How to Size a Liquid Drain Trap for Gas-Liquid Separators

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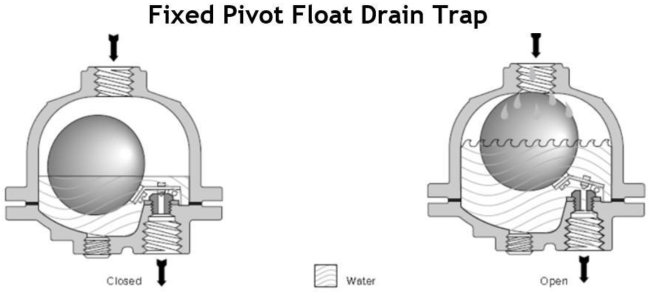
Liquid drain traps are a type of mechanical valve which enables drainage of a pressurized system without loss of process gas. The most common style of drain traps used in conjunction with our gas-liquid separators are called “float drain traps” due to the internal hollow stainless-steel ball within which rises and lowers based upon its buoyancy and the liquid level in the drain trap body. The float can be weighted to accommodate liquids having a specific gravity ≠ 1.0.

Thus, liquid enters the drain trap body causing the float to rise and when it rises sufficiently it lifts a valve plunger off its corresponding valve seat which leads to the drain. The system pressure acts against the liquid, pushing it through the orifice with the drainage rate dictated by the orifice size, differential pressure (system minus the pressure of the drainage location, often atmospheric pressure) and the specific gravity of the liquid.

When liquid level drops sufficiently, the float lowers and the valve plunger seats against the valve seat, sealing the drain port. Since there is always a buffer column of liquid within the drain trap, the process gas is not drained with the liquid.

Fixed Pivot Float Drain Trap



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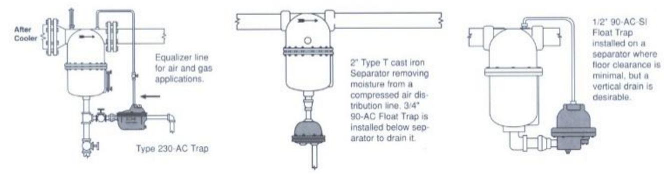
Float drain traps are offered in a variety of sizes and materials to suit a broad range of applications. The required material, drainage capacity, connection type, design pressure and temperature filter the list of available choices to just 1-2 designs for a given application.

The orientation of the drain trap in relation to the separator drain or piping to which it is attached may also favor one design over another. Likewise, if the liquid contains solids, certain plumbing designs are better than others.

The drain trap must be installed to enable venting of the gas to enable it to fill with liquid. If the liquid contains sufficient rust, pipe scale or other particulate, installing a Y style strainer ahead of the drain trap will simplify maintenance by protecting the trap from damage.

Typical Float Drain Trap Installations



How to Size a Float Drain Trap

Properly sizing a drain trap begins with determining the maximum amount of liquid to be drained. This is often not known with specificity and you can simply use the maximum separation capacity of the separator as a “worst case” sizing guideline.

Use a 1.75 multiplier as a safety factor to account for potential surges of liquid to determine the flow rate used for orifice sizing and apply a correction factor for liquids having a specific gravity ≠ 1.0.

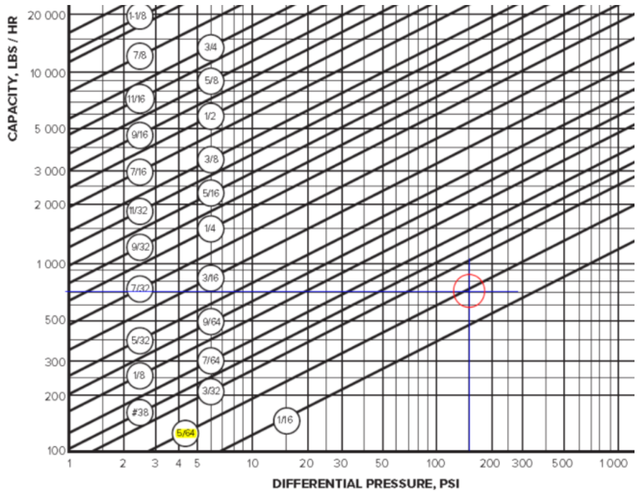
The safety factor is especially important when there is potential for liquid “slugs” or surges entering the separator and trap; if that is not a characteristic for your application then the safety factor can be lowered to around 1.2.

Once you know the total liquid flow rate to be drained in mass flow rate units (lbs/hr) for your application, the next thing you need to determine is the differential pressure available for drainage. Let’s assume the following design criteria: system operating pressure is 164.7 PSIG, the maximum amount of liquid to drain is 380 lbs/hr and it will be drained to a floor drain.

Applying a 1.75 safety multiplier to the drainage rate required establishes a targeted drainage rate of 665 lbs/hr. (1.75 x 380 lbs/hr = 665 lbs/hr).

Next calculate the differential pressure available, ΔPSI = System Pressure minus Pressure you are draining against (164.7 PSIG system pressure – 14.7 PSIG atmospheric pressure = 150 PSI differential pressure).

So, we are looking for an orifice which can drain up to 665 lbs/hr at a 150 PSI differential pressure. Referring to the orifice drainage capacity chart, draw a vertical line on the x-axis from the 150 differential pressure location slightly beyond the capacity you are sizing for, in this example you are sizing for 665 lbs/hr, so round-up to 700 lbs/hr on the chart. Now draw a horizontal line from the 700 lbs/hr mark slightly past the 150 PSI differential line. The minimum orifice size is the orifice flow curve closest to this intersection and the larger size orifices to the left.



Keeping with our example application, you require a minimum orifice size of 5/64" at 150 PSI differential pressure for a maximum drainage capacity of 700 lbs/hr and given the 1.75 safety factor, this means that the amount of liquid to be drained should be approximately ≤ 400 lbs/hr (700 lbs/hr maximum capacity ÷ 1.75 safety factor = 400 lbs/hr).

The chart above is from Armstrong, you can use the following formulas in MS Excel to calculate the capacity of a given size orifice diameter and differential pressure OR to calculate the minimum orifice diameter required given the differential pressure and drainage rate required. (You would round-up the minimum orifice size required to the nearest available orifice diameter applicable to the drain trap model in question).

Drainage capacity per orifice diameter and differential pressure:

```
=6889 * B1^2 * SQRT(A1) * (1.3962 + 0.0001 * A1) * SQRT(C1)
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A1 = Differential pressure (PSI)
B1 = Orifice diameter (inches)
C1 = Specific gravity (SG, dimensionless, e.g., 1 for water)

Minimum orifice diameter per PSI and required drainage capacity:

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=SQRT(B1 / (6889 * SQRT(A1) * (1.3962 + 0.0001 * A1) * SQRT(C1)))
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A1 = Differential pressure (PSI)
B1 = Flow Rate (Lbs/Hr)
C1 = Specific gravity (SG, dimensionless, e.g., 1 for water)

The next step to finalizing the proper orifice size is to review drain trap models which are offered in the material that you require and which are rated to your design pressure and temperature; narrow the list further by the desired connection type and flow path IN/OUT of the drain trap. Within that group of drain traps, see which orifices are available and choose the model offered with an orifice closest to the minimum size required.

It is important that the orifice size chosen is large enough for the drainage capacity required and rated for your design pressure, as each drain trap model has its own maximum design pressure rating for a given orifice size.

For example, the following table compares two different drain traps, the 1-LD and the 11-LD. Although the available orifices for these drain trap models are the same, the 11-LD model is rated for higher pressures.

Table LD-14. Maximum Operating Pressures for Handling Different Specific Gravity Liquids With Orifices Available in Guided Free Floating Lever Drain Traps. (See pages LD-29 and LD-30.)

Model No.	Sp. Grav	1.00		.95		.90		.85		.80		.75		.70		.65		.60		.55		.50	
	Orifice	Maximum Operating Pressure psig (barg)																					
	In	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg
1-LD	1/8	121	8.3	109	7.6	98	6.8	87	6.0	75	5.2	64	4.4	52	3.6	41	2.8	29	2.0	18	1.2	6	0.4
	7/64	143	9.9	130	9.0	116	8.0	103	7.1	89	6.1	75	5.2	62	4.3	48	3.3	35	2.4	21	1.4	7	0.5
	#38	182	12.5	164	11	147	10.2	130	9.0	113	7.8	95	6.6	78	5.4	61	4.2	44	3.0	26	1.8	9	0.6
	5/64	300	20.7	289	19.9	259	17.8	228	15.7	198	13.7	168	11.6	137	9.5	107	7.4	77	5.3	47	3.2	16	1.1
11-LD	1/8	176	12.1	161	11.1	146	10.1	130	9.0	115	7.9	100	6.9	85	5.8	69	4.8	54	3.7	39	2.7	24	1.6
	7/64	209	14	191	13	173	12	155	10.7	137	9.4	119	8.2	100	6.9	82	5.7	64	4.4	46	3.2	28	1.9
	#38	264	18	242	17	219	15	196	14	173	12	150	10.4	127	8.8	104	7.2	81	5.6	59	4.0	36	2.5
	5/64	400	28	400	28	384	27	344	24	304	21	264	18	224	15	183	13	143	9.9	103	7.1	63	4.3

Continuing with our example, we could use either model for our application, the primary difference between the 1-LD and 11-LD is that the 1-LD has a cast iron body whereas the 11-LD has a stainless-steel body.

If the orifice diameter is too small for the flow rate into the drain trap, liquid will build up in the system. In the case of centrifugal gas/liquid separators, once the liquid rises above the separator's vortex containment plate, re-entrainment of liquid is likely, reducing the effectiveness of separation and potentially damaging downstream equipment.

Conversely, if the orifice diameter is oversized, it results in an increased frequency of open/close cycles, accelerating wear of the valve plunger and seat. Over time, this can lead to leakage, inefficient drainage, or eventual failure of the drain trap mechanism.

Selecting the ideal float drain trap drainage capacity for a given application is nuanced as there are several aspects to consider and align with the available drain trap models and thus you can count on us to put our more than 30 years of experience to work for you!