Shock Control NSV

ISO 9001/ISO 14001
OHSAS 18001
MADE IN KOREA

SHOCK CONTROL

PRODUCT OVERVIEW

SHOCK CONTROL

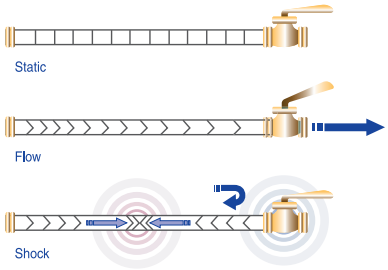
Theory for prevention of shock

Technical information on NSV Water Hammer Arrester

1. Introduction

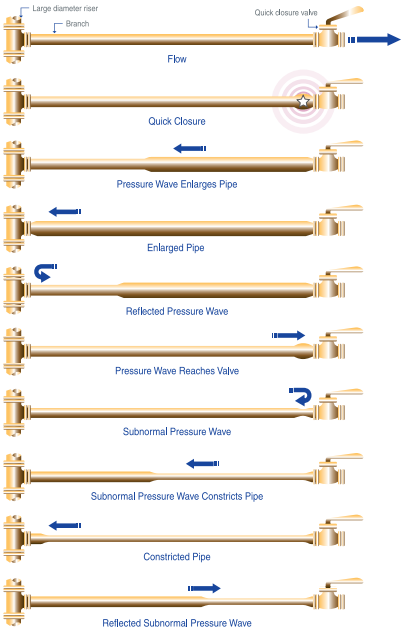
Water hammer is the phenomenon that enormous power and accompanying impulsive noise and vibration are generated when a sudden change occurs in the flow of fluid in the plumbing system in which uncompressible fluid flows.
When water hammer occurs, the impulse waves of very high intensity continue to move back and forth along the plumbing system until the energy completely disappears due to the viscosity of the fluid and pipe material.
The impulse wave is generated when the velocity of the fluid changes suddenly due to quick closing of the valve in the plumbing system. Automatic valves of electric, pneumatic, and spring types are being used increasingly, and for the manual valves, the preference is for ones operated by one touch action, which means cases of quick opening/closing of valves are also increasing so water hammer occurs more frequently and the impact is also becoming stronger.

2. Generation of water hammer



[Figure 1] Generation of water Hammer

As shown in [Figure 1], when the valve at the end of plumbing in which a fluid flow is closed quickly, an impulse wave occurs and propagates in the direction opposite to that of the flow of the fluid. The propagation speed of this impulse wave is 1200~1500m/s when the fluid is water.



[Figure 2] Illustrations of a Shock Wave

[Figure 2] shows the relationship between the movement of the impulse wave and the change in the status of the pipe.
As shown, the section of the pipe suffers a status change of 'expanded → restored → shrunken → restored' during one cycle of impulse wave propagation.
Enormous power is applied to the inner surface of the pipe at that time, and impact noise and vibration are generated as if the pipe is being beaten by a hammer and it might cause damage to the valve, parts like fittings etc., and even to the pipe itself, and there might be leakage due to loosening of connections.

3. Intensity of impacts

Impulse waves are generated only when a valve is quickly open or closed, and the quick open/close speed of ≤ (2L/a) seconds. When the speed of opening or closing the valve is long enough, such as ≥ (2L/a) seconds, an impulse wave is not generated, the dynamic pressure of the fluid is converted to static pressure and the pressure rises to the extent of the dynamic pressure. This is called surging.
The maximum pressure of the impulse wave when water hammer occurs is calculated using Joukowsky's formula as shown below.

$$Pr = \rho\alpha\nu \text{ (pa)}$$
$$= \rho\alpha\nu / 98000 \text{ (kgf/ cm}^2\text{)}$$

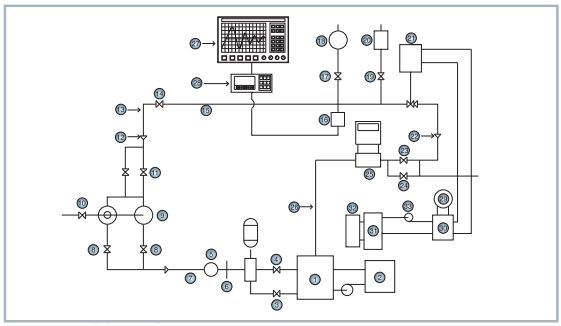
Where :
Pr : pressure rise
ρ : fluid density(kg/m^3)
α : propagation speed of the impulse wave(m/s: for water 1200~1500)

4. Effects of the impulse wave

- Pipe rupture
- Leakage at connections
- Loosening of connections
- Vibration and noises of/from pipe
- Damage to valves
- Damage to check valves
- Damage to flow meters
- Damage to pressure controllers and gauges
- Damage to recorders
- Loosening of pipe hangers and supports
- Damage to tanks and water heaters
- Damage to other facilities and devices

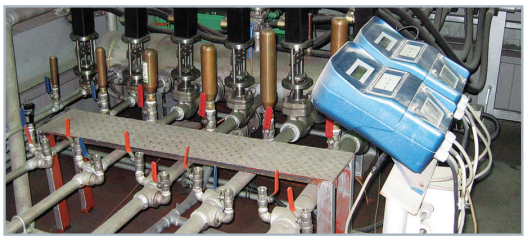
5. Water Hammer Arrestor

[Figure 3] shows an example of the test equipment for testing the impact absorbing capability proposed in KS B 2375 (Korean Standard)
[Figure 4] shows the test equipment for testing the impact absorbing capability owned by the company.



[Figure 3] Equipment for testing the impact absorbing capability, proposed in KS B 2375 (Korean Standard)

Number	Devices	Number	Devices	Number	Devices
1	Water tank	12	Return bend(250A)	23	Metering bend (50A)
2	Heater	13	Valve	24	Metering bend (15A)
3	Gate valve (50A)	14	Gate valve (50A)	25	Flow meter
4	Gate valve (40A)	15	Steel pipe	26	Steel pipe
5	Centrifugal pump	16	Pressure con-verter	27	Oscilloscope
6	T for water return, elbow	17	Ball valve	28	Digital pressure recorder
7	Steel pipe	18	Pressure gauge	29	Pressurizing pump
8	Gate valve (50A)	19	Ball valve	30	Water pressure solenoid valve
9	Air Pr. type water tank (113.5L)	20	Absorber for testing	31	Oil tank
10	Globe valve (15A)	21	Hydro surge valve (50A)	32	Oil cooler
11	Gate valve (80A)	22	Return bend (250A)	33	Counter

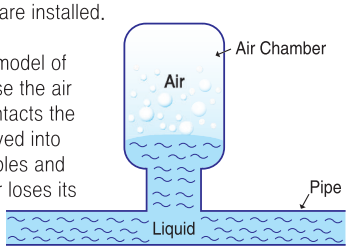


[Figure 4] Equipment for testing impact absorbing capability

6. Water Hammer Arrester

The means for preventing water hammer is to insert a gas (mainly air) filled space in the plumbing system in which valves that may be quickly opened/closed are installed.

[Figure 5] shows an early model of the air chamber. In this case the air in the chamber directly contacts the liquid and it may be dissolved into the liquid or becomes bubbles and in such cases the chamber loses its function.



[Figure 5] Air Chamber for Arresting Water Hammer

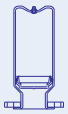
Recently the water hammer arresters being used have an air bladder, piston, etc., in the air chamber to prevent air from being lost.

7. Theory and features of the water hammer arrestor

While the compressibility of liquid is low, that of gas is high. The water hammer arrester uses the compressibility of gas. Gases having high stability such as air, nitrogen, etc., put into the flow of fluid, being isolated, can contract when there is a sudden pressure rise in the fluid, thus absorbing the shock from a certain disturbance such as the one caused by the sudden opening/closing action of a valve. The water hammer arrester applies this theory to a product.

It maintains the steady flow of the liquid by absorbing the water hammer's impulsive energy. Features of the water hammer arrester are as listed below.

- ▶ Maintains the pulsation when operating pumps.
- ▶ Absorbs noise · vibration caused by water hammer.
- ▶ Prevents impulse pressure in plumbing system of fire fighting facilities.
- ▶ Used to ensure a calm environment near humans.
- ▶ When the circulation pumps are started/stopped by automatic control, impulsive change in energy might occur due to the opening/closing action of check valves and thus noise · vibration might be generated. Water hammer arresters absorb and reduce such noise · vibration.

Items	Built in rubber film type	Built in bellows type	Built in piston type
Type			
Use	- For preventing water hammer and fluctuation in plumbing system - For protecting the flush valve in sanitary facilities	- For preventing shock in an oil pipeline	- For pressure control of hydraulic equipment - For sanitary plumbing

The products with structures shown in the table above absorb the impulse pressure according to the Boyle's law [P1 V1 = P2 V2 = Constant], where

– P1, P2 : the pressure of the water hammer arrester at the start and end of the time period under discussion regarding water hammer

– V1, V2 : the volume of the room in which air or nitrogen is filled (m^3)

8. Calculation of the capacity of the water hammer arrester

The capacity of the water hammer arrester can be expressed in terms of the inner volume. The required capacity can be calculated using the Greer Mercer's experimental formula shown below.

$$V = \frac{4.0 \times 10^{-3} \times QP_1(0.016L - tc)}{P_1 - P_2} \quad [Liter]$$

Where Q : flow before valve closing

P_1 : allowable impulse pressure (kg/cm2), 1.5 times P2 in most cases, but twice P2 when ≥ 250A

P_2 : pressure before valve closing (kg/cm2)

tc : roundtrip time of the impulse wave after valve closing (0.3~0.5sec) = 2L/C

L : total length of the pipeline (m)

Theory for prevention of shock

Information for selecting water hammer arrester

1. Fixture Units of principal facilities

Facilities	Means for control	Common use			Personal use		
		Total	Water supply	Hot water supply	Total	Water supply	Hot water supply
Toilet stool	Flush valve	10	10		6		
	Flush tank	5	5		3		
Urinal	Large stall	10	10				
	Midsize stall, wall mounted	5	5				
	Small stall, wall mounted	3	3				
Washbasin	Faucet	2	1 1/2 (2)	1 1/2	1	1	1
Shower head	Compound faucet	4	2(4)	3	2	1	2
Bathroom	Flush valve				8	8	3
	Flush tank				6	6	3
Shower booth	Faucet				2	1	2
Service sink	Faucet	3	3				
Laundry sink	Faucet				3	3	3
Mixed furniture	Faucet				3	3	3

※ What is Fixture Unit, FU?
Fixture Unit, FU is a unit to express the water flow load imposed by a fixture in a sanitary plumbing, put into use as a result of many research studies and experiments performed by PDI. It is the number obtained by dividing the water flow load of the fixture under discussion by that of a washbasin, the reference water flow load. It is used in determining the diameter of the water supply pipe in the sanitary plumbing system.

2. Selecting the water hammer arrester based on the pressure in the plumbing system

The ideal pressure value in the sanitary plumbing connected to a fixture is ≤ 4.0kgf/㎠. When the pressure is too high, pressure reducing valves should be installed for protecting fixtures. The criteria for selecting the water hammer arrester based on the pressure in the plumbing system is as shown in the table below.

When the water pressure is ≤ 4.5kgf/㎠	When the water pressure is 〉4.5kgf/㎠
Select based on the FU standards	Select the one that is one step higher than what is selected based on the FU standards

3. Selecting the water hammer arrester based on the length of the plumbing system

The water hammer arrester to be used for the case the installation point of the fixture is far in the plumbing system is selected referencing the tables below, depending on the pressure

(A) When the water pressure is ≤ 4.5kgf/㎠

Length of the plumbing \ Diameter of the pipe(B)	1/2″	3/4″	1″	1 1/4″	1 1/2″	2″
25ft(8m)	A	A	B	C	D	E
50 (15)	A	B	C	D	E	F
75 (20)	B	C	D	A, E	F	E, F
100 (30)	C	D	E	F	C, F	F, F
125 (40)	C	D	F	A, F	E, F	E, F, F
150 (50)	D	E	F	D, F	F, F	F, F, F

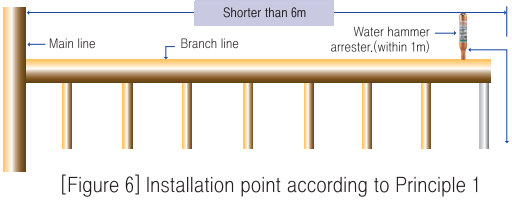
(B) When the water pressure is 〉4.5kgf/㎠ and ≤ 6.0kgf/㎠

Length of the plumbing \ Diameter of the pipe(B)	1/2″	3/4″	1″	1 1/4″	1 1/2″	2″
25ft(8m)	B	B	C	C	E	F
50 (15)	B	C	D	E	F	C, F
75 (20)	C	D	E	F	C, F	F, F
100 (30)	D	E	F	C, F	F, F	E, F, F
125 (40)	D	E	C, F	D, F	F, F	B, F, F, F
150 (50)	E	F	C, F	F,F	D, F, F	F, F, F, F

Note that the arrester of one step higher grade is selected when applying the table of case (B) due to the higher pressure, comparing with the case (A), for the same conditions for the length and diameter of pipe.

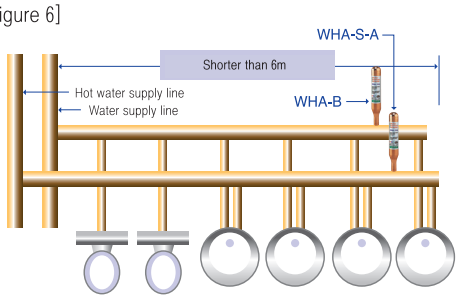
4. Installation

▶ Principle 1. When the length of the branch line is shorter than 6m, the water hammer arrester is installed between the last two points on the branch line where the fixtures are connected. Refer to [Figure 6], Installation point according to Principle 1.



[Figure 6] Installation point according to Principle 1

Example Selecting the model of the water hammer arrester for the water supply · hot water supply plumbing system shown in [Figure 6]



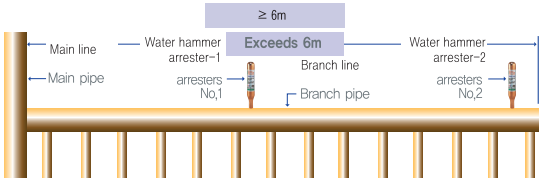
[Figure 7] Example of installation according to Principle 1

Fixture	Water supply	Hot water supply
Toilet stool (F, V) Washbasin Total	10×2=20 1.5×4=6 26	– 1.5×4=6 6
Selection	WHA–B × 1EA (FU : 12~32)	WHA–S–A × 1EA (FU : 4~11)

(Solution) FU and the result of model selection

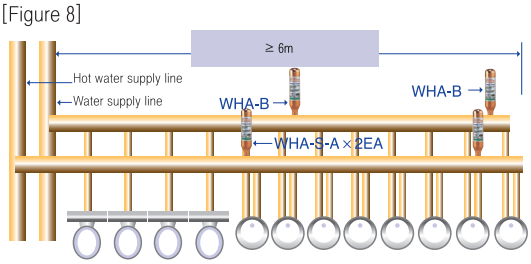
▶ Principle 2. When the length of the branch line is ≥ 6m, the branch line under discussion is divided into two parts and for each part the water hammer arrester is installed in the same manner as in the case of Principle 1, respectively, so eventually two water hammer arresters will be installed. Refer to [Figure 8] Example of installation according to Principle 2

Divide the entire number of FU covering overall section into a half, and install 2 water hammer arresters.



[Figure 8] Example of installation according to Principle 2

Example] Selecting the model of the water hammer arrester for the water supply · hot water supply plumbing system shown in [Figure 8]

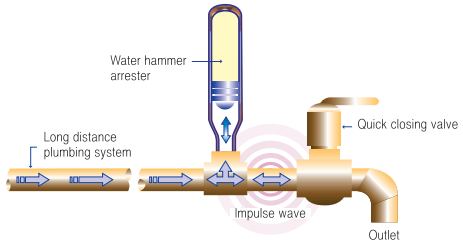


[Figure 9] Example of installation according to Principle 2

Fixture	Water supply	Hot water supply
Toilet stool (F, V) Washbasin Total	10×4=40 1.5×8=12 52	– 1.5×8=12 12
Selection	WHA–B × 2EA (FU : 12~32)	WHA–S–A × 2EA (FU : 1~11)

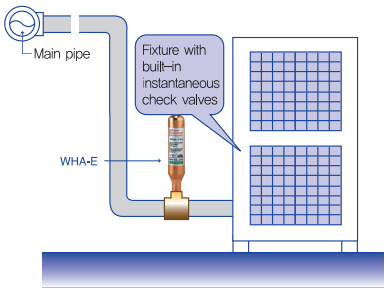
(Solution) FU and the result of model selection

▶ Principle 3. When the distance to the fixture is very long in a plumbing system, the water hammer arrester is installed as close to the point of quick open/close as possible.



[Figure 10] Installation point according to Principle 3

Example] Selecting the model of the water hammer arrester for the plumbing system (control valve, vacuum breaker, and other devices installed in the plumbing systems have been omitted) shown in [Figure 10]



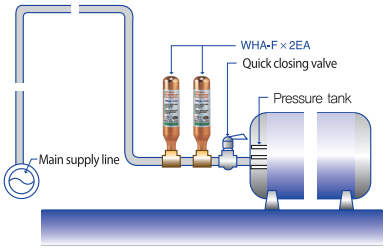
[Figure 11] The equipment with embedded quick closing valve

Items		For water supply
Conditions	Diameter (B) Length of plumbing (m) Water pressure (kgf/㎠) Velocity (m/s)	1" 28 3.74 2.44
Selection Refer to 〈Criteria (A) for selection of the water hammer arrester model〉		WHA–E × 1EA (FU : 114~154)

(Solution) FU and the result of model selection

Example] Selecting the model of the water hammer arrester when there is a single fixture or pressure tank connected to the plumbing system (having quick closing device) shown in [Figure 12]

[Figure 12]



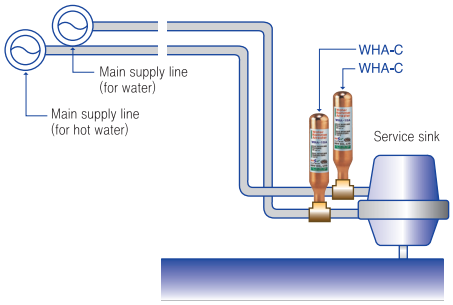
[Figure 12] The pressure tank with quick closing valve

Items		For water supply
Conditions	Diameter (B) Length of plumbing (m) Water pressure (kgf/㎠) Velocity (m/s)	2" 30 4.08 3.05
Selection Refer to 〈Criteria (A) for selection of the water hammer arrester model〉		WHA–E × 2EA (FU : 155~330)

(Solution) FU and the result of model selection

Theory for prevention of shock

Example] Selecting the model of the water hammer arrester for a single fixture (service sink) installed in the water · hot water supply system shown in [Figure 13]

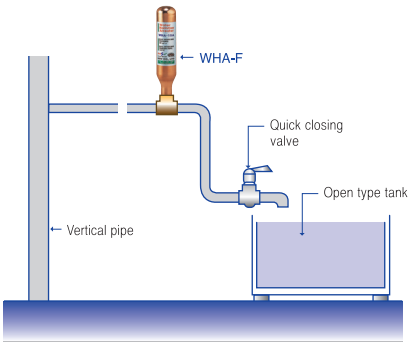


[Figure 13] Single fixture (service sink)

Items		For water supply
Conditions	Diameter (B)	3/4"
	Length of plumbing (m)	20
	Water pressure (kgf/㎠)	3.4
	Velocity (m/s)	1.8
Selection Refer to 〈Criteria (A) for selection of the water hammer arrester model〉		WHA–C × 1EA (FU : 33~60)

(Solution) Result of model selection depending on the length of the pipeline

Example] Selecting the model of the water hammer arrester when there is a single fixture or open type tank connected to the plumbing system (having quick closing device) shown in [Figure 14]

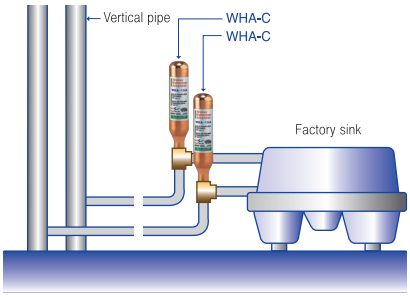


[Figure 14] Single fixture (open type tank)

Items		For water supply
Conditions	Diameter (B)	1 1/4"
	Length of plumbing (m)	30
	Water pressure (kgf/㎠)	3.6
	Velocity (m/s)	2.44
Selection Refer to 〈Criteria (A) for selection of the water hammer arrester model〉		WHA–F × 1EA (FU : 155~330)

(Solution) Result of model selection depending on the length of the pipeline

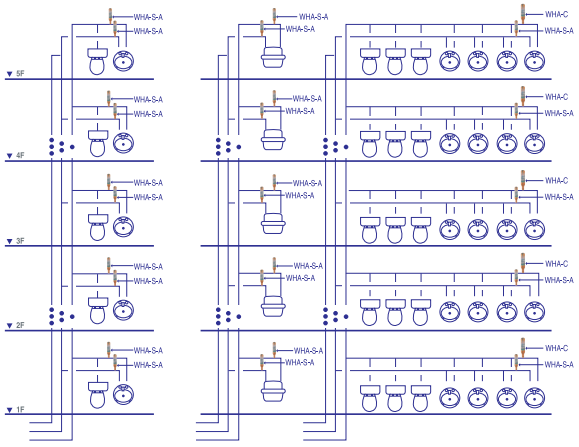
Example] Selecting the model of the water hammer arrester for a single fixture or device installed in the water · hot water supply system shown in [Figure 15]



[Figure 15] Factory sink with quick closing valve connected to a plumbing system

Items		For water supply
Conditions	Diameter (B)	1"
	Length of plumbing (m)	15
	Water pressure (kgf/㎠)	3.1
	Velocity (m/s)	2.44
Selection Refer to 〈Criteria (A) for selection of the water hammer arrester model〉		WHA–C × 1EA (FU : 33~60)

(Solution) FU and the result of model selection

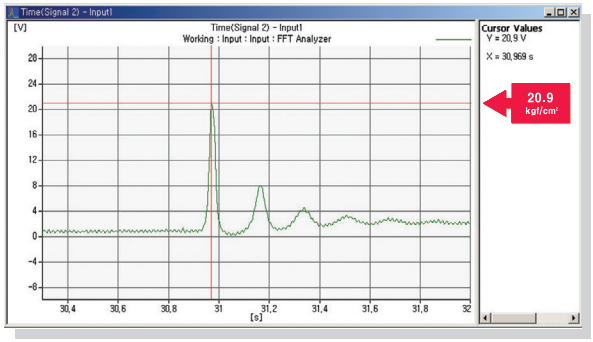


(A) Personal use (B) Common use

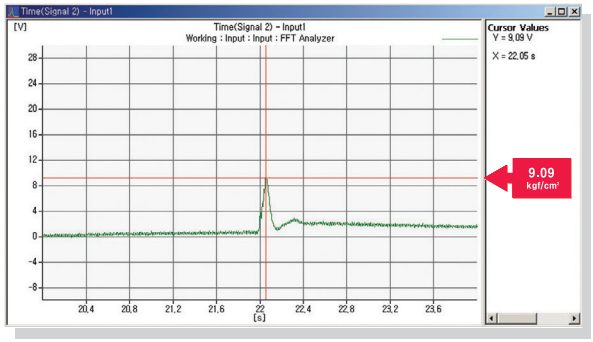
[Figure 16] Diagram of the sanitary plumbing system for which water hammer arresters have been selected

5. Measured data for maximum impact pressure

▶ Test results for the WHA-S-AA water hammer arrester used in copper sanitary plumbing system (operating pressure: 4.0kgf/cm^2)

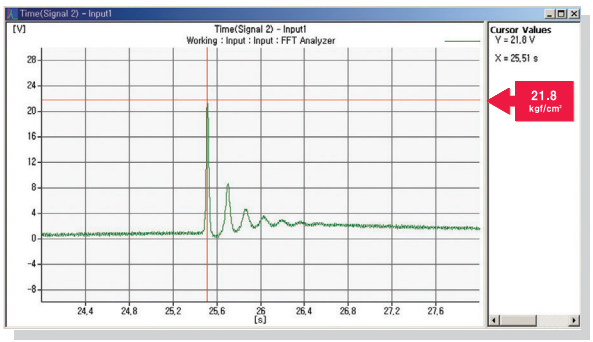


Before the installation of the water hammer arrester [20.9 kgf/cm^2]

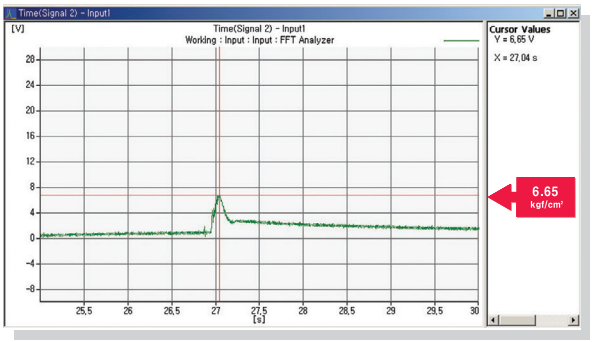


After the installation of the water hammer arrester [9.9 kgf/cm^2]
When repeating 100,000 times

▶ Test results for the WHA-S-A water hammer arrester used in copper sanitary plumbing system

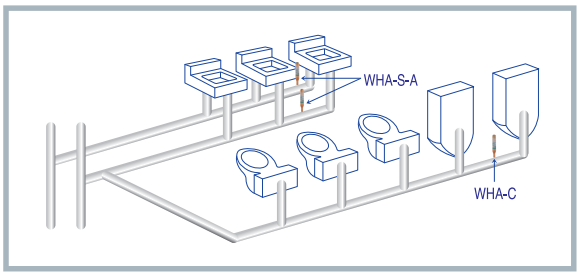


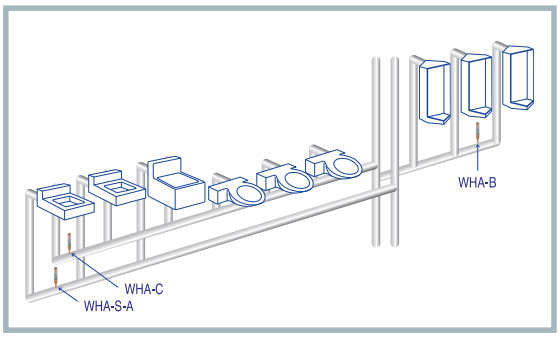
Before installation of the water hammer arrester [21.8 kgf/cm^2]

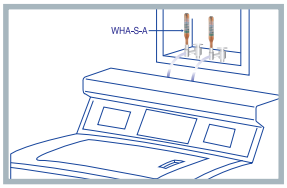


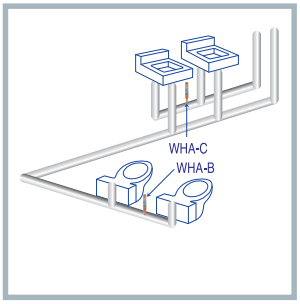
After the installation of the water hammer arrester [6.65 kgf/cm^2]
When repeating 100,000 times

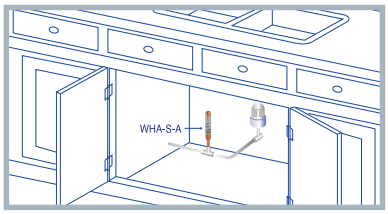
6. Figures illustrating the installation of the water hammer arrester

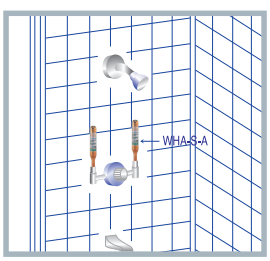


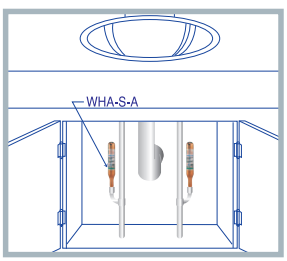






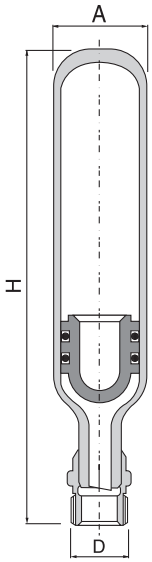






WHA Water Hammer Arrester (CM Adapter)

CM Adapter Type



■ Features

This product is made up of materials that are harmless to humans, including pistons, an O-ring and cooper pipe. Because the air layer is completely separated from the water with the presence of O-ring, it guarantees a semi-permanent life span.

- Working pressure(PV) : 10Kgf/cm^2
- Maximum impulsive pressure(P) : 38Kgf/cm^2
- Maximum working temperature : 120℃

■ Specification

No.	Name of Components	Material	Remark
1	Body	Copper	(KS D 5310,L-type), Molding
2	Pistion	P.P	Pressure-lubricated Dow-Coming 111 silicon compound, FDA approved (Uses the FDA-approved lubricant)
3	O-ring	EPDM	
4	CM Adapter	Brass	KS B 1544
5	Air Chamber	-	4.0kgf/cm^2 Air Charge
6	Soldering	Sn & Ag	Tin 96% & Silver 4%, is Harmless to humans (Uses items that are certified by the national institute)

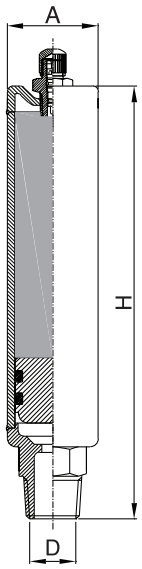
■ Dimension & Selection Guide

PDI certificate for WHA-S-A & S-AA model

Type	Dimension (mm)			Weight (kg)	Air Volume (cc)	Fixture Capacity Unit
	A	ØD	H			
WHA-S-AA(CM)	20A(22.22)	15A	150	0.2	31	~3
WHA-S-A(CM)	25A(28.58)	15A	210	0.2	80	4~11
WHA-S-B(CM)	32A(34.92)	20A	210	0.3	110	12~32
WHA-S-C(CM)	50A(53.98)	25A	226	0.4	180	33~60
WHA-S-D(CM)	50A(53.98)	25A	265	0.7	320	61~113
WHA-S-E(CM)	50A(53.98)	25A	338	0.8	470	114~154
WHA-S-F(CM)	50A(53.98)	25A	400	0.9	590	155~330

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

WHA-3000 STS Sanitary Water Hammer Arrester (CM Adapter)



■ Features

It is made up of special materials like Piston and O-ring with stainless steel tube having excellent corrosion resistance and because air layer is completely separated from water thanks to O-ring, it guarantees semi-permanent life span. It is made in compliance with PDI (Plumbing and Drainage Institute Standard), that is FU (Fixture Unit) definition and each model is proved to have volume appropriateness and reliability through 200,000 cycle tests.

- Working pressure(PV) : 10kgf/cm^2
- Maximum impulsive pressure(P) : 32Kgf/cm^2
- Maximum working temperature :120℃

■ Specification

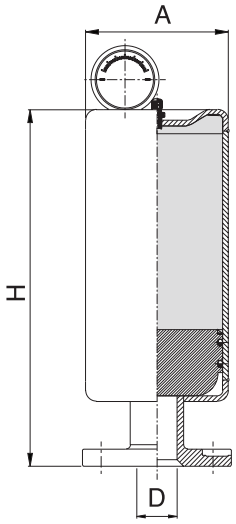
No.	Name of Components	Material	Remark
1	Body	STS	(Type 304SS), Molding
2	Piston	P.P	Pressure-lubricated Dow-Corning 111silicon compound, FDA approved (Used the FDA-approved lubricant)
3	O-ring	EPDM	
4	Adapter	STS	CM Type
5	Air Chamber	-	4.0kgf/cm² Air Charge
6	Air Valve	Brass	CR Plated

■ Dimension & Selection Guide

Type	Dimension(mm)			Air Volume (cc)	Fixture Capacity Unit
	A	ØD	H		
WHA-3015A	34	15A	163	70	1~11
WHA-3020B	38	20A	180	110	12~32
WHA-3025C	38	25A	226	150	33~60
WHA-3025D	60	25A	224	320	61~113
WHA-3025E	60	25A	252	390	114~154
WHA-3025F	60	25A	294	470	155~330

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

WHA-4000 Water Hammer Arrester (Flange Type)



■ Features

It is a semi-permanent water hammer arrestor made up of a stainless steel tube having excellent corrosion resistance with a built-in piston moving up and down to prevent the loss of air. Because it is an all-in-one type, it does not cause the leakage of water. Plus, it has a wide range of applications, including the pipe for drinking water. It is for pressures higher than 10kgf/㎠ with the pressure gauge on top to check the pressure applied. In general, it is installed on top of the special-purposed pump. Its volume appropriateness and reliability have been proved through 200,000 cycle tests.
The above special order-made model is a hybrid water hammer arrestor, which can be installed in the same direction in which fluid moves through a vertical/horizontal pipe.

- Working pressure : 10kgf/20kgf cm^2
- Maximum impulsive pressure : 32Kgf/cm^2
- Maximum working temperature : 90℃

■ Specification

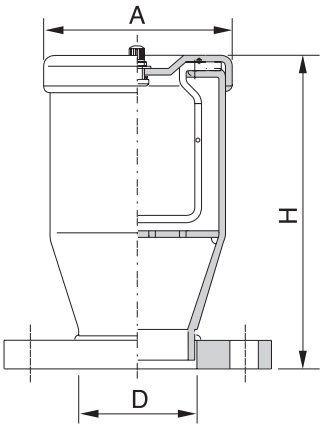
No.	Name of Components	Material	Remark
1	Body	STS	(Type 304SS), Molding
2	Piston	P.P, ABS	Pressure-lubricated Dow-Coming 111 Silicon Compound, FDA approved (Used the FDA-approved lubricant)
3	O-ring	EPDM	
4	Flange	STS	-
5	Air Chamber	-	7.5kgf/cm^2
6	Air Valve	Brass	Cr Plated
7	Pressure Guage	-	20, 30, 40kgf/cm^2
8	Filter Cap	ABS + Wire Netting	

■ Dimension & Selection Guide

Type	Dimension(㎜)			Air Volume(ℓ)	Flange Connection Diameter
	A	ØD	H		
WHA-4040	139.8	49.1	320	1.6	40A
WHA-4050	139.8	61.1	320	1.7	50A
WHA-4065	139.8	77.1	340	2.1	65A
WHA-4080	165.2	90.0	360	3.3	80A
WHA-4100	165.2	115.4	360	3.7	100A
WHA-4125	165.2	115.4	390	4.2	125A
WHA-4150	165.2	115.4	390	4.2	150A
WHA-4200	216.3	158.0	440	9.7	200A
WHA-4250	216.3	158.0	460	10.4	250A

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

WHA-6000 Water Hammer Arrester (Flange Type)



■ Features

It is a semi-permanent water hammer arrestor made up of steel with an EPDM air bag inside to prevent the leakage of air. Plus, it absorbs sudden pressure when the shut-off valve is closed. It is usually installed on top of the pump and/or the end of the fire pipe in parking space. Its volume appropriateness and reliability have been proved through 200,000 cycle tests.

- Working pressure : 10kgf/20kgf cm^2
- Maximum impulsive pressure(P) : 32kgf/cm^2
- Maximum working temperature : 90℃

■ Specification

No.	Name of Components	Material	Remark
1	Flange	SS400	-
2	Middle Plate	SS400	-
3	Body	SPP	-
4	Air Bag	EPDM65	-
5	Cap	SS400	-
6	Air Inlet	BS CR Plated	KS B 1503

■ Dimension & Selection Guide

Type	Dimension(mm)			Air Volume (ℓ)	Flange Connection Diameter
	A	ØD	H		
WHA-6040	124	61.1	202	0.4	40A
WHA-6050	124	61.1	202	0.4	50A
WHA-6065	124	77.1	202	0.4	65A
WHA-6080	150	90.0	232	0.8	80A
WHA-6100	150	115.0	232	0.8	100A
WHA-6125	176	141.0	265	1.4	125A
WHA-6150	176	141.0	265	1.4	150A
WHA-6200	226	166.6	315	3.6	200A
WHA-6250	226	166.6	340	3.6	250A

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

WHA Water Hammer Arrester

■ Installation guides for water hammer arrestor – CM Adapter Type

WHA–1000 series

1. Wipe the inner side of the inlet of the water hammer arrestor to remove foreign material.
2. Prepare the adaptor for the water hammer arrestor and a TEE that meet the corresponding specifications.
3. Fix the TEE and join the adaptor for the water hammer arrestor and the TEE with proper torque.
4. Join the water hammer arrestor to which the TEE is joined and piping.
5. Check for any defects in the joined portions, then operate the device to check for any abnormalities.

WHA–3000 series

1. Be careful not to exceed the maximum torque when joining the adapter to TEE.
2. Be careful not to disassemble the water hammer arrestor arbitrarily or to apply external shock, because compressed air is filled inside the water hammer arrestor.
3. Do NOT arbitrarily open the air inlet valve on top of the water hammer arrestor and vent the air inside.
4. If the water hammer arrestor is installed outdoors, take measures to prevent freezing.
5. For water piping only. Not for piping for high temperature steam, gas, or chemicals.

■ Installation guides for water hammer arrestor – Flange Type

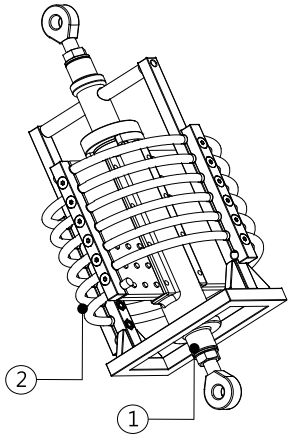
WHA–4000 series

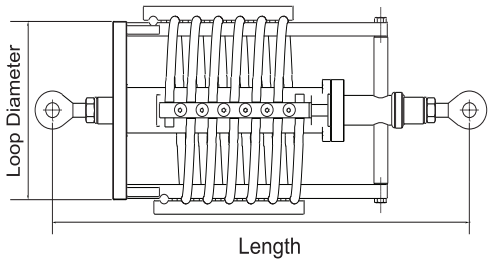
1. Make sure that the surface on which the flange of the water hammer arrestor is assembled is free of foreign materias like rust, oil, dust, paint, etc.
2. Prepare gaskets, bolts, and nuts meeting the standards and specifications of the flange.
3. Check for the balance of the flange, centering, alignment of plumbing, etc.
4. Tighten the flange of the water hammer arrestor and the gasket pipe connection with bolts and nuts, two or three times diagonally in order to balance.
5. Check for any defects in the joined portions, then operate the device to check for any abnormalities.

WHA–6000 series

1. Be careful not to exceed the maximum torque when tightening the flange with bolts.
   (Excessive torque may damage the surface of the flange and affect the seal.)
2. Be careful not to disassemble the water hammer arrestor arbitrarily or to apply external shock, because compressed air is filled inside the water hammer arrestor.
3. Do NOT arbitrarily open the air inlet valve on top of the water hammer arrestor and vent the air inside.
4. If the water hammer arrestor is installed outdoors, take measures to prevent freezing.
5. For water piping only. Not for piping for high temperature steam, gas, or chemicals.

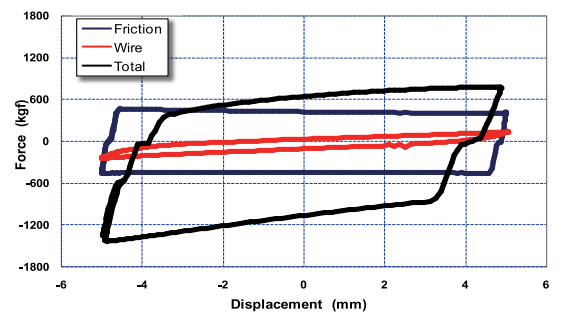
VD10 Friction & Wire Damper





■ Features

VD10, a parallel combination of a friction damper and a wire damper (using elasticity and damping characteristic of wire rope), is an effective damping device with high elasticity and damping characteristic to seek stability and vibration isolation simultaneously. You can save money because there is no risk of oil leakage, no limit to service life, and no maintenance, unlike existing hydraulic or mechanical dampers.



■ Specification

No.	Name of Components	Material
1	Friction Damper	STS304
2	Wire Damper	STS304

■ Specification

VD10 aims to isolate vibration. A fluid flow inside the pipe produced a vibration frequency, which comes close to the natural frequency of the pipe itself and then resonance occurs. Absorbing the energy from the resonance, this product stabilizes dynamic behavior of the piping system and prevents the vibration from being transmitted to the support structure.

■ Dimension & Selection Guide

Model	Rated Load (kgf)	Stroke (mm)	Dimension (mm)			
			Loop Dia.	Length	Wire	Loop
VD10-500	200-500	±25	150	430	Φ8	6
VD10-1000	500-1000	±40	300	770	Φ16	

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.