


Parallel Slide Gate Valve – Flow Throttle-ability Gate Valve
 Design Features & User Benefits, Hi-Fluidic®

www.keyvalve.com



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 민경화

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Page 1

Parallel Slide Gate Valve – Flow Throttle-ability Gate Valve
 Design Features & User Benefits, Hi-Fluidic®

Key Valve Technologies Limited(KVT)

The people of KVT challenge

to develop new ideas for the valves
adopting new technology of relative
field of science

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Page 2

Parallel Slide Gate Valve – Flow Throttle-ability Gate Valve
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SPL Parallel Slide Gate Valve (PSGV) - Design Features



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Page 3

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KVT Parallel Slide Gate Valves -

- Two piece Parallel Discs Gate
- SPL(Spring Pack Loaded) Sliding Discs & Arrangements
- Flow Throttle-ability Seat Ring Design(Downstream)
- Advantages of Sliding Seating
- Stellite Hardfacing & Super Ceramic(CrN) Coating Disc
- Back Seating & Pressure Sealed Bonnet Design
- Design consideration for in-line Maintenance
- Positive Flexibility Seating under irregular Thermal Expansion(Structural Discontinuity in Valve Body)
- Qualified by CE-PED, Testing & References

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Page 4

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Conventional Wedge Gate – Fundamental Problem

A

B

C

Easy to trap the impurity particle at near closing

Easy to fail the leak tight structure due to high wedging effects

Seal Ring

Wedge

Wood Turner

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Page 9

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PSGV Flow Throttling Control

- V-Port Design (Downstream port)
- Linear / \sqrt{v} Flow Characteristics Possible
- Much Higher Flow Capacity(Cv) values
- Can achieve Leakage Class VI
- Photos – for Blow Down Control

HI-Fluidic PSGV Control Valve

Korea Atomic Energy Research Inst.
2*2500#RTJ, CF8M

It is the best control valve to maintain leakage class VI

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Page 10

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Design Features – Arrangement of Spring Pack

Guides & holds the discs by pin and Spring (For 2" & bigger sizes, install spring pack)

Variable numbers of Spring pack per Size

Arrange. of Spring Cartridge in Disc	1Ea(*1)	1Ea(*2)
upto 1.5"(DN40)		
2.0"(DN50)-4"(DN100)	1Ea(*1)	1Ea(*2)
5"(DN125)-8"(DN200)	3-4Ea	
10"(DN250)-32"(DN800)	6-16Ea	

*1 : Smaller Size Disc Springs
*2 : Larger Size Disc Springs

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Page 11

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Design Features – Two Piece Parallel Discs Gate & Discs guide

- Disc holder design relatively high reduces the overall height of the valve body and reducing the valve weight → Compact & art design of HI-Fluidic PSGV.
- Wide flat seat is smoothly guided in the full travel without separating from seating in full open position. In wedge gate valve, the wedge must have positioning guides on its sides to keep it in line while closing under full flow condition. These guides are usually made of any hard material, and tend to wear, and eventually may cause jamming. As discs are guided only by its full Stellite® and fine lapping seating surfaces, SPL PSGV never occurs such as jamming even horizontal installation the valve in vertical piping.
- Disc holder in the two piece gate design is threaded into stem → larger than DN 66 and all sizes of power operated. (Disc & stem precisely assembled into seat rings)
- Disc holder grips two SPL discs and pinned → DN 60 and smaller size in manual valves.
- SPL PSGV is fully guided through out its travel in sliding seat. Travel stop is on back seat in open position and is on yoke stop in full closed position.

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Page 12

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Design Features – Arrangement of PSEV Trim Set



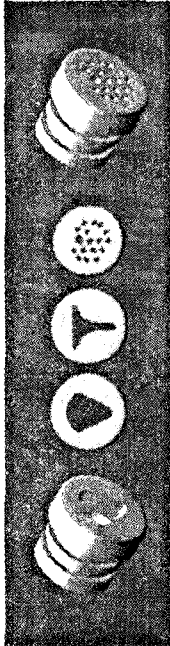
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Page 13

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Design Features – Seat Ring Design for PSEV Control Valve



Unseal EC% Let Down

KVT offer a reliable control solutions to maintain the zero leaks of the control valves.

We had referenced these PSEV control valves to be main feed water minimum flow control function (dP = 1.40bar) in POSCO's 100MW class thermal power plants.

Operation for all the valves are perfect and never leaks in the valve seat.

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Page 14

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Design Features – Brief Outlines the PSEV



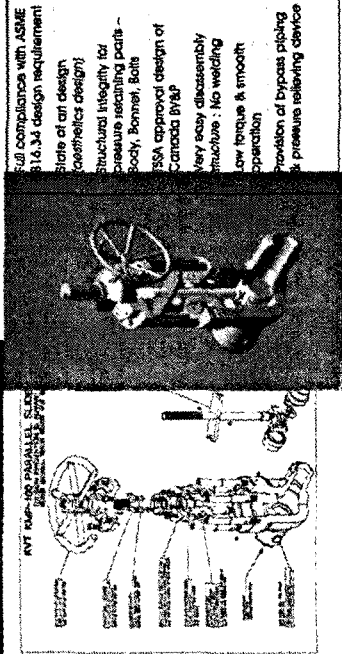
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Page 13

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Design Features – Brief Outlines the PSEV



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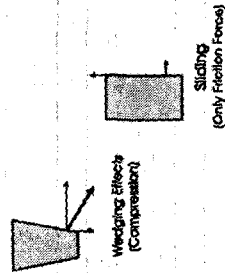
Page 15

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Design Features & User Benefits, HI-Fluidic®

Design Features – Spring Pack Loaded(SPL) Parallel Slide Disc, Sliding Sealing

Sealing is obtained by sliding, not by compression according to wedging effects.



- No need for final surge of torque to make the seating leak tight.
- No additional power is required for the first effort in unseating the discs.
- Unseating torque for SPL PSEV are ten times more lower than a wedge gate.
- Actuator size can be much smaller (at least 1 ~2 size) than for the wedge gate.
- Achieving smaller stem diameter brings much reliable packing sealing results & long life.
- Denying local stress & fatigue on the seating surface due to impurities are much less on SPL PSEV, which results in longer lifetime and reliable leak tight.

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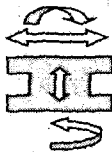
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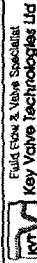
Design Features & User Benefits, Hi-Fluidic®

Design Features – Spring Pack Loaded(SL) Parallel Slide Disc, Sliding Sealing

- Sealing is obtained by sliding, not by compression according to wedging effects.
- No tendency to mark, notch, notch, local strain hardening, or indent the sealing surface due to cumulate impurities on sealing surfaces → better tightness & longer maintenance free lifetime.
- The exact position of the stem is not critical when the valve is closed. As a result, there are no problems with differences in thermal expansion coefficient of material. Also the motor actuators can be stopped with general position switches.



Tilt-able & Rotate-able
Laterally Flexible
Sliding Up/Downward



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Page 17

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Design Features – Stellite Hardfacing & Super Ceramic Coating

Stellite Hardfacing by weld deposit

- KVT use only DeLoro® welding rods
- Disc : Stellite #6 (AWS R CoCr-8) Hardness HRC 39-43 1.15C, 27.76Cr, 4.8W
- Seat Ring : Stellite #12(AWS R CoCr-FA) Hardness HRC 47-51 1.40C, 39.60Cr, 8.25W
- CIN Ceramic Coating (HV 2100, 7000?) by Cathodic Arc Evaporation Process. Super resistance against corrosion
- Stellite is a time proven hard-facing material which is erosion & corrosion resistant and which retains high temperature hardness to minimize galling and surface degradation.
- Different hardness between seat & disc is good for anti-galling. KVT PSGV have HRC 5-7 hardness different.
- In case of quick opening/closing or frequently operating PSGV, KVT strongly recommend the use of CIN Coating disc. This is a proven coating material by Korea Atomic Energy Research Institute (KAERI).



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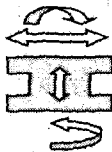
Page 18

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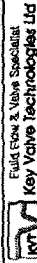
Design Features & User Benefits, Hi-Fluidic®

Design Features – Spring Pack Loaded(SL) Parallel Slide Disc, Sliding Sealing

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Tilt-able & Rotate-able
Laterally Flexible
Sliding Up/Downward



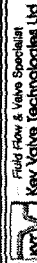
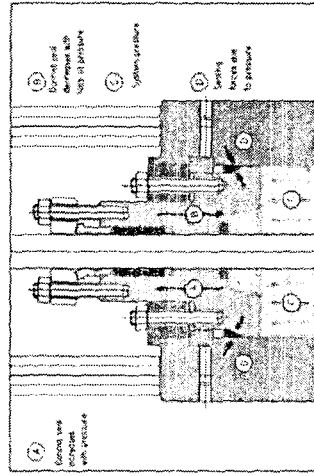
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Design Features & User Benefits, Hi-Fluidic®

Design Features – Back Sealing & Pressure Seal Design



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Page 19

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Design Features & User Benefits, Hi-Fluidic®

Design Features – Back Sealing & Pressure Seal Design

- Back seat is of integral and cone-on-cone design
- The time proven Delta type pressure seal design seals more effectively as pressure increase because the pressure forces the sealing elements into closer contact. Sealing effectiveness is thus unaffected by high temperature relaxation of materials and pressure cycles.
- The pressure seal gasket has an optimum angular relationship with body and bonnet to provide a high elastic & resilient sealing force as it yields initially under bolting (screwed) pre-load and then under line pressure. The gasket is shaped a delta form and made pure graphite of very high resilient properties.
- KVT's narrow cone-on-cone design withstands over-torquing better than other design
- In comparison with other pressure seal design, KVT design is unique and simple for the sizes (even small size) and effective sealing area provided, and for ease of maintenance after long years service.
- In order to disassemble a KVT Hi-Fluidic pressure seal bonnet, line pressure must be relieved and cooled – This is important safety feature of the KVT design.



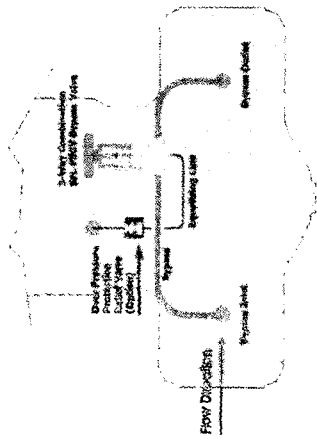
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Page 20

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Design Features – Bypass & Over Pressurization Protection Design

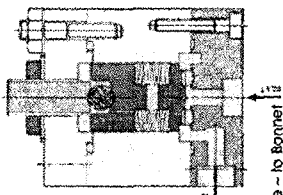
- Bypass Valve is used to reduce the traversing differential pressure across the valve seat.
- Also provides a convenient means for the initial warming through of pipe line
- Equalizing device is used to relieve the fluid trapped between the seat faces



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Overpressure Protection Relieving Device (KVT Own Design)

OVERPRESSURE PROTECTION RELIEF DEVICES FOR HI-FLOW PARALLEL SLIDE GATE VALVE



- Compact Design
- Reliable Operation
- Easy Set Pressure
- Wide Set Range - 40 ~ 350 barg

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 Design Features & User Benefits, Hi-Fluidic®

Design Features – In-Line Maintenance & Others

- Stem Packing – Packing stays resilient to maintain long term sealing-ability. KVT use the stem packing of some special.
- Stem Bushing – An Aluminum bronze alloy bushing with two paired resinite thrust bearing eliminates galling of the stem and provides smoother operation, reduce torque, longer life.
- Four windows bar type yoke – to promote air cooling of the packing chamber area, ease access to the pressure seal bonnet and ease disassemble the whole valve at in-line condition.

All KVT Hi-Fluidic Valves have been designed for ease of in-line maintenance, KVT also offers a variety of portable field tools - and the services of KVT trained specialists – to provide in-line repair and refitting or replacement of internal parts.

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 Design Features & User Benefits, Hi-Fluidic®

Design Features – Spring Pack Loaded (SPL) Parallel Slide Disc, Sliding Sealing

- Sealing is obtained by sliding, not by compression according to wedging effects.
- Test results of the valve internal binding.
- Compare with wedge gate valve
- Test specimen : DN 40, ANSI 1500#
- Room temperature & 400°C hot temp.
- Heating in open position and closed, and then re-open the valve after cooling.

Solid Wedge Class	SPL PSGV	
	Open	Close
Normal	404	405
Heating/cooled	412	406
		86

• Result show that wedge gate sealing tend to jam & binding as a result of body contraction after cooled. Like these malfunction problems often occur of a wedge gate valve if they are closed while hot, and cooled afterwards. SPL PSGV never occur.

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Design Features & User Benefits, HI-Fluidic®

Design Features – Spring Pack Loadact(SPL) Parallel Slide Disc, Sliding Sealing

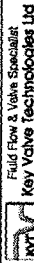
- Sealing is obtained by sliding, not by compression according to wedging effects.
- Longer maintenance free lifetime on sealing surfaces → Sealing integrity endurance test
- Test Conditions
 - Size : DN40, ANSI 1500#, A105
 - Actuator : Spring return(RA), Piston
 - Fluid : rusted water
 - Open/Closing time : below 10 seconds

Test Results

Number of cycles	Result of valve seat leak	
	Specimen 1	Specimen 2
10,000	No leak	No leak
20,000	No leak	No leak
30,000	No leak	No leak
40,000 ~	No leak	No leak

- Stop at 40,000 cycles due to limited test times.
- Test duration : 24days

We can guarantee the best quality of sealing integrity of a power operated PSGV when introducing CrN super ceramic coating to the discs.

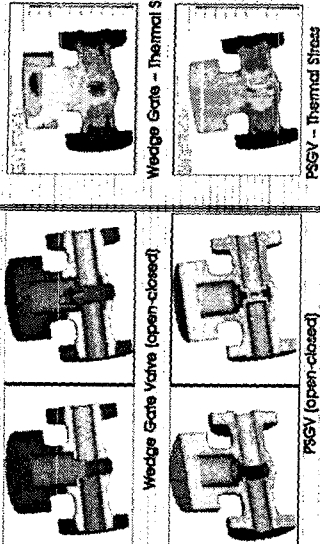


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Design Features & User Benefits, HI-Fluidic®

Design Features – FEA Design for Structural Integrity & Thermal



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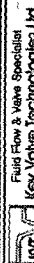
Design Features & User Benefits, HI-Fluidic®

Design Features – FEA Design for Structural Integrity & Thermal

SPL PSGV		Max. Stress	Max. Strain
Temp.	°C	188	0.031
Open Position		188	0.113
		300	0.272
		40	0.030
Close Position		180	0.132
		300	0.317

General Wedge Gate

Temp.	Appl. Press.	Max. Stress	Max. Strain
°C	bar/g	bar/g	mm
40	188	1843	0.039
180	188	8254	0.114
Open Position		188	0.238
		40	0.032
Close Position		180	0.165
		300	0.328

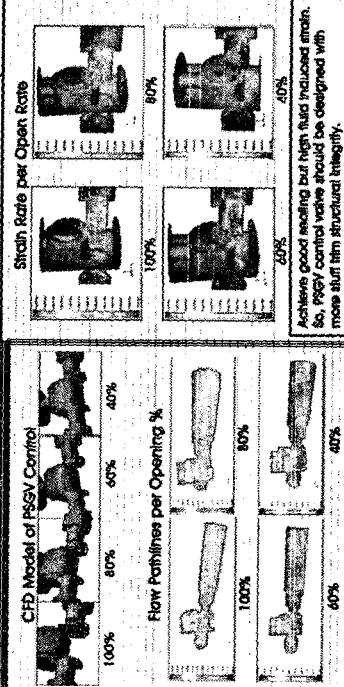


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Design Features – Fluid Flow Analysis by CFD in PSGV Control Valve - example



Achieve good sealing but high fluid traxload main. So, PSGV control valve should be designed with more stiff firm structural integrity.


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Parallel Slide Gate Valve – Flow Throttle-ability Gate Valve


Design Features & User Benefits, Hi-Fluidic®

Design Features – Spring Pack, Loaded(SPL) Parallel Slide Disc, Sliding Sealing

- Pressure sealed bonnet using high density pure graphite gasket (Della formed)
- To protect bonnet over pressure introducing pressure relieving device
- Bypass piping
- SPL Parallel sliding discs
- Wide flat seats
- Travel stop on Yoke
- Non-revolving stem by stopper
- Different hardening on seatings → Different hardness (~ 5 HRC) on seating surface: Discs – S11 #12, Seal – S11 #6
- Integrated back seat in bonnet – conical type
- Flow is directional
- Two thrust bearings and A-bushes bushing



Key Unit packed at its ports with air for power station, DN200-ANSI 2500# DVI, Bypass & Pressure relieving device, Motor & Manual operation, total 12 tpb



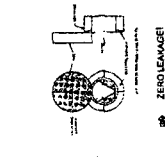
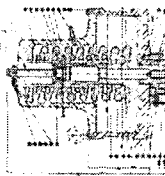
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Page 29

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Design Features & User Benefits, Hi-Fluidic®

Design Features – Gate Control Valve → SPL PSGV

- High Spring Rate of Disc Spring (RCORDEL 718) yields a good Seating Force
- Design of the Outer Edge of Disc is based on Lifeability Cycle Test (Actual Operation Condition, 172bars-342°C at KAERI Test Lab)
- Design by FEA, specific for Thermal Effects
- No stopper inside of valve

KVT Designed for Nuclear Power Plant



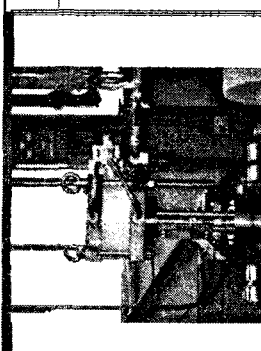
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Page 30

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Fast Acting Pneumatic PSGV – Proto Type Model Testing in hot test loop



KAERI Atomic Energy Research Institute(KAERI)
Thermal Hydraulic Testing Lab

- Valve Size : 2”(50mm)
- Valve Pressure Class : 2500# RTJ
- Opening Time : 0.3 Second
- Closing Time : 0.7 Second
- Valve Stroke : 40mm
- Valve Stroking Speed : 100 mm/sec (* MOVs Stroking Speed Synntec.)
- Testing Cond. : 172bars, 342deg.C
- Differential Pressure : 172bar
- Fluid Medium : Steam
- Test Purpose : Sealing Integrity and CN Coating Endurance Test in Hot Cond.



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Page 31

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Advantages of each type Seating Figuration in a Gate Valve

Seating Mechanism	Advantages	Dis-advantages
Solid Wedge	<ul style="list-style-type: none"> Increasing stem torque → increasing seating (for compressive seating) Simple Bi-directional flow 	<ul style="list-style-type: none"> Possible seat leaks under hot service due to plating reaction forces such as thermal Possible thermal binding Low flexibility
Split Wedge	<ul style="list-style-type: none"> Strong opposed plating reaction force Increasing stem torque → increasing seat force 	<ul style="list-style-type: none"> Possible pressure locking Possible seating unreliability
Flexible Wedge	<ul style="list-style-type: none"> Low flexibility opposite plating reaction & thermal Increasing stem torque → increasing seat force 	<ul style="list-style-type: none"> Possible pressure locking & also jamming High torque when unseating after cooled
Parallel slide Double Flat Seat	<ul style="list-style-type: none"> High flexibility to the plating reaction & thermal Constant stem force in operating Long life seating integrity & easy maintenance Fast acting operation using pneumatic actuator 	<ul style="list-style-type: none"> Possible pressure locking Wide flat seat area required
Parallel Expanding	<ul style="list-style-type: none"> Increasing stem torque → increasing seat force Positive seating Easy maintenance 	<ul style="list-style-type: none"> Possible pressure locking Lack of flexibility to plating reaction High torque when unseating after cooled
Knife Gate	<ul style="list-style-type: none"> Low pressure service. Good for off fluid Low weight 	<ul style="list-style-type: none"> Leads to seat No good for high temp. service



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Page 32

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Application	Others
<ul style="list-style-type: none"> • Power Generation • Feed Water Heater Isolation • Main Steam Stop & Isolation • Boiler Blow-off • Main Steam Drains • Heater Drains • Turbine Drains • Soot Blower Steam Isolation • Safety Valve Isolation • Blow-down • Reheater Isolation • Boiler Recirculation Pump Isolation • High Energy System Isolation 	<ul style="list-style-type: none"> 1. Raw Water (River) Stop Valves 2. Process Steam Stop Valves 3. Quick Open/Close Stop Valves 4. Fast Acting Stop Valves 5. High differential Press. Control Valves such as Blow-down Control 6. Steam Dump Valve

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Quick Opening PSGV

- 12", 600# RF, Pneumatic Platoon
- Operation Condition >
- Pressure : 60 barg
- Temp : 70° F
- Differential Press. : 60bar
- Opening Time : 1.0 second

KAERI
Line Breaking Research Work

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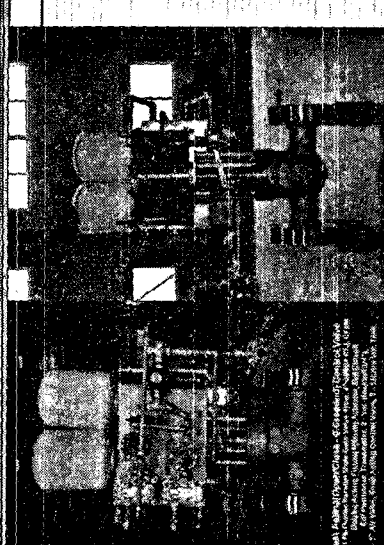
Standard Material Construction – Pressure Sealed Bonnet

Part Name	Carbon Steel	Alloy Steel	Stainless
Body	A214-WCA108	A417-WCA11	A481-CR3MS316
Bonnet	WCBA108	WCVF22	CF8M/SS316
Disc	SS410/A105+HF	F22+HF	SS316+HF
Stem	SS410	SS410/SS431	SS316
Seat Ring	SS410/1020+HF	F22+HF	SS316+HF
Gasket	WGLD GRAPHITE	→	→
Coating	GRAPOLITE	→	→
Padding Gland	SS410	→	SS316
Bonnet End	A193-B7/B16	A193-57/B16	A193-B8
Bonnet Comp	1046	1046	SS304
Gasket retainer	SS410	→	SS316
Gland Ring	SS410	→	SS316

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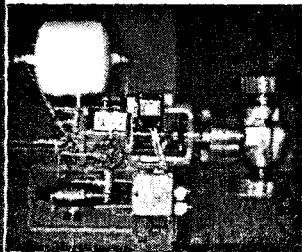
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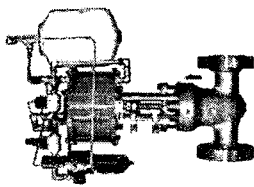


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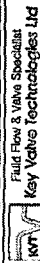
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Design Features, Hi-Fluidic® Gate Valve
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Quick Open/Close Parallel Slide Gate Control Valve
Control Valve, Next Image at 1/2 Scale
Opening in Valve, Same as 1/2 Scale



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Key Design Constitution of PSGV according to ANSI B16.34

Intermediate Pressure Class and its Wall thickness

$$P_{rd} = P_1 + \{ (P_d - P_1) / (P_2 - P_1) \} \times (P_2 - P_1)$$

P_{rd} : Intermediate Pressure Class

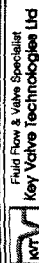
P_1 & P_2 are ratings corresponding to pressure class P_1 & P_2

P_1 : Low designated pressure class, P_2 : next designated class of P_1

$$t_m = t_1 + \{ (P_{rd} - P_1) / (P_2 - P_1) \} \times (t_2 - t_1)$$

t_1 & t_2 are wall thickness corresponding to pressure class & nominal size of P_1 & P_2

KVT DESIGN & MANUFACTURE THE INTERMEDIATE CLASS VALVES AS PER CUSTOMER REQUESTS AND/OR KVT ENGINEERING EFFORTS.



Fluid Flow & Valve Specialist
Key Valve Technologies Ltd

Parallel Slide Gate Valve – Flow Throttle-ability Gate Valve
Design Features & User Benefits, HI-Fluidic®

KVT Valve Developments For Thermal Cycling Plant

Conventional Valve Problems

- Lack of high temperature strength
- Thermal fatigue cracking.
- Heavy weights.
- Crack detection on fabrication welds of forged valve bodies.
- Welding Dissimilar metals.

9%Cr Alloy Steel Solution(C12A)

- Modified 9%Cr typically has twice the hot strength of the usual Chrome Moly and CMV steels.
- Greater resistance to thermal cracking.
- Half the weight/could be used with down pressure class).



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Epilogue

All the products of KVT are based on engineering experience, which are also for valuable customer satisfaction.

KVT dream is to be the respective valve manufacturer of the users

Thank you very much for your valuable attentions



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