service:–50~+60°C (-58~+140°F), High Temp.service:0~+100°C (32~+212°F)		

kentintrol™

Severe Service Valve Solutions

KOSO

Figure 1. **VeCTor (Velocity Control) Labyrinth Disk Stack Trim Design**

Introduction to Koso Kent Introl's 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, Butterfly Valves and Surface Choke Valves. KKI has been manufacturing Severe Service Valves for over 30 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.

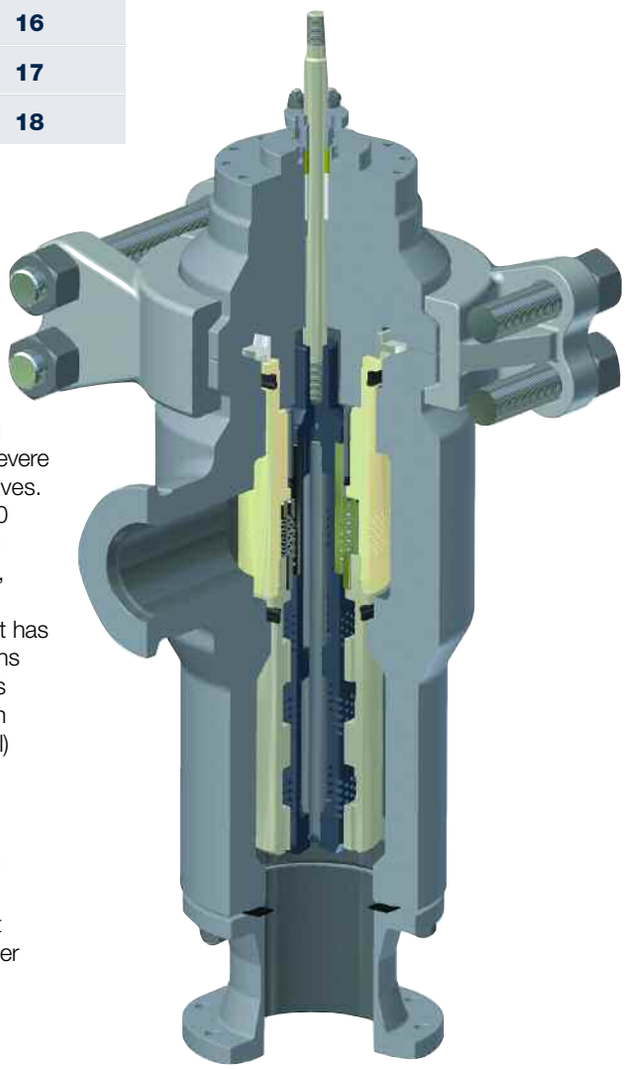


Figure 2. **Turbotrol Valve incorporating 9 Stages of pressure let-down (15 turns), 5 Stages in Tungsten Carbide.**

Quality Manufacturing

KKI manufactures from it's plant in the UK, with global sales and application support from specialist sales people and carefully selected agents throughout the world. Maintaining the highest standards of quality throughout design, production and customer service is the cornerstone of KKI's philosophy. Our plant is accredited in accordance with Quality Management System ISO 9001 and Environmental Management System ISO 14001. In addition all valves, where applicable, conform to ATEX, PED and are CE marked accordingly. Safety is the key element in anything we do. We hold the Royal Society for Prevention of Accidents (ROSPA) silver award for occupational safety.

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

The trims presented in Figures 3-6 are some examples of the Severe Service Trims Available from Koso Kent Introl.

Figure 3. **HFL-3 High Performance Multi-Sleeve / Multi-Step Trim**

Figure 4. **Tungsten Carbide Plug for Heavily Contaminated Fluids.**

Figure 5. **VeCTor ‘M’ - Velocity Control Trim Design**

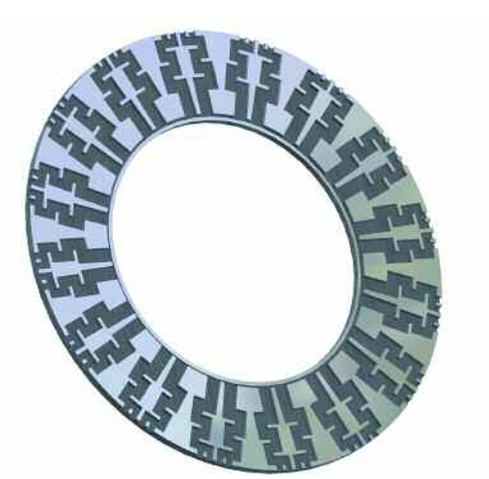


Figure 6. **VeCTor ‘D’ Disk - Velocity Control Labyrinth Trim Design**

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.

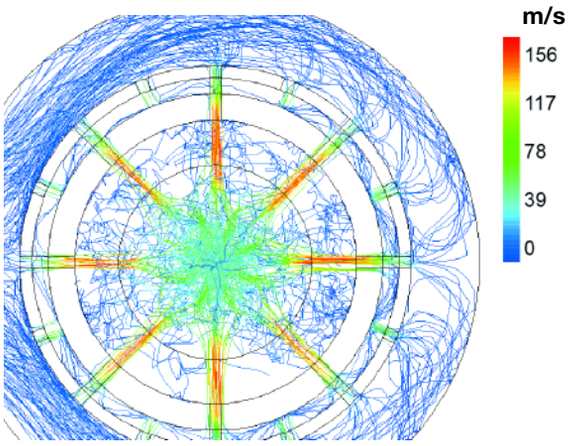


Figure 7. **Plan View of a Valve Trim showing the Sand Particle Trajectory**

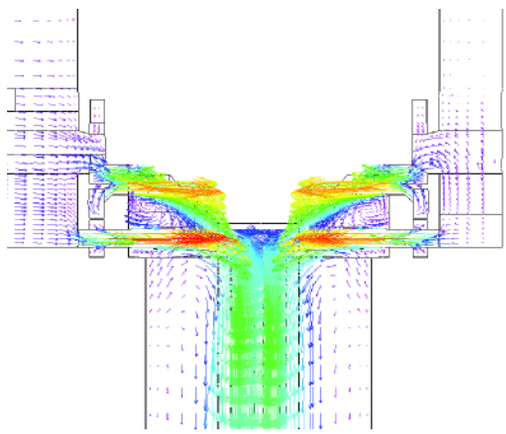


Figure 8. **CFD Analysis of a Valve Trim**

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.

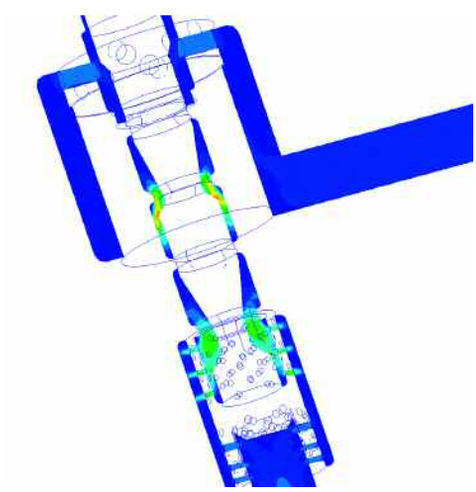


Figure 9. **CFD Analysis of 5 stage microspline**

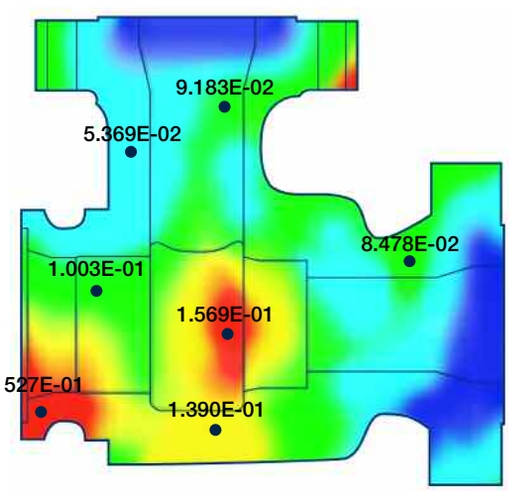


Figure 10. **Choke body evaluation using Finite Element Analysis**

Specialist Application - Case 1
Minimum Flow Pump Re-circulation 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, resulted in this extreme level of erosion. The valve operated for only a few hours before it had to be taken out of service.

Figure 11. **Cage Guided Trim with Severe Cavitation Damage**

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 18 turns within the existing valve body design, see Figure 12. 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.

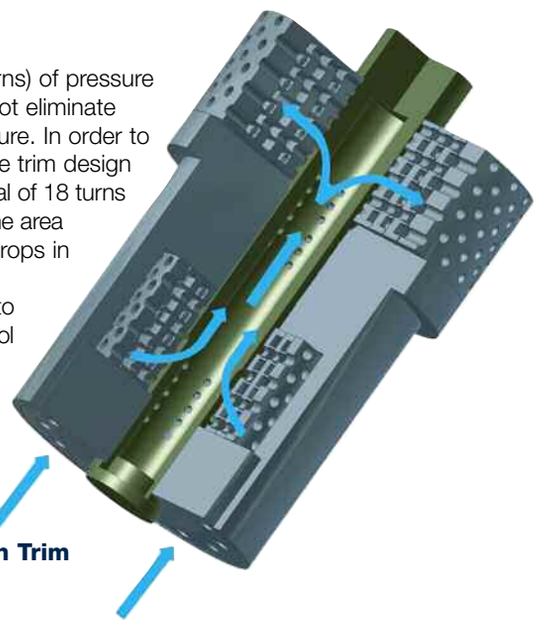


Figure 12. **HFL-9 Stage Anti-Cavitation Trim**

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 (P_v) 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 on the www.kentintrol.com website.

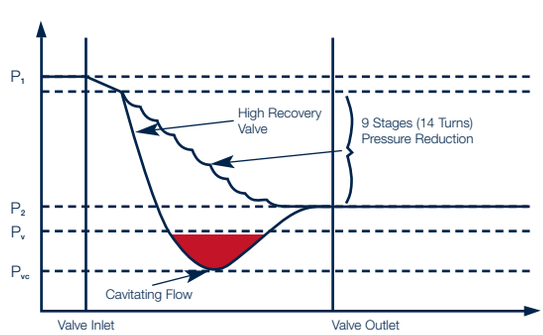


Figure 13. **Comparison between Low and High Recovery Trim Designs**

Series 51 & 57 Turbotrol Severe Service Valves

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 typically employed on applications where the pressure drop requirement is in excess of 200 bar and the downstream pressure close to P_v. The design incorporates between 4 and 9 stages (9 and 18 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.

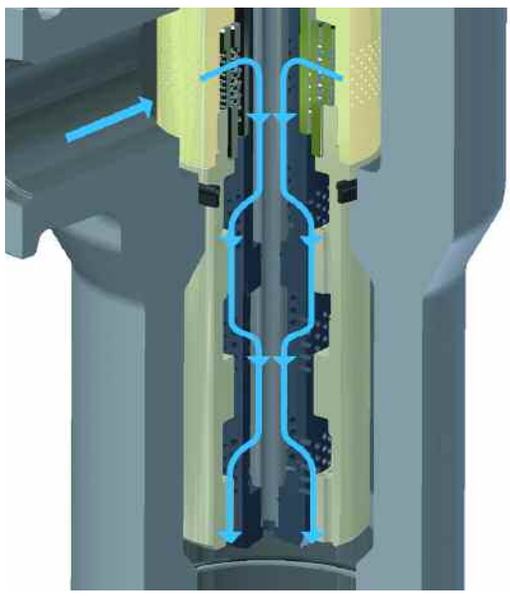


Figure 14. **Illustration of a 9 Stage Turbotrol Trim**

Turbotrol Design Specification

- Sizes - 1.5" 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 MR0175 / NORSOK
- End Conns. - ISO 10423 / API 6A / API 17D / ANSI Flanges / Hub type connections
- Stages of let-down 4 to 9 (9 to 18 turns)

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.

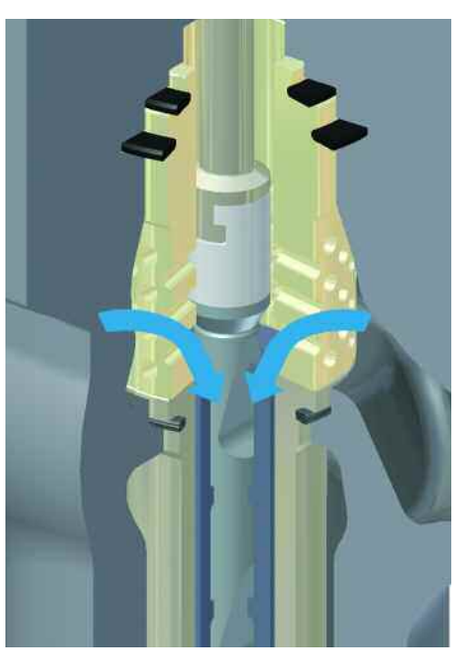


Figure 15. **Illustration of a Multi-Spline Trim**

Specialist Applications - Case 2
Fire Water Protection System

The fire water system on offshore platforms (represented in Figure 16) has proven to provide a 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.

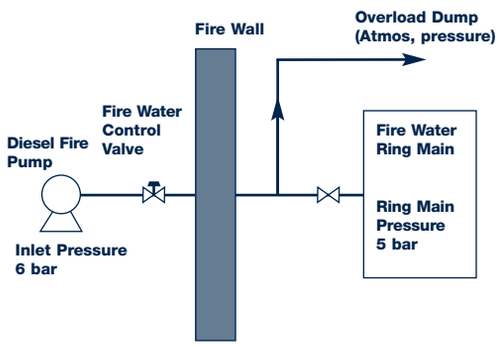


Figure 16. **Firewater System**

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 shown in Figure 17 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.

Figure 17. **Cavitation Damage to Butterfly Valve**

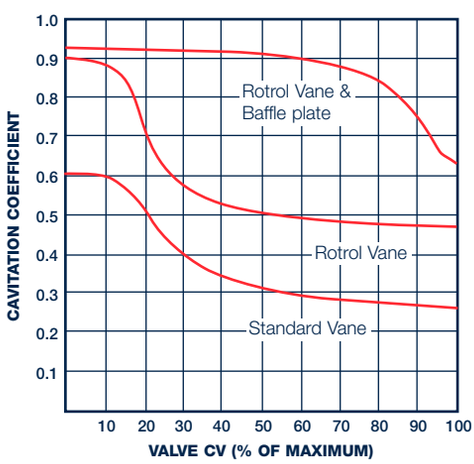


Figure 18. **Pressure Recovery Comparison**

Although it was clear that a larger globe type valve fitted with a low pressure recovery 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 Figure 18. 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.

Figure 19. **The Rotrol Valve**

Rotrol - Series 63 to 66

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.

The innovative design, refer to Figure 20, 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 Figure 21. 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, see Figure 20. 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 degrees 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.

Figure 20. **Rotrol Valve with Outlet Baffle Plate**

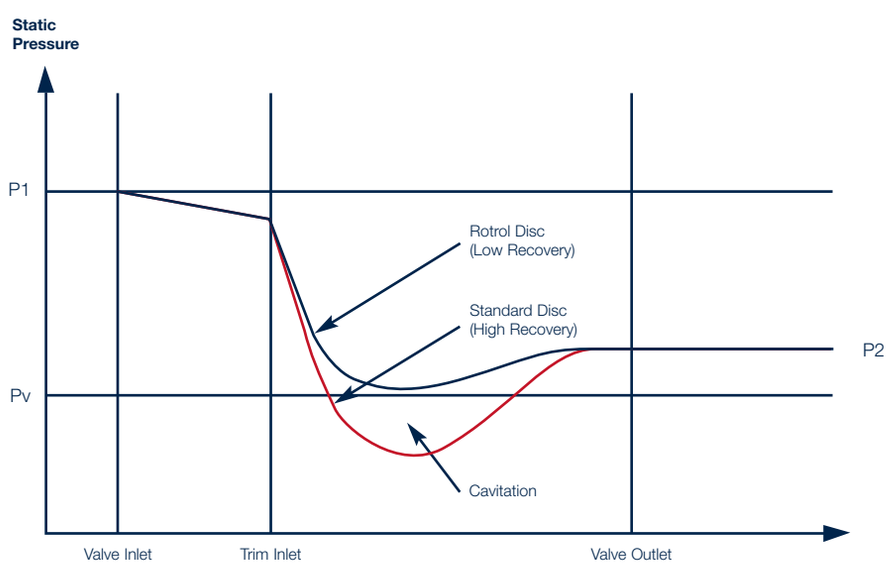


Figure 21. **Comparison of Pressure Recovery between Low and High Recovery Vane Designs**

Specialist Applications - Case 3
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 Figure 22. 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.

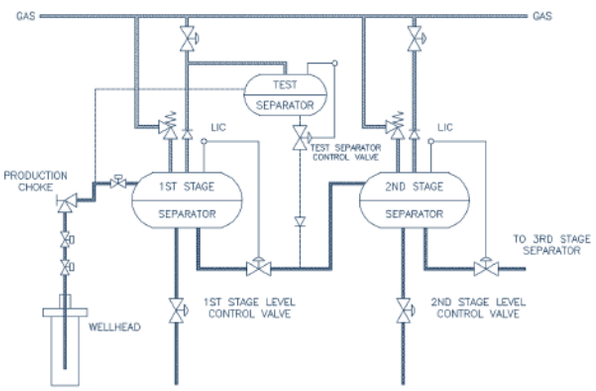


Figure 22. **Separator Level Control Schematic**

Figure 23. **Erosion Damage to Stellited Trim after 2 Weeks Service**

Over the next two years KKI developed the LCV trim design, see Figure 24, introducing various design enhancements to ensure that the trim would withstand the erosive nature of the medium. These enhancements included the introduction of dead-band, a 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 Figure 25 shows a relatively small amount of erosion to the sacrificial elements after 2 years operation.

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

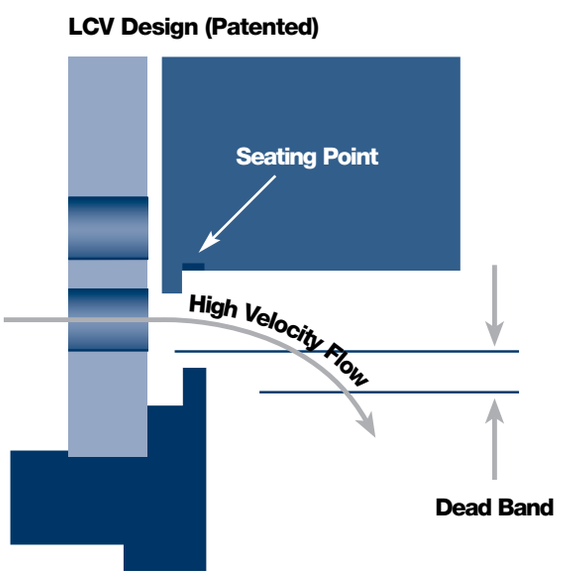


Figure 24. **LCV Design Principle**

Figure 25. **Tungsten Carbide Trim After two Years operation**

Severe Service Surface Choke Valves

Koso Kent Introl has been supplying high technology severe surface choke valves since 1975. The design of the severe service 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

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 MR-01-75 / 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.

Figure 26. **Surface Choke with Electrohydraulic Actuator**

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

Figure 27. **Be-spoke Designed Severe Service Choke Valves**

Erosion / Flashing Service

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.

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	= volume of material eroded mm^3/mm^2
u	= velocity of fluid jet m/sec
ρ	= density of fluid kg/m^3
t	= duration hours
β	= coefficient depending on material hardness (refer to table)
θ	= angle of incidence of a jet with surface degree (min. for use in the equation = 20º)

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

Figure 28. **Material Hardness Coefficients**

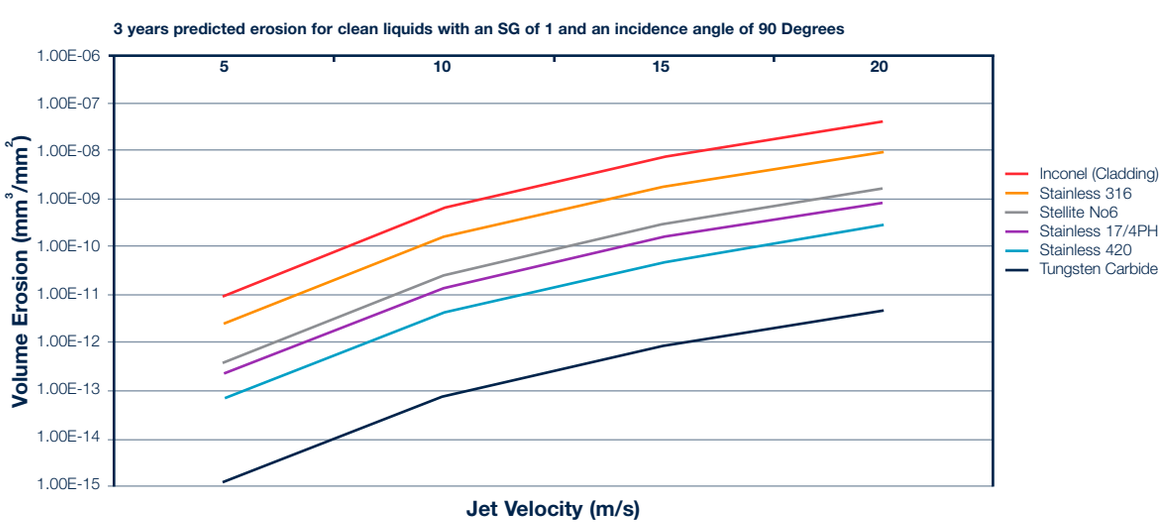
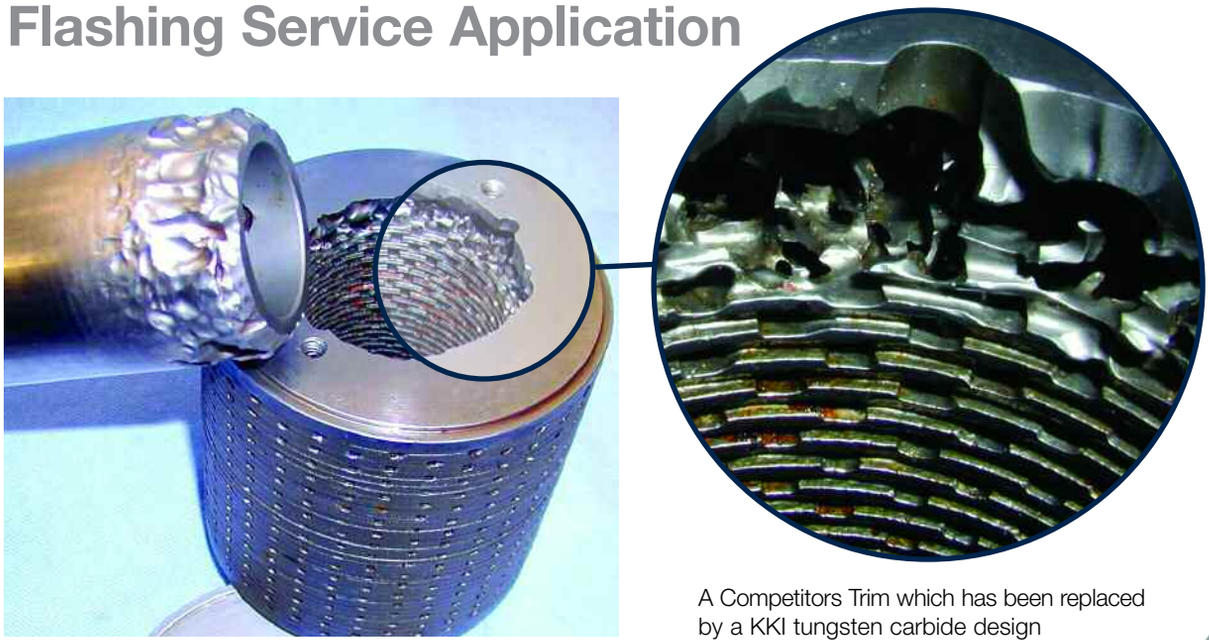


Figure 29. **Erosion Rates for Various Material Grades**

$$V = 7.463 \times 10^{-7} \left(\sqrt{u} \cdot \frac{\rho}{\beta} \right)^{6} \times t \times (\sin(\theta))^{0.65}$$

Specialist Applications - Case 4
Flashing Service Application



A Competitors Trim which has been replaced by a KKI tungsten carbide design

Figure 30. **Competitor's torturous path trim design that failed on a Severe Service application due to contamination and Interstage Flashing**

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.

KKI have retro-fitted a large number of 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.

Reference to Figure 30 above shows a Competitors multi-stage trim that has suffered from flashing erosion damage. Figure 31 presents a tungsten carbide trim designed to replace the above trim.

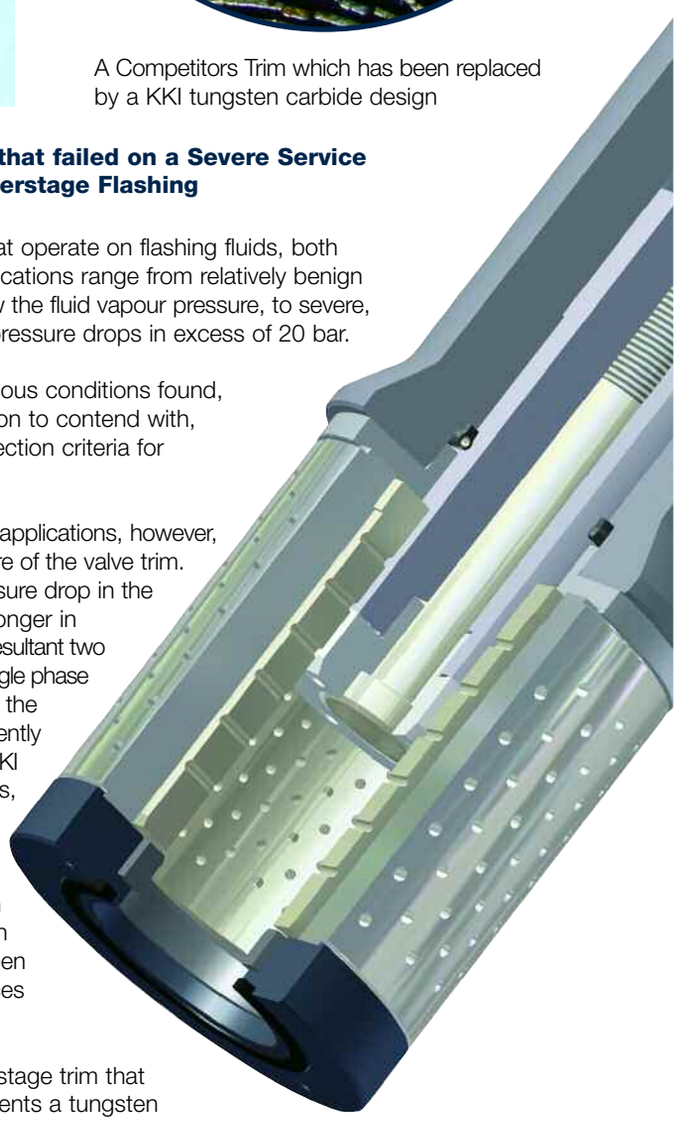


Figure 31. **Illustration of a Tungsten Carbide trim that replaced a Competitors torturous path trim design**

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. 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 valve. 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.

Figure 32. **HFQ low noise trim**

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.

Figure 33. **5 Stage (9 turn) Low Noise Trim Design**

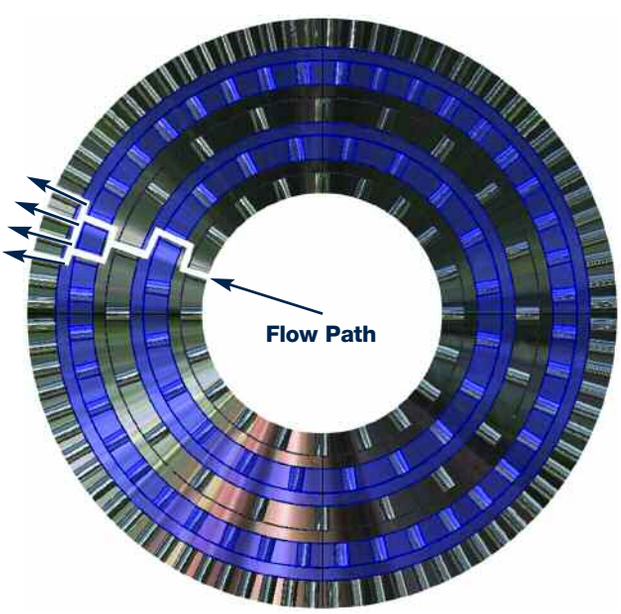


Figure 34. **Plan view of a HFQ low noise trim**

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).

Control Valve complete with outlet taper pipe and baffles

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 value 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.

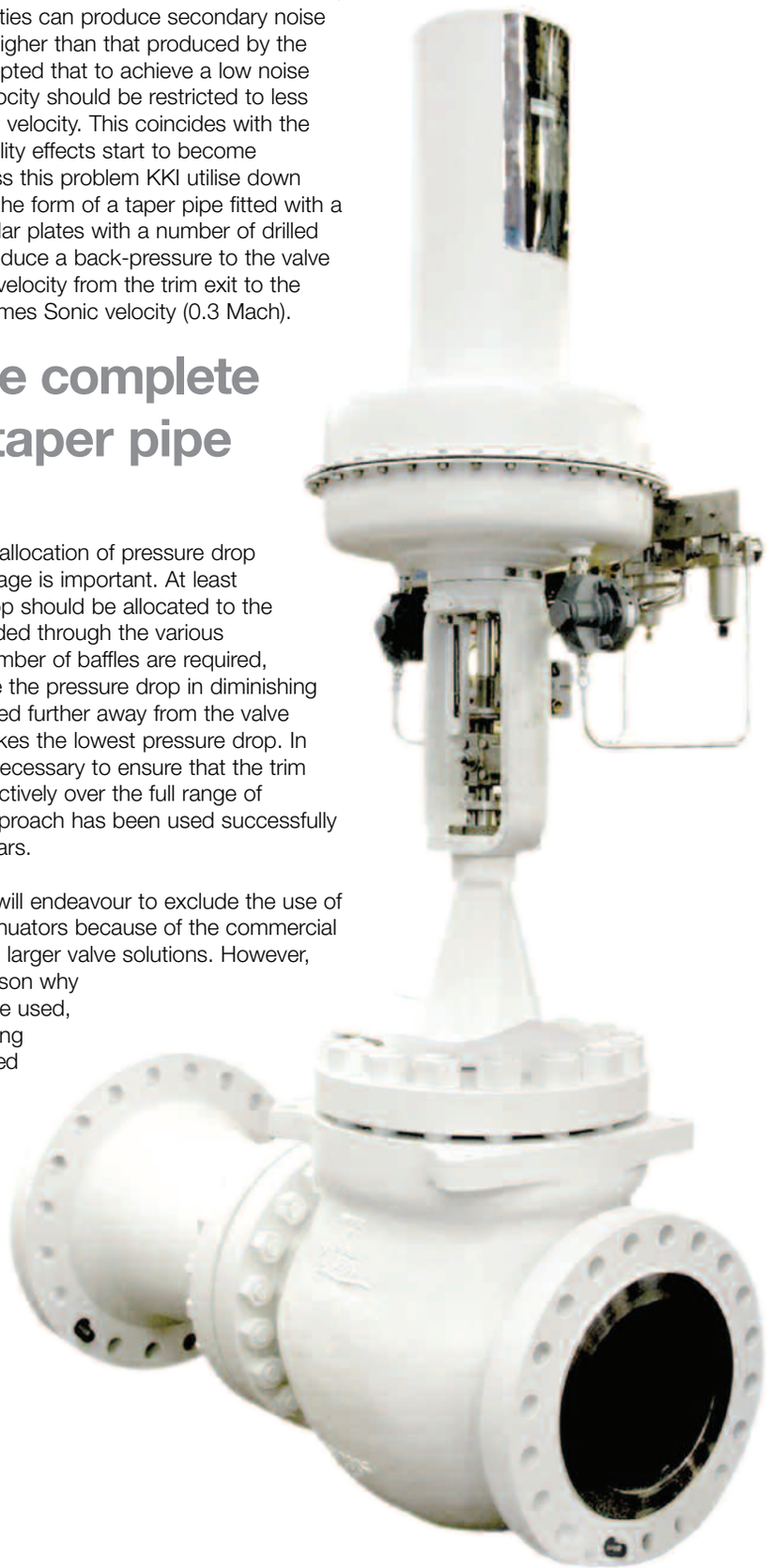


Figure 35. **Valve and Silencer**

Specialist Applications - Case 5
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 a 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 fracture of 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 2006 the valves continue to function satisfactorily with minimum Service Requirement.

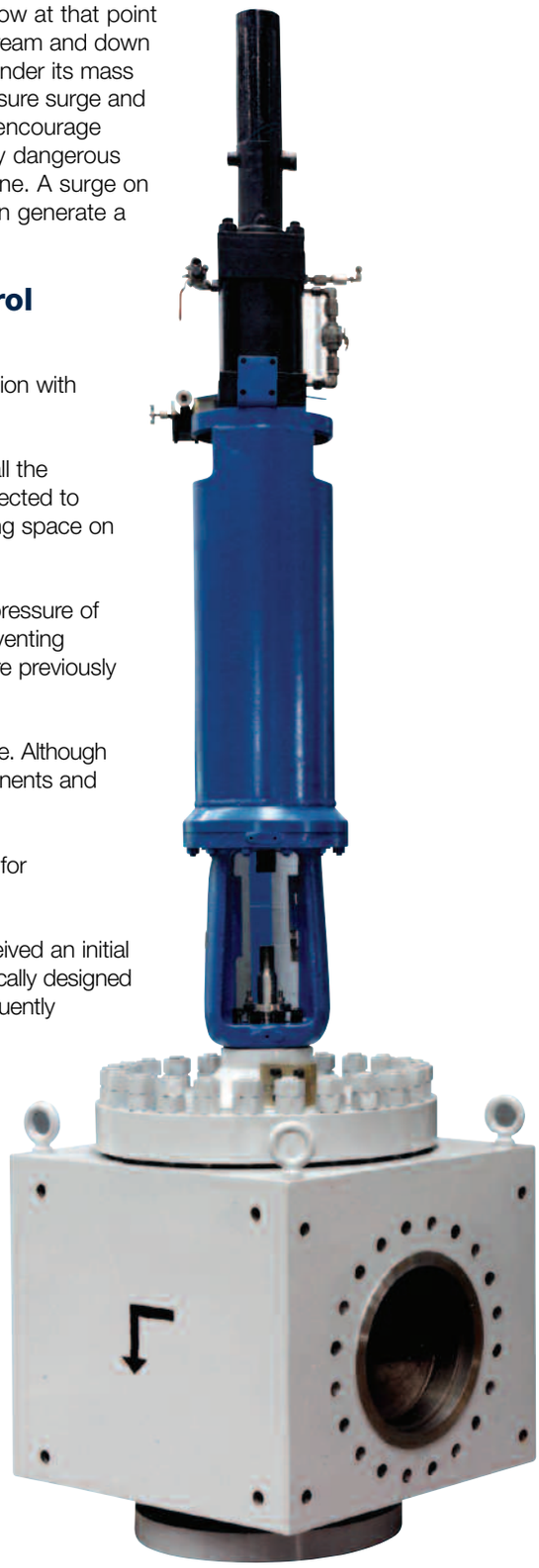


Figure 36. **Alaska Pipeline Anti-Surge Severe Service Control Valve**

Specialist Applications - Case 6

Compressor Re-Cycle / Anti-Surge Control Valve (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. 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.

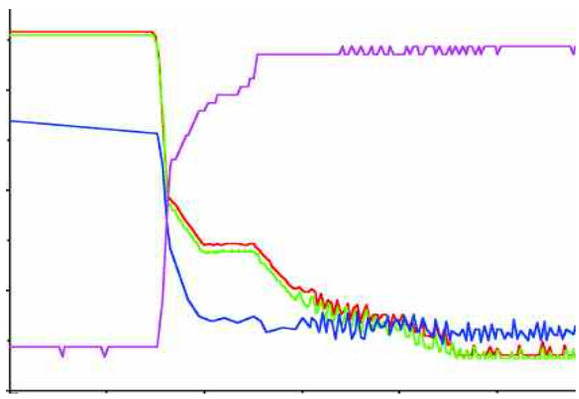


Figure 37. **Trace during normal operation**

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 figures 37 to 39 present traces of the actual valve opening conditions during a re-cycle operation. Under most of the operational range the valve control remained stable, as represented in Figure 37. The green and red lines are the input (instrument signal) and output (valve position) of the device. However, under certain instances the response of the valve was eratic as shown in Figure 38. 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.

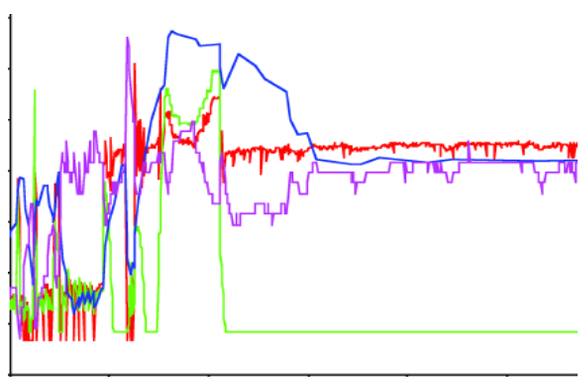


Figure 38. **Trace during erroneous operation**

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, Figure 39 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.

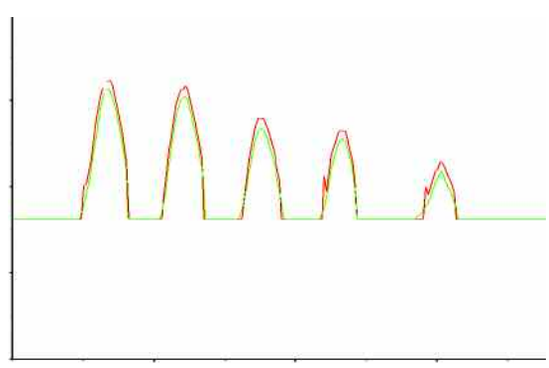


Figure 39. **Trace after modification**

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.

As well as the VeCTor D Labyrinth trim shown in Figure 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 Figure 42.

Figure 40. **VeCTor D Labyrinth Disc**

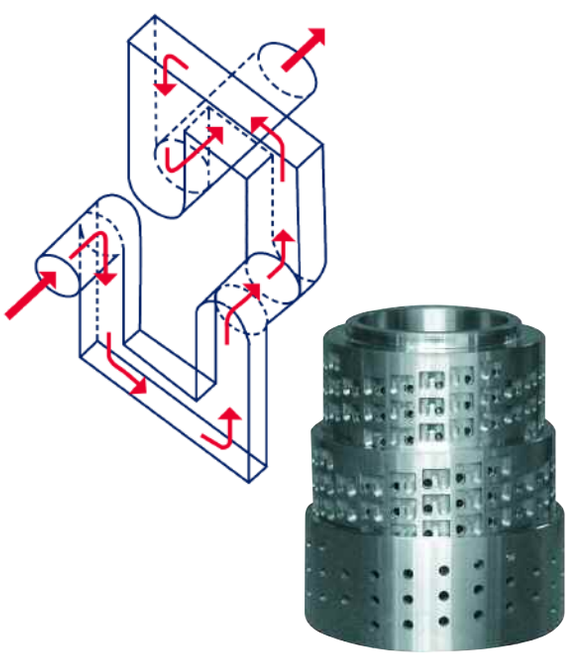


Figure 41. **VeCTor M Trim Design**

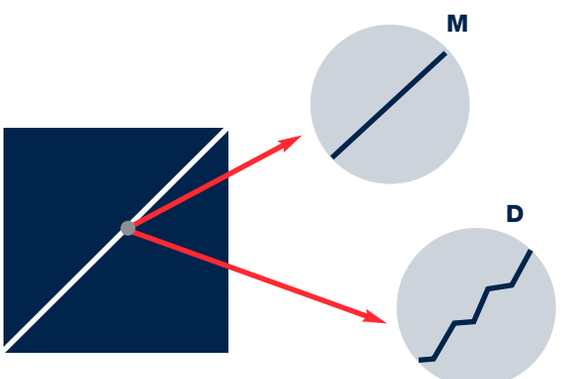


Figure 42. **Flow Characteristic comparison between D and M VeCTor**

Performance Testing

KKI continually tests it 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 standard
- 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 - verify Control Valve operation at sub zero temperature
- 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 Tests - To reduce the emissions through the valve packing.

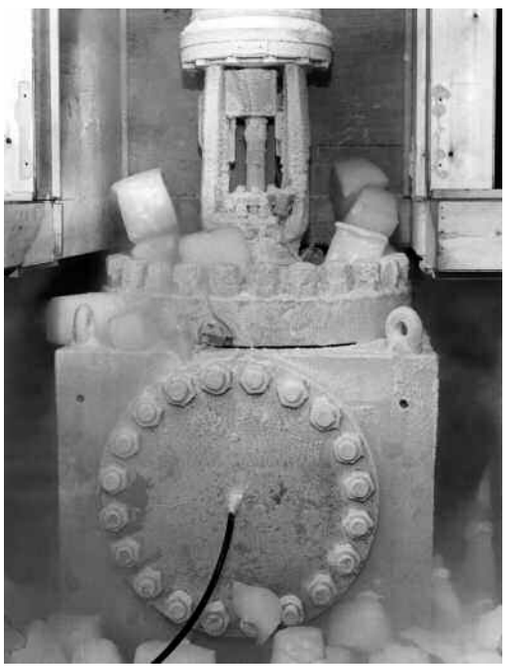


Figure 43. **Anti-surge Valve on Cryogenic Test**

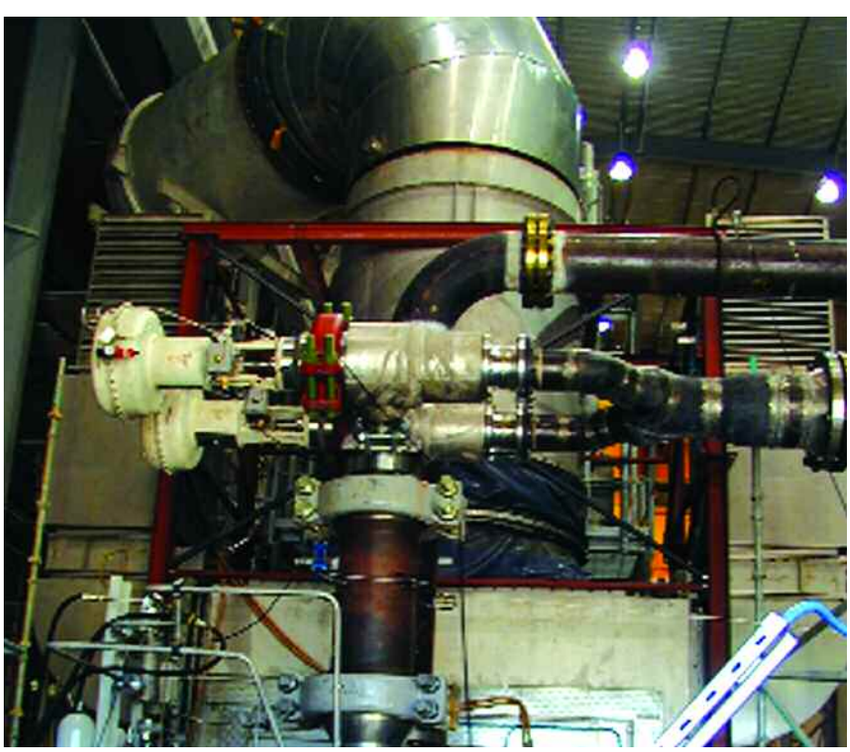


Figure 44. **Turbotrol Valve on 480 bar Test Loop - undergoing FAT**

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