Drain Separator

2

Step 0 Type/Structure/Features

Please refer to this for structure and features of Drain Separator.

Step 1 Selection

Details are on the product page.

Step 2 Sizing

Please use Drain Separator of same size with pipe.

Step 3 Attention for usage

Please check some guidelines for optimal usage of Drain Separator such as installation.

Reference material Experiment on Drain Separator

What is a Drain Separator ?

In a steam/air piping system, drain (water) causes problems, such as rust and water hammer. It also decreases the dryness and heat quantity content of steam and thermal efficiency in a steam system.
The DS-1 and DS-2 are separators making use of centrifugal force and impact force to effectively separate drain inside piping.

■Problems related to existence of drain in the piping system

Failure to properly handle drain in steam piping and air/gas systems results in various problems.

Declined thermal efficiency

Drain in a steam system reduces the effective heat quantity (latent heat) in addition to the dryness of steam. In some situations, drain exposes an excessive load on a steam trap, making the discharge capacity insufficient. It also forms water film on the heating surface of the system, which prevents thermal conduction and reduces the system's efficiency.
Additionally, the water directly carried over from a boiler (hot water before evaporation) contains a lot of impurities, and part of them form scale that blocks thermal conduction on the heating surface.

Outbreak of water hammer

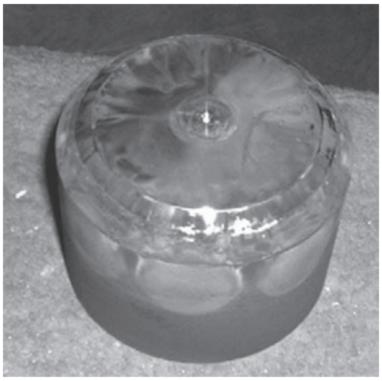
Water is higher than steam in density and slows its velocity inside piping because of its characteristics. However, drain inside steam piping is carried by steam flowing at high velocity and may give a strong vibration or load to a valve or controlling unit when drain strikes against it. This is called water hammer and causes damage to or wear (erosion) in units.

Formation of scale

In general, carbon steel pipes for piping are widely used for steam piping. When drain or another liquid contacts them, rust forms. It is quite likely that pressure reducing valves and other control units will malfunction due to scale, including rust.

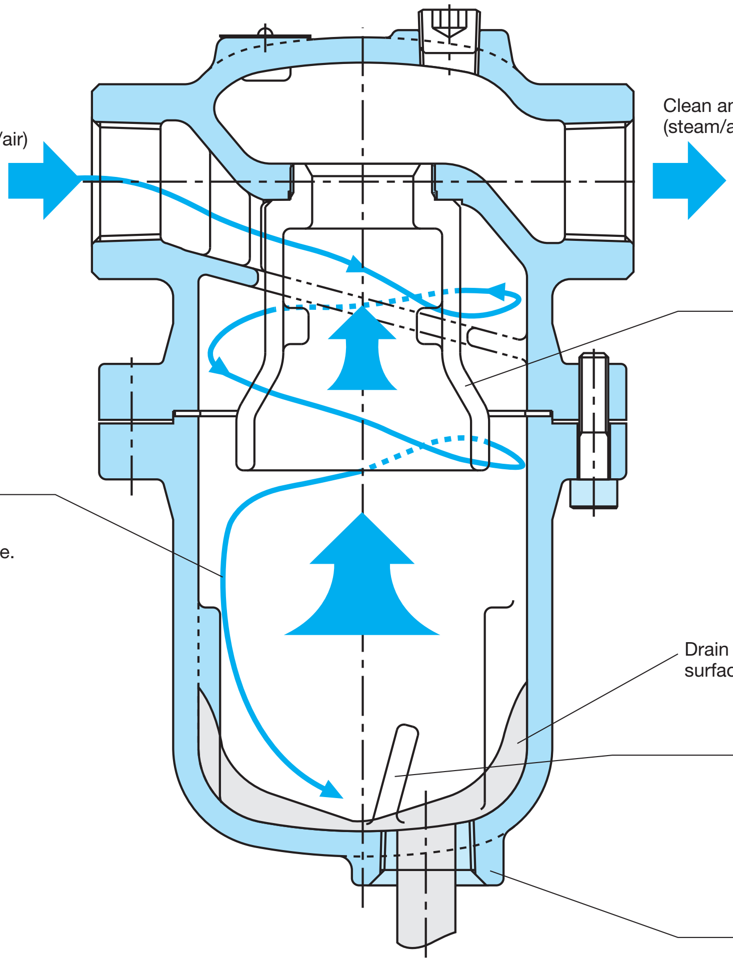
Drain problems in air/gas systems

Piping or valve corrosion attributable to drain causes a strainer or trap to clog, and cleaning by air blowing sometimes increases contamination against expectations.


Erosion on main valve of pressure reducing valve

Structure and Principal of Drain Separator

There is no movable part. The capacity will not change almost permanently, since the design itself has made this perfomance possible.



■Operation

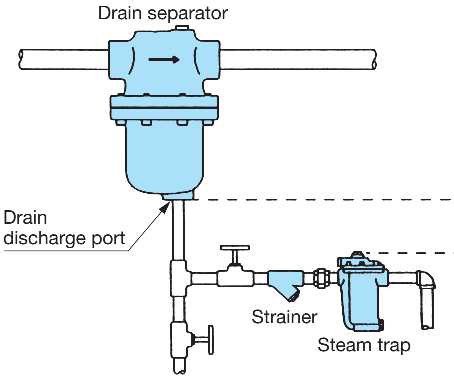
When steam or air flow into the drain separator, centrifugal force is generated by internal structure. Drain circles along the internal surface of the body due to difference of specific gravity.

- Size of separator can be the same as piping size. Since sectional area of inside separator is larger than piping size, pressure loss is considered as zero.
- Since no movable parts are used inside, the drain separator is maintenance-free (except the aging of the gasket).

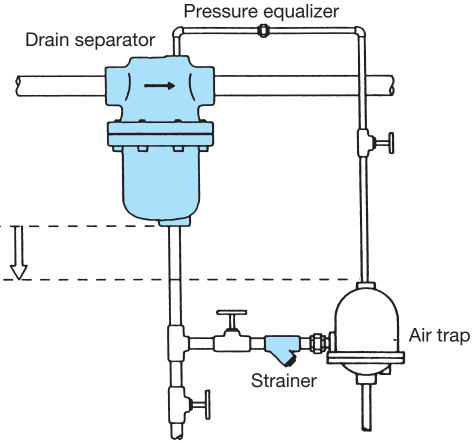
Guidelines for Drain Separator

Step 0

<For steam>

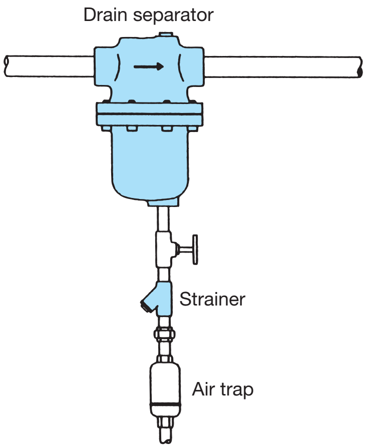


<For air>



- Connect the drain separator horizontally to piping with the drain discharge port down.
- Place a trap under the drain discharge port.
- Set the top of the trap lower than the drain discharge port of the drain separator.

<For air>



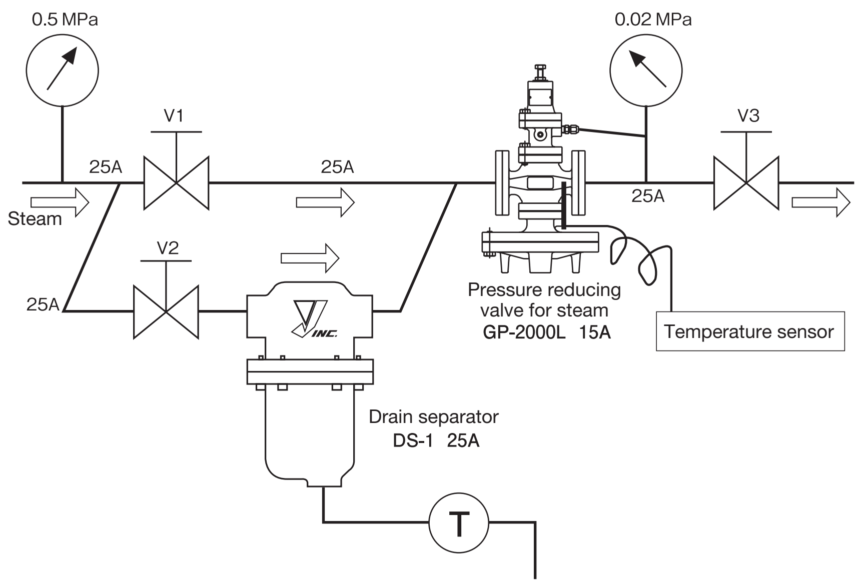
Experiment on Drain Separator

Reference material

Following is result of experiment on drain separator.

■Experiment procedure

1. Supply steam with pressure around 0.5 MPa.
2. Use V1 and V2 to switch the line with and without DS-1 Drain Separator.
3. Reduce steam pressure to 0.02 MPa by GP-2000L pressure reducing valve.
4. Measure the steam temperature at the outlet of pressure reducing valve GP-2000L (not the surface temperature of outlet of pressure reducing valve) by temperature sensor installed on the outlet side of the pressure reducing valve.
5. V3 is for adjustment of steam flow rate and kept at certain opening.
6. Test conditions are as follows:
   A: V1: open, V2: closed, flow does not go through DS-1
   B: V1: closed, V2: open, flow goes through DS-1
7. Test on each condition is continued for 10 minutes, while the temperature is measured every minute. Each test is conducted 2 times continuously switching V1 and V2.



■Experiment result

Table 1 shows the result under conditions: supplied steam pressure P_1 = 0.46 MPa, reduced pressure P_2 = 0.02 MPa and steam flow rate 150 kg/h.

Table 1. Change of temperature of the outlet of pressure reducing valve

No.	Test condition	Temperature of outlet of PRV after 10 mins
1	A (did not go through DS-1)	104.2℃
2	B (went through DS-1)	* 123.7℃
3	A (did not go through DS-1)	105.0℃
4	B (went through DS-1)	* 124.5℃

* Saturated steam temperature at 0.02 MPa is 104.8℃

This result implies that under this condition, steam becomes superheated steam when its pressure is reduced after going through separator (DS-1).

Experiment on Drain Separator

■Consideration

Dryness indicates amount of water (condensate/drain) contained in steam. So dryness of complete steam is described as 100%, and if the entire amount is drain, the dryness is 0%.
In other words, dryness mentions how many percent of latent heat the steam contains.
Thus, here we will consider improvement of dryness by converting heat quantity into temperature.
Under the conditions (supplied steam pressure P_1 = 0.46 MPa is reduced to 0.02 MPa), theoretical temperature of steam by dryness is as on the table below:

Table 2. Theoretical value of steam temperature

0.46 MPa steam				0.02 MPa steam		Surplus heat amount after pressure reduction (KJ)	Theoretical temperature rise (℃)	Theoretical steam temp. (℃)
Dryness (%)	Sensible heat (KJ)	Latent heat (KJ)	Total heat (KJ)	Total required heat (KJ)	Saturation point (°C)			
100	658	2094	2752	2684	104.8	(1) 68	(2) 34	(3) 138.8
99	658	2073	2731			47	23.5	128.3
98	658	2052	2710			26	13	117.8
97	658	2031	2689			5	2.5	107.3

* Specific heat of steam is assumed as 0.5°C/KJ.
* Heat amount is shown in value contained by 1 kg of steam, figures after decimal point omitted.

Assuming dryness is 100%, when steam with supplied pressure P_1 = 0.46 MPa is reduced to 0.02 MPa, the difference of total amount of heat becomes surplus:

2752 (KJ) – 2684 (KJ) = 68 (KJ) … (1) in Table 2

Since the specific heat of steam is around 0.5°C/KJ, we can convert this surplus heat into temperature and calculate theoretical temperature rise:

68 (KJ) x 0.5 (°C/KJ) = 34 (°C) … (2) in Table 2

Therefore, theoretical temperature of steam after pressure reduction is

104.8 (°C) (saturated) + 34 (°C) = 138.8 (°C) … (3) in Table 2

This is temperature of superheated steam.

Considering above, we can compare the test result and theoretical value in Table 2 as follows:

(I) Under condition A (steam does not go through Drain Separator), temperature after pressure reduction is 104-105 °C, so it is saturated steam at 0.02 MPa. This means dryness of steam supplied to pressure reducing valve without going through DS-1 is 97% or lower (we cannot specify actual dryness). * If it is 97%, 104.8 (°C) + {5 (KJ) x 0.5 (°C/KJ) } = 107.3 (°C) > 104-105°C

(II) Under condition B (steam goes through Drain Separator), temperature after pressure reduction is 123-124°C, so it is superheated by +18-19°C compared to saturation temperature at 0.02 MPa. * If it is 98%, 104.8 (°C) + {26 (KJ) x 0.5 (°C/KJ) } = 117.8 (°C) < 123-124°C
This means dryness of steam supplied to pressure reducing valve after going through DS-1 is 98% or higher. (This system is not insulated and subject to effect of heat release, so it is assumed that dryness is actually around 99%.)

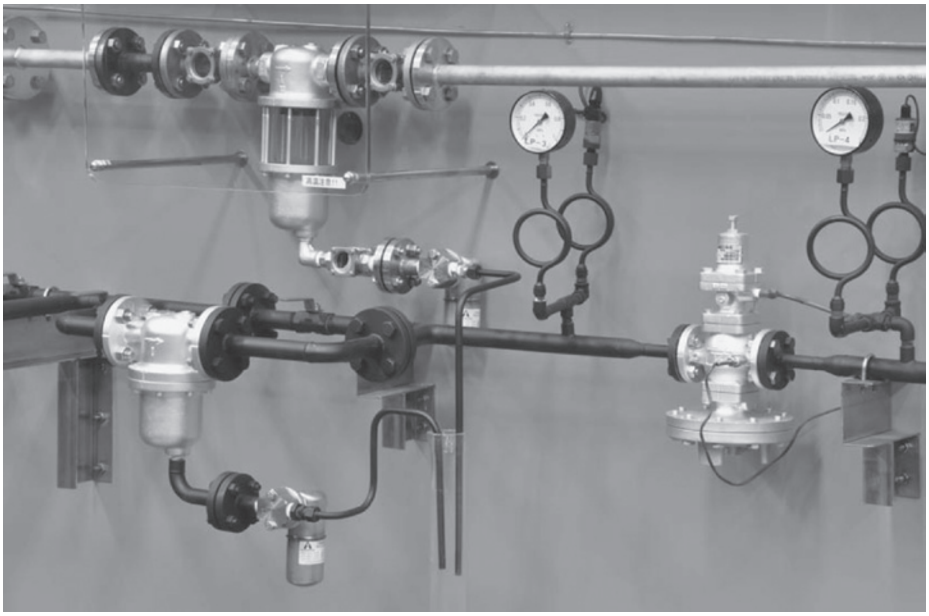
Thus, it can be concluded that steam with dryness 97% is improved in quality into dryness 99% by going through DS-1.

Reference material

■Note

This is a test result only under conditions mentioned above. Especially, please be advised that dryness of steam cannot be maintained for long, and it will drop soon due to heat release affected by factors such as distance from DS-1.

Besides, this experiment is just an example to check effect of DS-1 and it is not to guarantee its performance.



Experiment at TSC

DS-1,2

Drain (condensate) in steam and air piping causes a decline in thermal efficiency, water hammer, corrosion of devices, valves, and pipes, and many other problems.
The DS-1 and DS-2 drain separators are capable of efficiently separating condensate from steam and air with the aid of centrifugal force generated from the configuration of the passage. In normal condition, use a separator of the same size as piping for both steam and compressed air systems.

DS-1

DS-2

■Features

1. High efficient drain separation due to cyclone type.
2. Extremely low pressure loss.
3. Trouble-free by minimizing the number of moving parts.

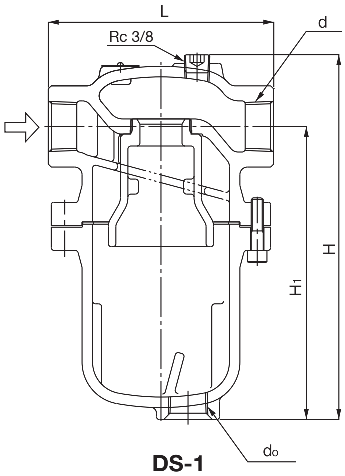
■Specifications

Model		DS-1	DS-2
Application		Steam, Air	
Maximum pressure		2.0 MPa (1.0 MPa for air)	
Maximum temperature		220℃	
Material	Body	Ductile cast iron	
	Nozzle	Cast iron	
	Receiver	Ductile cast iron	
Connection		JIS Rc screwed	JIS 10K/20K FF flanged

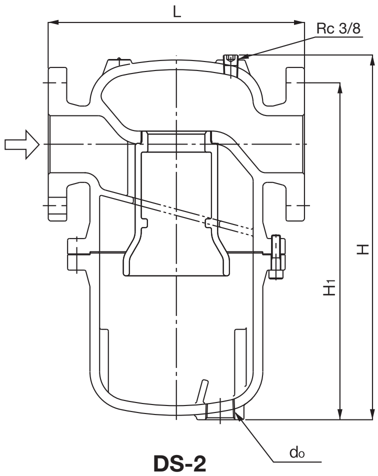
■Dimensions (mm) and Weights (kg)

Model	Nominal size	d	L	H	H_1	d_0	Weight
DS-1	15A	Rc 1/2	150	243	193	Rc 3/4	7.1
	20A	Rc 3/4	150	243	193	Rc 3/4	7.1
	25A	Rc 1	150	243	193	Rc 3/4	7.3
	32A	Rc 1-1/4	190	282	213	Rc 1	12.5
	40A	Rc 1-1/2	190	282	213	Rc 1	12.5
	50A	Rc 2	219	342	260	Rc 1	20.5
DS-2	15A	–	174 (178)	243	193	Rc 3/4	8.5 (8.7)
	20A	–	204 (208)	243	193	Rc 3/4	9.6 (9.8)
	25A	–	204 (208)	243	193	Rc 3/4	10.1 (10.5)
	32A	–	222 (226)	282	213	Rc 1	15.6 (16.0)
	40A	–	242 (246)	282	213	Rc 1	16.3 (16.7)
	50A	–	246 (250)	342	260	Rc 1	24.7 (24.9)
	65A	–	288 (292)	418	314	Rc 1	40.0 (40)
	80A	–	335 (343)	484	361	Rc 1-1/4	54.0 (56.0)
	100A	–	390 (402)	594	445	Rc 1-1/4	96.0 (100.0)

· The above values in parentheses are the dimensions and weights of JIS 20K FF flanged.



DS-1



DS-2

■Selecting a Nominal Size

Keep the instruction described below in mind to enable the drain separator to operate most effectively and meet working conditions to the fullest extent possible.

· Selecting a drain separator nominal size
Select the same nominal size as that of piping (nominal size of piping = nominal size of drain separator). Using a drain separator of a smaller nominal size may increase pressure loss, resulting in failure to keep the specified pressure at the outlet of a unit.

Table 1: Working flow velocity

Application	Flow velocity
Steam	30 m/sec or less
Air	15 m/sec or less

* Keep the fluid below the specified flow velocity.
* A higher flow velocity may cause drain separation to fail.

■Guidelines for Drain Separator

1. Check the following direction of the fluid and the inlet and outlet directions of the drain separator in advance, and properly install it.
2. When connecting it to piping, securely support the product and the piping with a lifting device.
3. When installing the product, secure the space of the dimension H_3 shown in the figure below, which is required for maintenance and inspections.
   * When using model DS-1, 2 for steam application, it is recommended to replace the gasket after 2 years as a guide.

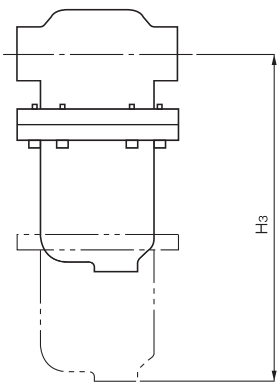


Table 2: Maintenance required dimension

Model	Nominal size	H_3
DS-1 DS-2	15A	210
	20A	210
	25A	210
	32A	240
	40A	240
	50A	290
DS-2	65A	350
	80A	410
	100A	550