Al Andalus BIMEX

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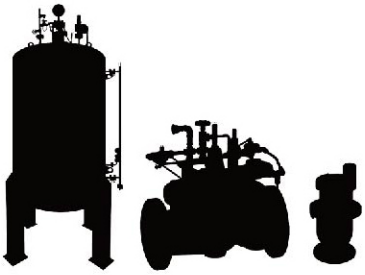
Water Hammer

Surge Protection System



Definition of Water Hammer

When a valve in piping is opened or closed suddenly, or when there is a drastic fluctuation in the flow upon operating or stopping the pump, the pressure fluctuates, and the flow also changes abruptly, which is called Water Hammer phenomenon. When closed is the valve at the bottom of the piping filled with liquid flowing in it, the flow in the piping decelerates suddenly, and the kinetic energy that the liquid bears turns to pressure energy, which results in seismic waves flowing through the pipe.

The same phenomenon may take place when a closed valve is opened suddenly. The pressure at the moment that the valve is closed becomes limitless if the wall of the pipe is a rigid body and the liquid is completely incompressible. In reality, however, the pipe wall is expanded upon closing the valve although the extent is not very outstanding and the liquid is compressed to the point of increasing the pressure to a limited extent since liquid is somewhat compressible and the pipe wall is elastic. The phenomenon of Water Hammer takes place without any advance notice just as blackout, and it causes drastic increase or decrease(negative pressure) of pressure. Thus, it is vital to install equipment to relieve the impact of Water Hammer to secure safe operation of a piping system. The pressure within a piping should be controlled in a certain range during the operation even under an unexpected situation.

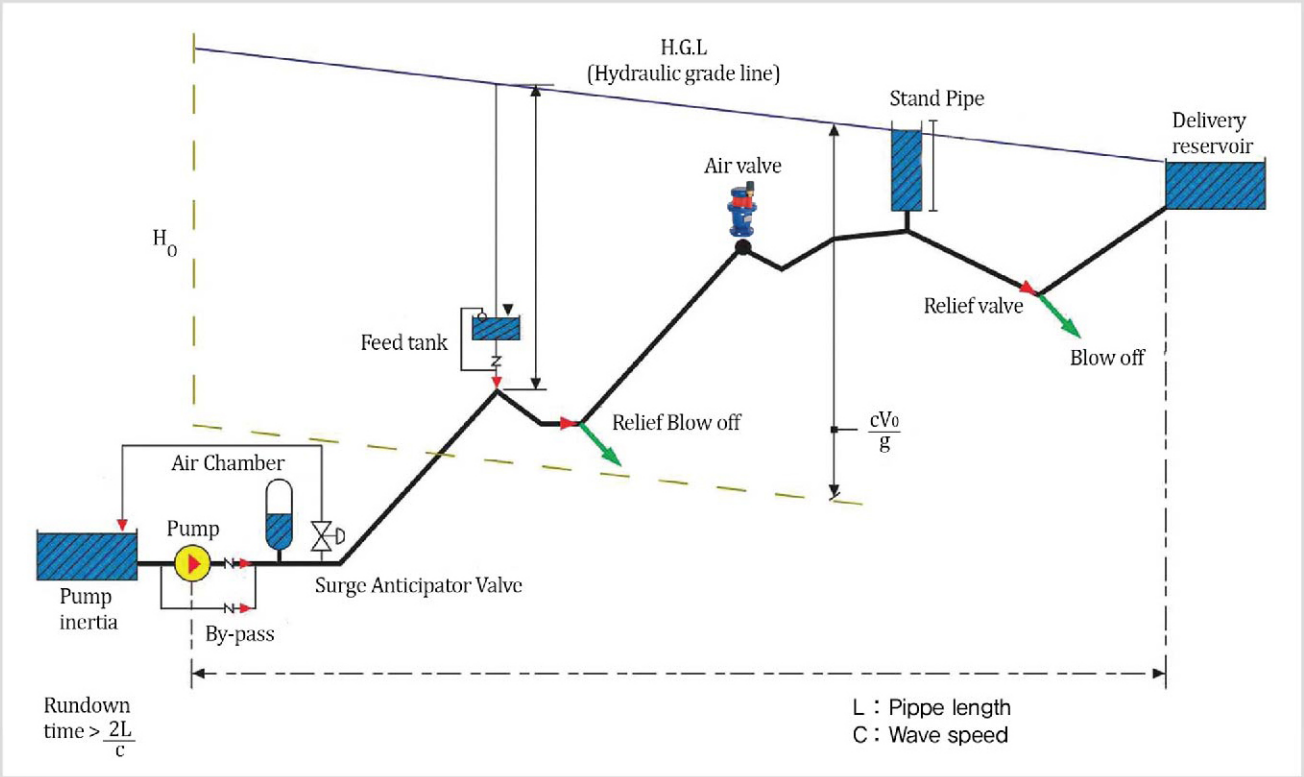
Damage of Water Hammer

- Raised pressure in the pipeline causes break of facilities such as pumps, valves, pipes, and supporting structures.
- Vapor cavities causes collapseor heavy shock wave geberated in the course of column separation and subsequent return causesbreak of the pipeline.
- Low pressure in water supply pipeline causes health risk by letting in pollutants from outside.
- Water hammer may cause vibration and noise or make automatic control hard due to abnormal pressure wave.

Why do a surge(Water Hammer)analysis necessary?

- Pressure extremes usually occur during a period of transient flow
- Pressures may exceed design limits
- Undesirable conditions occur (low pressures, cavitation, large pressure spikes, etc.)
- High pressure transients break pipes
- Low pressure transients destroy seals
- Low pressure reansients may cause health risk
- Evaluate surge protection schemes

Surge Protection System



Characteristics of Water Hammer Cushion by Type

ITEM / TYPE	Control properties				Componenet	Feature
	EXTERNAL POLLUTANT	UP SURGE	DOWN SURGE	SURGE CONTROL		
Stand Pipe	Flowed in	Controllable	Controllable	Passive	Pipe	Simple design, needed to install higher than H.G.L, Fluid is exposed to air, which may result in smell leakage in case of sewage water and cause health risk for water supply.
Feed Tank (one way)	Flowed in	Uncontrollable	Controllable	Passive	Open tank	Prevents column separation due to inflow under negative pressure. Installation place is limited as it is fixed on the top of the pipeline.
Air Valve (Vacuum Breaker)	Flowed in	Uncontrollable	Controllable	Passive	Air Valve (Vacuum Breaker)	Handles negative pressure by letting in air, when negative pressure works in the pipeline. Often installed on the pipeline, making maintenance hard. Pollutants may flow in with air.
Surge Valve	Blocked	Controllable	Uncontrollable	Passive	Control Valve	Control only follows water hammer, and surge control at the time of system failure may be useless.
Air Chamber	Blocked	Controllable	Controllable	Active	Pressure Vessel Compressor, auto control panel	Expensive, positive measure against up/down surge, possible to install in/out-doors, and clean by using a closed tank.

Types of Water Hammer preventive device

Water Hammer Protection System

Separate® Water Hammer cushion

separate small-sized water hammer cushion, which can be easily mounted on water tap and valve front where water hammer occurs.

-MODEL : MIN150
-Max working pressure : 10kg/cm²·G
-Max velocity : 3m/sec
-Outside dimension : Φ88mm×113mm
-Volume : 160cc(mℓ)
-Max shock pressure : 14kg/cm²·G
-Max working temp : 90°C
-Pre-charged Air : Set to 1.5kg/cm²·G which can be adjusted if necessary.

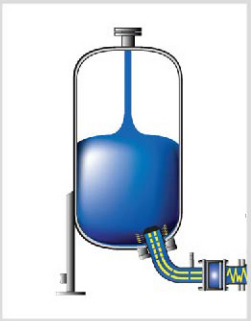
[Structure and Mechanism]
Once the valve is closed, shock(water hammer) occurs.
In this case, resulting extremely high pressure is separated by the diaphragm, compressing sealed air, which absorbs shock energy and prevents shock

Small-sized® Water Hammer cushion

is designed with a sufficient capacity to install at places such as water pipe of a building. Installation capacity and quantity are calculated as in the table below. Air seal pressure must be set to the pipeline pressure at the place of installation.

-Max working pressure : 7.0kg/cm²·G
-Max shock pressure : 15kg/cm²·G
-Max working temp : 60°C
-Pre-charged Air : 3.5kg/cm²·G

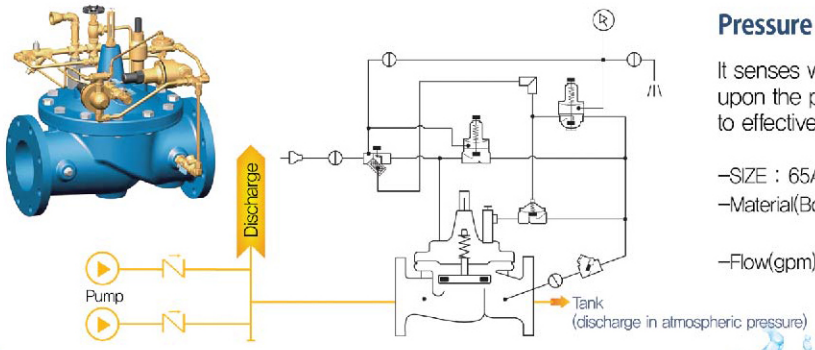
Model	Capacity	Outside dimension (mm)			Unit grade(FU)
		Diameter	Height	Joint	
DUF-010	2.6	155	218	20A	1-1
030	2.9	155	232	20A	12-332
060	3.2	155	248	20A	33-66
150	3.8	155	286	32A	114-154
330	4.1	155	302	32A	155-330



Bladder-® embedded Water Hammer Preventive Device

The embedded bladder in the compression tank helps storing compressed air semi-permanently, which removes the need for a separate compressor. Besides, it controls rise/falling surge as well as various surges effectively.

-Model : 200~5000lit, 10kg/cm²·G,16kg/cm²·G
-Option : 10~60lit, 200kg/cm²·G,300kg/cm²·G



Pressure Relief & Surge Anticipator Valves

It senses when the pressure of Down Surge is low upon the pump stopping and opens the main valve to effectively control the Up Surge pressure.

-SIZE : 65A 65A (2½") ~ 600A (24")
-Material(Body) : ASTM · A536 (250Psi/#150, ASTM A216-WCB, 720Psi/#300)
-Flow(gpm) : 670/65A, 1800/100A, 1000/200A, 1600/300A, 25000/400A

Petrochemical Plant Bladder-type Water Hammer Preventive Device

Butyl/NBR/Viton/EPDM Bladder

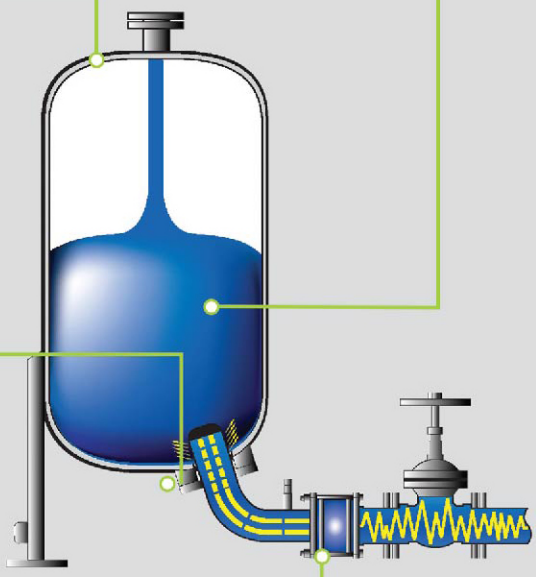
High quality butyl rubber that the air transmissivity is very low, the thermal resistance is excellent, and the durability is proved.

-Bladder : low in air permeability and possible to provide various types of bladders

Pressure Vessel

Examined by the Korea Occupational Safety and Health Agency (KOSHA)
Bladder Type-Closed it should be approved by KOSHA Korea Occupational Safety and Health Agency according to the industrial safety and health law section 34 and its enforcement regulations section 58-9(ASME possible)

-Pressure vessel : Examined by the Korea Occupational Safety and Health Agency (KOSHA)-ASME Stamp(Option)
-Size : 0.2~5.0 cm^3
-pressure : 10k, 16k



Silent Distribution Chamber

Anti-noise & vibration distribution chamber: Bladders can be easily damaged by shock wave; thus, input and output resistance factor is optimized while absorbing shock wave (if necessary)

Up & Down Surge Control valve

As a two-way control check valve for differential friction factor, the bypass pipes with built-in Orifice are installed in parallel to the connecting pipes to effectively control surge. These are an all-in-one control valve that effectively control the Water Hammer phenomenon.

Model	Volume	Dimension		Connection	Weight	Remarks
	Liter	A, mm	B, mm	C, mm	Kg	
BAL 200K	200	1280	610	65A	150	150
BAL 300K	300	1610	610	65A	200	200
BAL 400K	400	1960	610	65A	220	220
BAL 500K	500	2310	610	65A	270	270
BAL 600K	600	1920	753	100A	340	340
BAL 800K	800	2380	753	100A	420	420
BAL 1000K	1000	2120	915	100A	550	550
BAL 1500K	1500	2800	915	100A	680	680
BAL 2000K	2000	2410	1233	150A	1020	1020
BAL 2500K	2500	2850	1233	150A	1080	1080
BAL 3000K	3000	2510	1570	200A	2050	2050
BAL 4000K	4000	3060	1570	200A	2200	2200
BAL 5000K	5000	3600	1570	200A	2450	2450

Air-Chamber Type

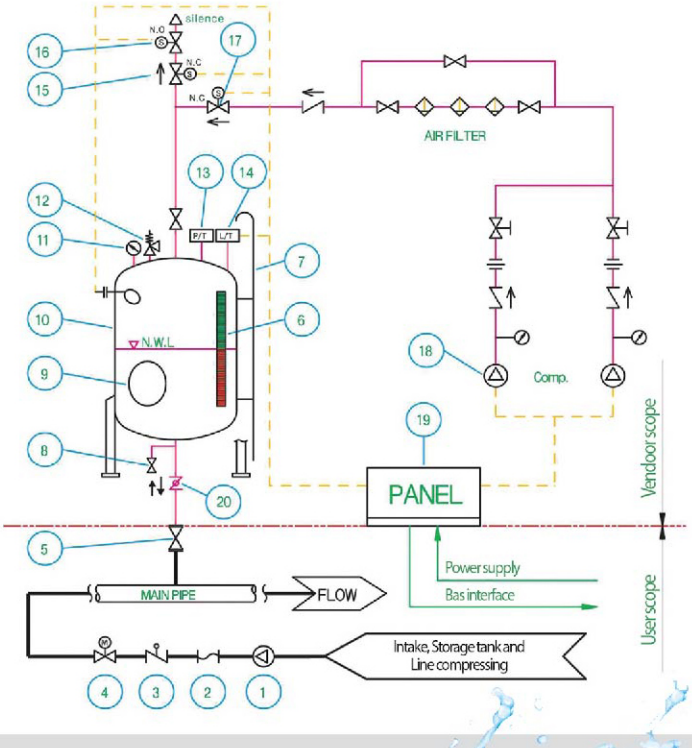
In the piping of pump discharge, installed is the compressed container with water and compressed air in the ratio of 50 to 50 to control Up and Down Surge in the Water Hammer preventive devices. If an Orifice is installed in a side pipe of the connecting piping, the Up and Down Surge is more effectively controlled.

Model V: vertical H: horizontal	Capacity (㎥)	Air – Chamber Dimension (Φ X H)mm	Tank weight per at 10 kg/cm². design			Remarks
			Product	Operation	Hydraulic pressure	
HWT-500V	0.5	Φ700 X 2,350H	400	650	900	Customized productiom is available, depending on on-site
800V	0.8	Φ930 X 2,500H	600	1,000	1,400	
1,000V	1.0	Φ930 X 2,700H	700	1,200	1,700	
1,500V	1.5	Φ1,208 X 2,800H	900	1,700	2,500	
2,000V	2.0	Φ1,208 X 3,500H	1,020	2,010	3,020	
5,000V	5.0	Φ1,540 X 4,700H	2,000	4,600	7,100	
10,000V	10.0	Φ2,000 X 5,200H	5,200	11,200	17,200	
10,000H	10.0	Φ2,000 X 4,100H	5,200	11,200	17,200	
20,000V	20.0	Φ2,720 X 5,900H	6,560	16,560	26,560	
20,000H	20.0	Φ2,720 X 4,700H	6,560	16,560	26,560	
30,000V	30.0	Φ2,980 X 4,700H	8,750	23,750	38,750	
50,000V	50.0	Φ3,240 X 4,900H	13,670	38,670	63,670	
90,000H	90.0	Φ4,000 X 8,700L	32,000	77,000	122,000	
100,000H	100.0	Φ4,000 X 9,700L	38,000	88,000	138,000	

Either the vertical or horizontal type is available according to the onsite condition, and the pipe diameter may be changed according to the distance.

1. Designed Compression: 10, 15, 20, 25, 30, 40 Bar
2. Vertical or horizontal types
3. Compressor: Selected according to the chamber capacity and operation pressure
4. Chamber materials or coating specifications selected according to the type of the fluid(water system)

Components of Air Chamber Type System



No	DESCRIPTION
1	Pump
2	Flexible Joint
3	Check Valve
4	Motor Operated Valve
5	Connection Valve
6	Level Gauge
7	Plat Form/Ladder
8	Drain Valve
9	Manhole
10	Air Chamber
11	Pressure Gauge
12	Safety Valve
13	Pressure Sensor
14	Level Transmitter
15	Vent Sol. Valve
16	Gas Maintaining S.Valve
17	Charge Sol. Valve
18	Compressor
19	Control Panel
20	Up Down Sureg Control Valve (Option)

Key Features of the Controller

Digital PID Controlling Method

The adoption of Digital PID Controlling Method realizes high-accuracy controlling by drastically reducing the deflection of controlling the water level of the Air Chamber according to the operation, stop, and flow of the pump.

Korean LCD/ Touch Screen

The data values displayed on LCD are to help users maintain and operate the unit readily.

Remote Control System(OPTION)

The control panel contains the long-distance communication modem, which connects the unit to an internet line/public phone line and enables services necessary for maintenance including monitoring and remote controlling by the customer service team of the company.

Skip & Rotary Control

Malfunctioning of the duty compressor automatically initiates the operation of the next compressor except when it is operating. A compressor stopped due to malfunctioning returns to the working mode upon reset, and the number of compressors is adjusted according to the water level. To evenly control the operation hours and times of the compressors in parallel, the priority of the compressors being operated is to be periodically changed, which prevents wear and breakdown of a compressor.

Powerful Self-diagnosis

The hardware functions of the microprocess and software functions to prevent malfunction/abnormal condition enhance the reliability.

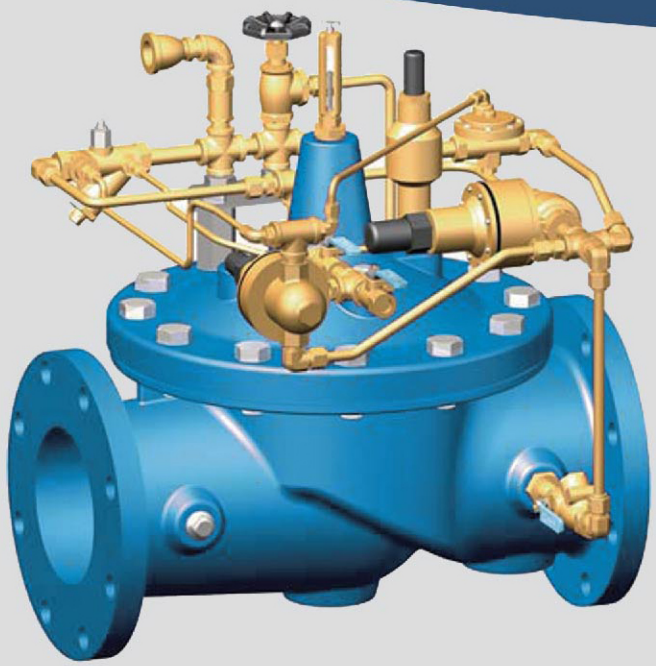
Reliable Level Sensing & High Efficiency Control

Upon excessive errors or malfunctions of the level transmitter, the technology to sense and compare the level properly helps operating the unit in a reliable manner(patent). In connection with the operating pumps, it recognizes the proper range of the water level according to the pump operation, which saves the compressor power as much as 50% of the existing way(patent).

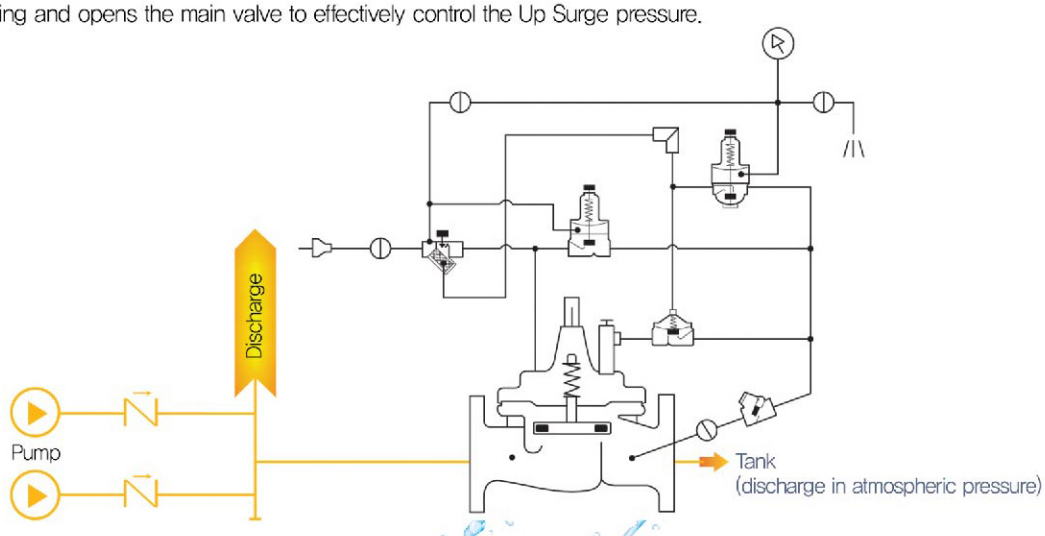
Operation and Failure Data Management

Upon Water Hammer, the specific information including the highest pressure, level(the upper and lower limits), operation data of each compressor, causes and time of malfunctions, etc is recorded in the Non-Volatile Memory in order to continue to monitor the operating condition and provide accurate service information upon problems. The records of accumulated hours of use and operating times of each compressor are kept as a part of the various maintenance predictive functions for the maintenance of major parts.

Pressure Relief & Surge Anticipator Valves



It senses when the pressure of Down Surge is low upon the pump stopping and opens the main valve to effectively control the Up Surge pressure.



Size

Pattern	Threaded	Flanged	Grooced End
Globe	3/8"–3"	1 1/2"– 36"	1 1/2" 2"–2 1/2"–3"–4–6–8"
Angle	11/4"–3"	2"–16"	2"–3"–4"

Operating Temperature

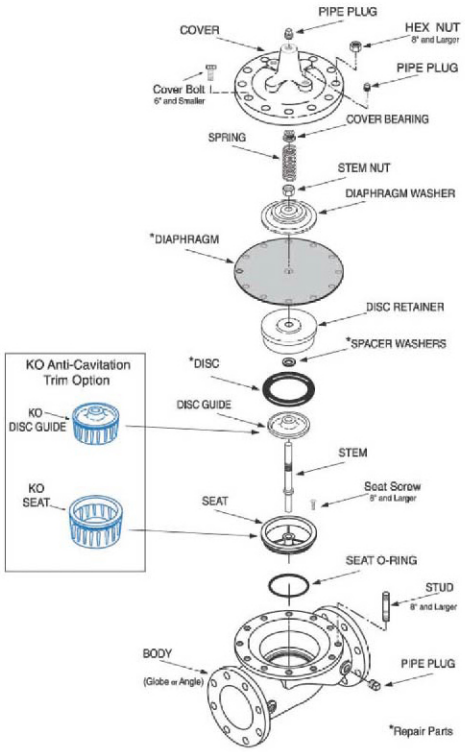
Fluids
–40°C to 82°C

Pressure Range(High Pressure, barg)

Valve Body & Cover		Pressure Class			
		Flanged			Threaded
Grade	Material	ANSI Standards*	150 lb	300 lb	End* Details
ASTM A536	Ductile Iron	B16.42	17.2	27.6	27.6
ASTM A216–WCB	Cast Steel	B16.5	19.7	27.6	27.6
ASTM B62	Bronze	B16.24	15.5	27.6	27.6

Meterials

Component		Standard Material Combinations	
Body & Cover	Ductile Iron	Cast Steel	Bronze
Available Sizes	1 1/4"–36"	1 1/4"–16"	1 1/4"–16
Disc Retainer & Sea & Cover Bearing	Cast Iron	Cast Steel	Bronze
Trim: Disc Guide, Seat & Cover Bearing	Bronze is Standard Stainless Steel is optional		
Disc	Buna–N Rubber		
Diapragm	Nylon Reinforced Buna–N Rubber		
Stem, Nut & Spring	Stainless Steel		



Functional Data

Valve Size		Inches	3/8	1/2	3/4	1	11/4	11/2	2	21/2	3	4	6	8	10	12	14	16	20	24	30	36
		m.m	10	15	20	25	32	40	50	65	80	100	150	200	250	300	350	400	500	600	800	900
Cv Factor	Globe Pattern	Gal./Min.(cpm)	1.8	6	8.5	13.3	30	32	54	85	115	200	440	770	1245	1725	2300	2940	5345	7655	10150	13320*
		Litres/Sec.(Vs)	.43	1.44	2.04	3.2	7.2	7.7	13	20	28	48	106	185	299	414	552	706	1286	1837	2436	3200
	Angle Pattern	Gal./Min.(cpm)	–	–	–	–	27	29	61	101	139	240	541	990	1575	2500*	3060*	4200*	–	–	–	–
		Litres/Sec.(Vs)	–	–	–	–	6.5	7	15	24	33	58	130	238	378	600	734	1008	–	–	–	–
Equivalent Length of Pipe	Globe Pattern	Feet(ft)	25	7	6	23	19	37	51	53	85	116	211	291	347	467	422	503	595	628	1181	2285
		Meters(m)	7.6	2.2	4.8	7.1	5.7	12	15.5	16	26	35	64	89	106	142	129	154	181	192	552	569
	Angle Pattern	Feet(ft)	–	–	–	–	28	46	40	37	58	80	139	176	217	222*	238*	247*	–	–	–	–
		Meters(m)	–	–	–	–	8.7	14	12	11	18	25	43	54	66	68	73	75	–	–	–	–
K Factor	Globe Pattern		18.3	3.7	5.7	6.1	3.6	5.9	5.8	4.6	6.0	5.9	6.2	6.1	5.8	6.1	5.0	5.2	4.6	4.0	5.3	7.8
	Angle Pattern		–	–	–	–	4.4	7.1	4.4	3.3	4.1	4.1	4.1	3.7	3.6	2.9	2.8	2.6	–	–	–	–
Liquid Displaced from Cover Chamber When Valve Opens	Fl. Oz		.12	.34	.34	.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	U.S Gal		–	–	–	–	.02	.02	.03	.04	.08	.17	.53	1.26	2.51	4.0	6.5	9.6	12	29	48	90
	ml		3.5	10.1	10.1	20.7	75.7	75.7	121	163	303	643	–	–	–	–	–	–	–	–	–	–
	Litres		–	–	–	–	–	–	–	–	–	–	2.0	4.8	9.5	15.1	24.6	36.2	45.4	109.8	197	340

Cv Factor

$$Cv = \frac{Q}{\sqrt{\triangle P}} \qquad Q = Cv\sqrt{\triangle P} \qquad \triangle P = \left(\frac{Q}{Cv}\right)^2$$

K Factor (Resistance Coefficient)

The Value of K is calculated from the formula : $K = \frac{894d^4}{Cv^2}$

Equivalent Length of Pipe

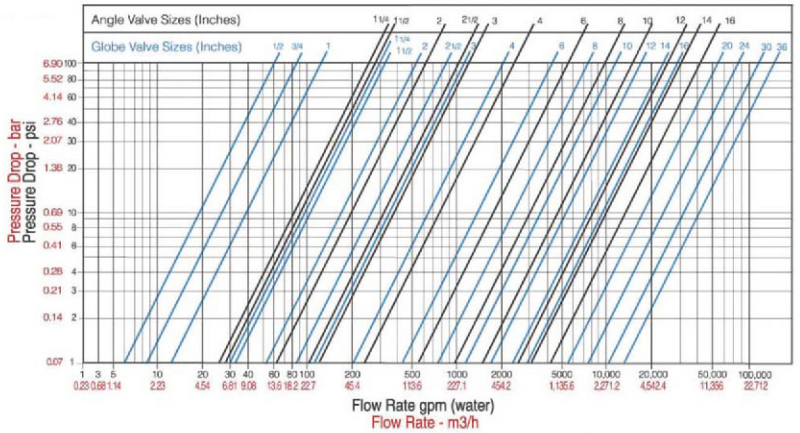
Equivalent Length of Pipe(L) are determined from the formula : $L = \frac{K\,d}{12\,f}$

Fluid Velocity

Fluid Velocity cabe calcuted from the following formula : $V = \frac{.4085\,Q}{d^2}$

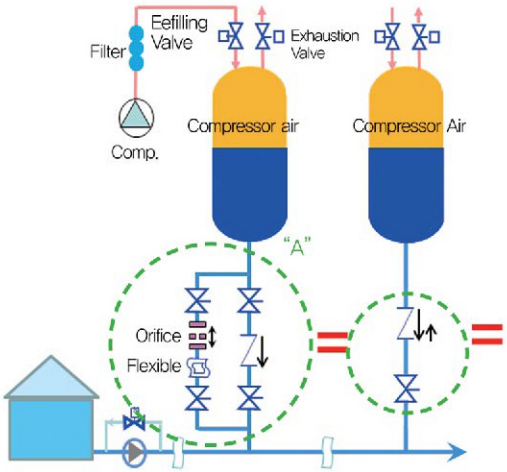
Cv = U.S. (gpm) @ 1 psi differential at 60°F water
d = Inside pipe diameter of Schedule 40 Steel Pipe (inches)
f = Friction factor for clean, new Schedule 40 pipe
K = Resistance Coefficient (calculated)
L = Equivalent Length of Pipe (feet)
Q = Flow Rate in U.S. (gpm) or (l/s)
V = Fluid Velocity (feet per second) or (meters per second)
△P = Pressure Drop in (psi) or (bar)

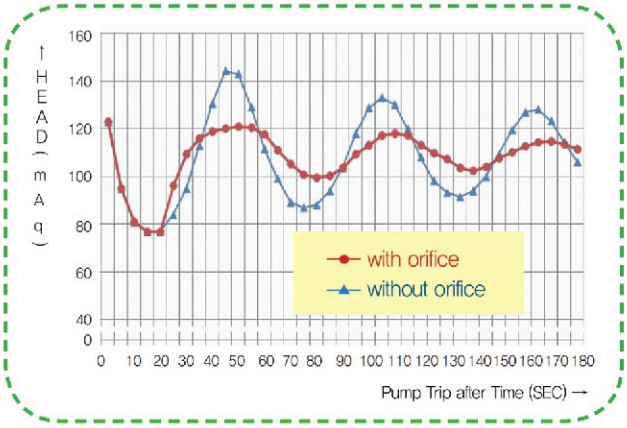
Model 100–01



New Technology:

UP-DOWN Surge Control Valve
(Main connecting pipe + check valve + side pipe + Orifice unification)

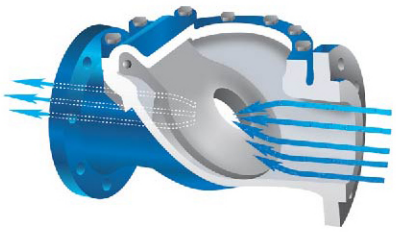




Features

Installation of Orifice at the side-pipe with an Air-Chamber (Figure A) reduces Water Hammer more effectively.
By means of a single 『Interactive friction co-efficient control check-valve』, prevention of malfunctions and reduction of Water Hammer are possible in the complicated side-pipe "A."
However the orifice is not effective in all cases so it must be judged when analyzing pipe flow.

Interactive friction co-efficient control check-valve



Interactive friction co-efficient control check-valve for the inflow from the pipe to the compression tank, Orifice increases the friction resistance which effectively controls the Up Surge

Smooth flow from the compression tank to the pipe!
Effective prevention of Down – Surge

Power-saving and high reliability in controlling(Air Chamber Type)

Super power-saving

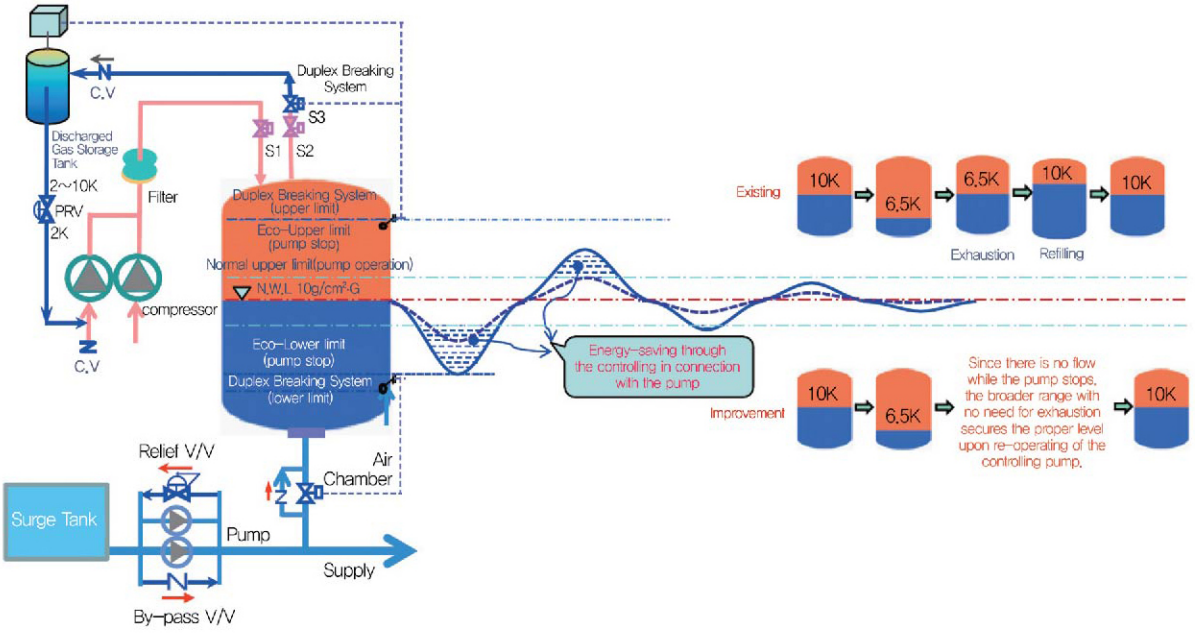
Unlike the existing manner that maintains the level up to 50% regardless of the pump operation state, the range of water level within the Air Chamber is widened when the pump stops in connection with the pump, the provider of the fluid flow, which maintains the compressor power down to 50%. Besides, the hydro-electricity capacity+power costs can be drastically saved as only the minimum amount of air for dissolution is necessary.

High reliability

Vital is the storage of compressed air, the source of energy for the Air-Chamber Type water hammer preventive device. While the existing method may lose the functions when any of the level sensor-electronic valve-controller is broken, this technology adopts the function of keeping the minimum amount of the compressed air by means of a separate electronic valve in connection with the separate, highly reliable level switch, which protects the system in a more reliable way.

Environment-friendly technology

High efficiency of the compressor that reduces energy consumption down to 50% compared to the existing way, which contributes to reduction of carbon-dioxide, the ultimate hygienic condition, and supply of clean drinking water with no oil element.



Notes:

Notes:

Water Hammer

Surge Protection System

Services Provided:
1. Piping flow interpretation(Design of the Water Hammer preventive device in consideration of the occurrence of Water Hammer and usage)
2. Design/production/installation/follow-up maintenance of a Water Hammer preventive device

Note _
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