Sizing and Selecting Horizontal Flash Tanks and Vent Lines

High-pressure steam systems require flash tanks — here is a guide to determining sizes

Condensate temperatures in high-pressure steam systems generally are only slightly less than the saturated temperature of the steam. When hot condensates are discharged into lower-pressure areas, condensate temperature immediately drops to the saturated temperature of the low-pressure area. As the result of the drop in temperature, heat released evaporates a portion of the condensate, generating flash steam.

To return condensate to the boiler or to discharge it to the sewer, it is necessary to separate flash steam from the condensate. This is accomplished by discharging condensate through steam traps into a vented tank, referred to as a flash tank. Its an important note here to say that separating the vapor does not reduce the outlet liquid temperature below 210F so care must still be taken when discharging to any electric condensate pump.

Flash steam produced in the flash tank may be vented to the atmosphere,flash steam condenser or piped to a low-pressure main. Condensate remaining may then be returned to the boiler or discharged to drain.

Tanks must be large enough to ensure dryness of the released steam and to avoid carryover by the steam of water in droplet form. When using horizontal flash tanks, the required area is found by multiplying the diameter of the tank by its length. This measures the tank's capacity to handle condensate. Table 1 illustrates the required area for each 1,000 lb. of condensate/hour with varying steam and flash pressures.

How big a tank?

Application: An shell and tube exchanger condenses 12,000 lb. of steam/hr. Assuming the flash tank is vented to the atmosphere, determine the size of the flash tank required with a steam pressure of 10 PSIG.

Solution: Enter table 1 at 10 PSIG steam pressure, moving horizontally to 0 PSIG. Find .75, which is the number of square feet required for each 1,000 lb. of condensate. Since 12,000 lb. of steam are generated, it may be determined that by multiplying 10 x .62, 6.2 sq. ft. of surface will be required, or that the diameter of the tank in feet times its length in feet must equal 6.2. Thus, a tank 1.6' ft 18" Diameter by 4 ft 48". may be used.

Application: A process steam heating coil operating at 100 PSIG condenses 18,000 lb. of steam/hr. The flash tank is to discharge its flash into a 5-PSIG low pressure main header. Determine the size of the flash tank required.

Solution: Again, using table 1, enter at 100 PSIG initial pressure. Move horizontally to the 5-PSIG column and find 1.92.
Then:

18 x 1.92 = 34.6 sq. ft.

A flash tank 4 ft.(48") by 9 ft. will be satisfactory for the application.

Its worthy to note that flash tanks that incorporate an internal sparge line can reduce the overall square footage required due to the inlet flow velocity being reduced into smaller flows by means of orifices placed in the sparge pipe. These must be designed to create an overall velocity of less than 1' per minute, or 1/4" drill orifice for each 1/4 GPM. 5,000 lbs hr = 10 GPM

10 GPM x 4 (1/4" orifices =40 Drilled Orifices

The inlet pipe velocity is then sized to limit flow below 2' per min of in this case 2" pipe size which is .96 ft per min on 2' pipe.

Sizing the internal sparge with this method reduces the sq/ft required by 25%. Using the example above the 34.6 sq.ft required would be reduced to 26.17.

Sizing vent lines

If flash steam is to be discharged to the atmosphere, a properly sized vent line must be provided. To determine the proper size, first find the area of the flash tank, using the method described above.

Application: Determine the size of the vent line using table 4. The first application has 12,000 lbs hr operating at 10 psig discharging to atmosphere. Using the Flash Table 3 10 psig condensate flashing to 0 psig would generate 2.9% Flash or 12,000lbs/hr x 2.9% = 300lbs hr.

Solution: To determine the size of the vent line for 300lbs/hr Enter Table 4 at the 300lbs/hr flow bottom left, move straight to the right as shown to the 0 psig pressure line, then move straight up vertically until that line meets the 1000'per minute horizontal line. The vent line size is read at 5" size min as illustrated. Sizng vent lines in this method has proven to eliminate water droplets from being drawn up the vent by velocity and out of the vent pipes onto roofs, sidewalks, ect.

High velocity in atmospheric vent lines creates a syphon effect and can and will produce condensate geysers so this should not be taken lightly.

It is advisable to also install Thermaflo VH Vent heads at the top of each vent line to impinge this liquid if adverse uncontrolled conditions occur such as blowing unmaintained steam traps.

Figure 1 shows a typical flash-tank piping diagram in which the flash is discharged to the atmosphere.

FLASH TANKS

TABLE 1 FLASH TANK IN SQ. FT. = DIAMETER x LENGTH OF HORIZONTAL TANK FOR 1,000 LB. CONDENSATE PER HOUR BEING DISCHARGED

Steam Pressure PSIG	Flash Tank Pressure PSIG										
	0	2	5	10	15	20	30	40	60	80	100
400	5.41	4.70	3.89	3.01	2.44	2.03	1.49	1.15	.77	.56	.42
350	5.14	4.45	3.66	2.81	2.28	1.91	1.38	1.07	.70	.51	.37
300	4.86	4.15	3.42	2.62	2.11	1.75	1.26	.96	.62	.44	.31
250	4.41	3.82	3.12	2.39	1.91	1.56	1.11	.85	.52	.37	.25
200	3.99	3.40	2.80	2.12	1.68	1.37	.97	.72	.43	.28	.18
175	3.75	3.20	2.61	1.95	1.57	1.25	.87	.64	.38	.23	.15
160	3.60	3.08	2.50	1.86	1.46	1.19	.80	.59	.34	.21	.12
150	3.48	2.98	2.41	1.80	1.40	1.14	.77	.56	.31	.19	.10
140	3.36	2.86	2.31	1.72	1.35	1.05	.72	.52	.29	.16	.08
130	3.24	2.76	2.23	1.65	1.29	1.02	.67	.49	.26	.14	.07
120	3.12	2.65	2.15	1.57	1.22	.97	.61	.44	.23	.12	.04
110	2.99	2.52	2.05	1.50	1.15	.91	.58	.40	.20	.09	.02
100	2.85	2.41	1.92	1.40	1.07	.85	.53	.36	.16	.06	
90	2.68	2.26	1.81	1.30	.99	.77	.48	.31	.13	.05	
80	2.52	2.12	1.67	1.18	.90	.68	.42	.25	.09		
70	2.34	1.95	1.55	1.08	.81	.61	.35	.20	.04		
60	2.14	1.77	1.39	.96	.70	.52	.27	.14			
50	1.94	1.59	1.22	.81	.58	.41	.20	.08			
40	1.68	1.36	1.02	.67	.44	.30	.11				
30	1.40	1.10	.81	.50	.29	.16					
20	1.06	.81	.55	.28	.12						
12	.75	.48	.28								
10	.62	.42	.23								

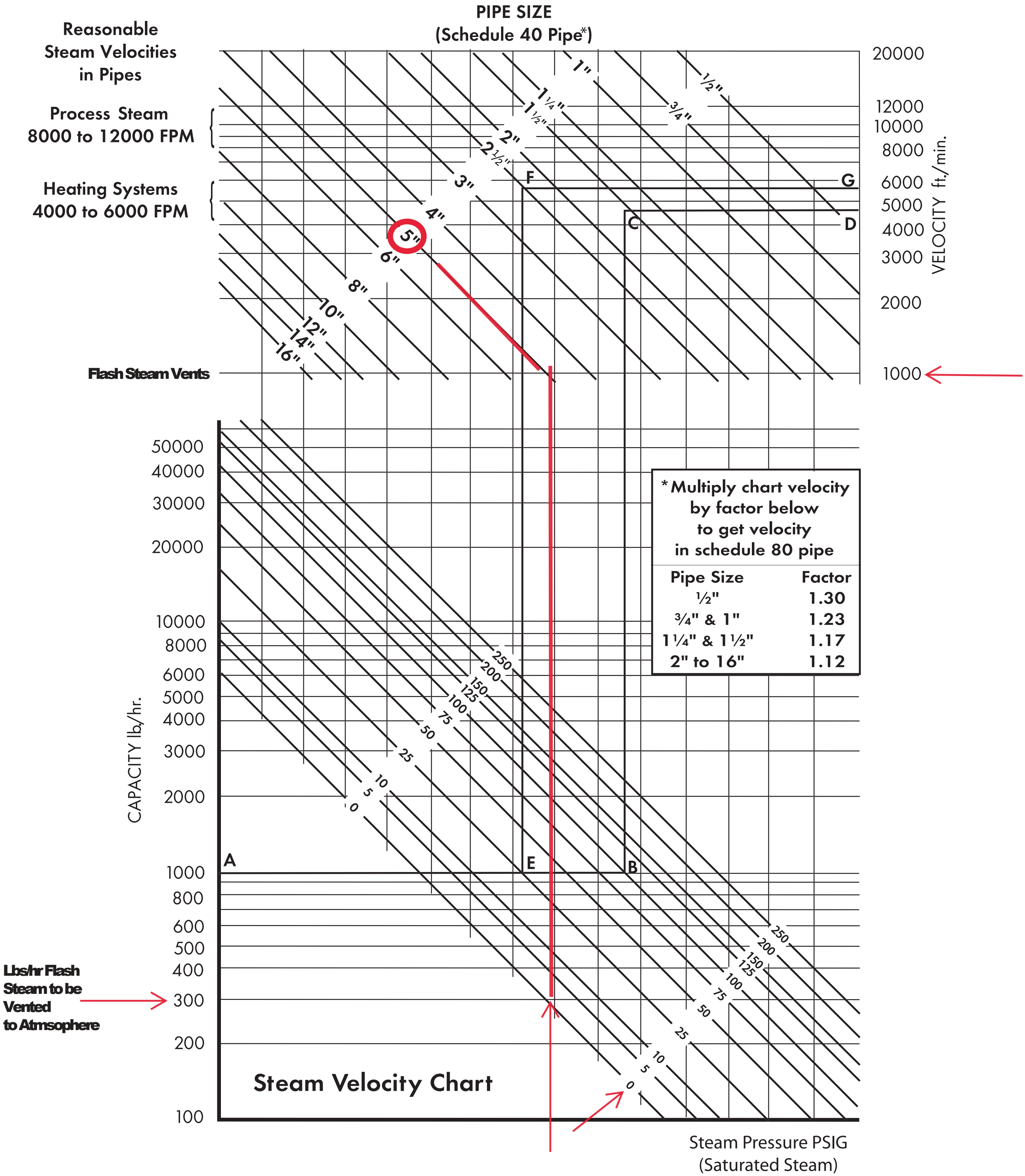
Flash Steam Table

TABLE 3 PERCENT FLASH

Steam Pressure PSIG	Flash Tank Pressure										
	0	2	5	10	15	20	30	40	60	80	100
5	1.7	1.0	0								
10	2.9	2.2	1.4	0							
15	4.0	3.2	2.4	1.1	0						
20	4.9	4.2	3.4	2.1	1.1	0					
30	6.5	5.8	5.0	3.8	2.5	1.7	0				
40	7.8	7.1	6.4	5.1	4.0	3.1	1.3	0			
60	10.0	9.3	8.6	7.3	6.3	5.4	3.6	2.2	0		
80	11.7	11.1	10.3	9.0	8.1	7.1	5.5	4.0	1.9	0	
100	13.3	12.6	11.8	10.6	9.7	8.3	7.0	5.7	3.5	1.7	0
125	14.8	14.2	13.4	12.2	11.3	10.3	8.6	7.4	5.2	3.4	1.5
160	16.8	16.2	15.4	14.1	13.2	12.4	10.6	8.5	7.4	5.5	4.0
200	18.6	18.0	17.3	16.1	15.2	14.3	12.8	11.5	9.3	7.3	5.0
250	20.6	20.0	19.3	18.1	17.2	16.3	14.7	13.6	11.2	9.8	8.2
300	22.7	21.8	21.1	19.9	19.0	18.2	16.7	15.4	13.4	11.8	10.1
350	24.0	23.3	22.6	21.6	20.5	19.8	18.3	17.8	15.1	13.5	11.9
400	25.3	24.7	24.0	22.9	22.0	21.1	19.7	13.5	16.5	15.0	13.4

Percent flash for various initial steam pressures and flash tank pressures.

TABLE 4 STEAM VELOCITY CHART



*Multiply chart velocity by factor below to get velocity in schedule 80 pipe

Pipe Size	Factor
½"	1.30
¾" & 1"	1.23
1¼" & 1½"	1.17
2" to 16"	1.12

FLASH TANKS

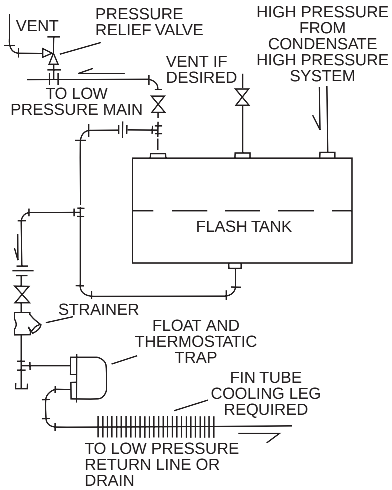


__Figure 1__ A typical flash tank piping diagram discharging to atmosphere.

NOTE: Never Omit trap if condensate is discharged into vented pump receiver.

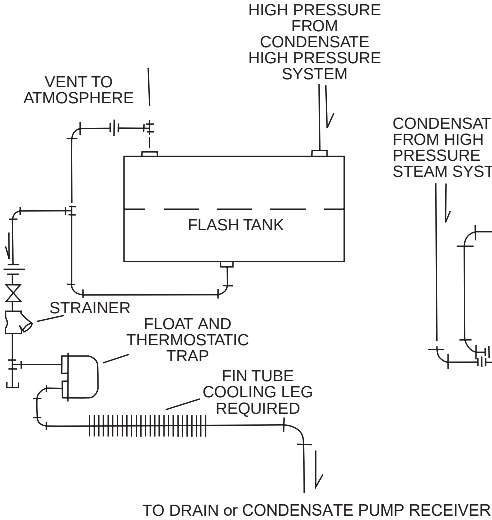


__Figure 2__ A typical flash tank piping diagram with flash discharging to atmosphere and draining to an electric or pressure operated return pump receiver

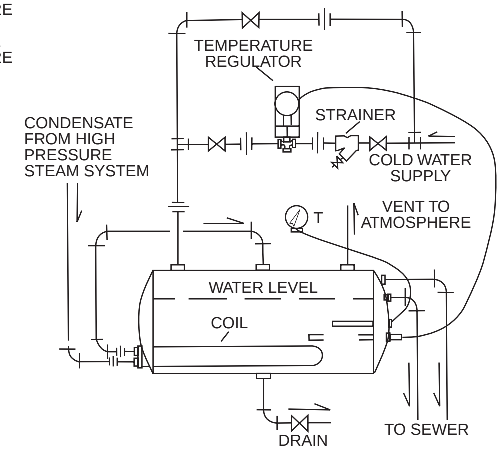


__Figure 3__ This diagram depicts a combination flash tank installation with subcooling condensate.

Since low noise level is important, a velocity in the 4,000 to 6,000 FPM range must be selected. Enter table 4 at 1,220 lb./hr., moving horizontally to a flash-steam pressure of 10 PSIG. Then move up to 4,000 to 6,000 FPM velocity. Here, the chart shows that a 3-in. pipe will handle about 6,000 FPM, or a 4-in. line would handle about 3,500 FPM. Always size atmospheric vent lines at 1000 FPM.

When vent lines cannot be extended to discharge outside the buildings, it is important that the condensate be cooled below the dewpoint to prevent the exhaust from condensing and wetting walls, machinery, floors and so on.

Estimating temperature

Since the dewpoint depends on several factors, including relative humidity and temperature (which are variable), the temperature to which the condensate must be cooled should be estimated for individual cases.

The following is the recommended procedure:

Calculate the size of the flash tank in the method described above:

Estimate the dewpoint, assuming unfavorable conditions, and, when making the estimate, take ventilation into account – it is a factor in determining relative humidity:

Once the dewpoint is known, estimate the quantity of cooling water that will be required and finally:

Determine the pipe size and size of temperature regulator valve required. A self-contained regulator with a normally closed valve to open when the temperature rises is recommended. All such controls have an ample range over and under the calibration point so that setting may be adjusted after installation.

Application: Calculate the quantity of cooling water required to cool condensate in a flash tank vented to an enclosed space, assuming the following data:

Steam pressure is 100 PSIG;

Condensate is entering the flash tank at 1,550 lb./hr. at 335°F;

Ambient temperature of the space into which vent discharges is 75°F; and

Cold water temperature is 50°F.

Assuming that ventilation at the above temperature will be sufficient to have not more than 70 percent relative humidity, the dewpoint will be 64.5°F (determined from psychrometric chart).

To allow 1°F for safety, condensate should be cooled from 338°F to 63.5°F. When the installation is completed, further adjustment can be made by resetting the regulator. The heat to be extracted from the condensate is equal to:

1,500 lb./hr. x (338–63.5)°F = 410,000 BTUH

The quantity of cooling water required:

$$\frac{410{,}000 \text{ BTUH}}{(63.5 - 50)°\text{F}} = 30{,}500 \text{ lb./hr.}$$

or 3,670 GPH = 61 GPM

A 1.5-in. pipe to supply the water and a 1.25-in. temperature regulator are recommended for this application.

Flash tanks separate flash steam from the condensate by venting the flash steam to the atmosphere or piping it to a low-pressure main, while returning the remaining condensate to the boiler or discharging it to the drain. If flash steam is discharged to the atmosphere, a flash tank and a properly sized vent line must be determined; if discharged to low-pressure mains it is necessary to calculate the correctly sized line connecting the flash tank to the low-pressure main. Also, the proper temperature for cooling the condensate must be determined for projects in which vent lines cannot be extended to discharge outside the buildings.

Different situations require individual solutions to determine the correctly sized flash tank, connecting pipe and cooling temperature needed, but the calculation examples offered here provide the means to determine the necessary installations and accessories required.