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What You Should Know About Flash Tanks

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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.

Flash steam produced in the flash tank may be vented to the atmosphere 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?

Problem: An absorption machine 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 12 PSIG.

Solution: Enter table 1 at 12 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 12 x .75, 9 sq. ft. of surface will be required, or that the diameter of the tank in feet times its length in feet must equal 9. Thus, a tank 2 ft. by 4.5 ft. may be used.

Problem: A dryer operating at 100 PSIG condenses 18,000 lb. of steam/hr. The flash tank is to discharge its flash into a 5-PSIG heating main. 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. by 9 ft. will be satisfactory for the application.

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.

Problem: Determine the size of the vent line using table 2. If, as in the first problem, tank size is 2 ft. by 4.5 ft. (9 sq. ft.), refer again to table 2, where 9 sq. ft. falls on 7.4-to-12 line. For this range, a 2-in. vent line would be satisfactory.

Problem: Determine the size of the vent line if the flash tank size is 4 ft. by 9 ft. or 36 sq. ft. In table 2, 36 is in the 27-to-36 line, and, in this case, a $3^1/_2$ in. vent would be needed.

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

If it is desired to utilize the flash steam by discharging it into a low-pressure main, refer to figure 2. In this instance, it will be necessary to properly size the line connecting the flash tank to the low-pressure main.

Using table 3, determine the percent of flash. Multiply this percentage by the condensate load in lb./hr. to determine the number of pounds of steam that are flashed. Determine what steam velocity will be acceptable in the line. If a low noise level is desired, a relatively low velocity must be selected – 4,000 to 6,000 FPM.

Where noise is not a factor, a velocity of 12,000 FPM or higher may be used. After velocity has been determined, the required pipe size can be found in table 4.

Problem: 10,000 lb./hr. of condensate is discharged into a flash tank from a 125-PSI steam system. Flash steam is to be piped into a 10-PSIG low-pressure heating main. Determine the size pipe required for connecting the flash tank to the steam main.

Enter table 3 at 125-PSI initial pressure. Move horizontally to the 10-PSIG column and find 12.2 percent flash. Then the amount of flash steam/hr. is found this way:

10,000 x 12.2 percent = 1,220 lb./hr.

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								

TABLE 2 VENT LINE SIZE FOR HORIZONTAL FLASH TANKS

Area in Sq. Ft. *	Vent Pipe Size
Less than 3.2	1″
3.2 to 5.5	1¼″
5.5 to 7.4	1½″
7.4 to 12.0	2″
12.0 to 17.5	2½″
17.5 to 27	3″
27 to 36	3½″
36 to 47	4″
47 to 73	5″
73 to 105	6″
106 to 140	7″
140 to 185	8″
185 to 300	10″
300 to 420	12″

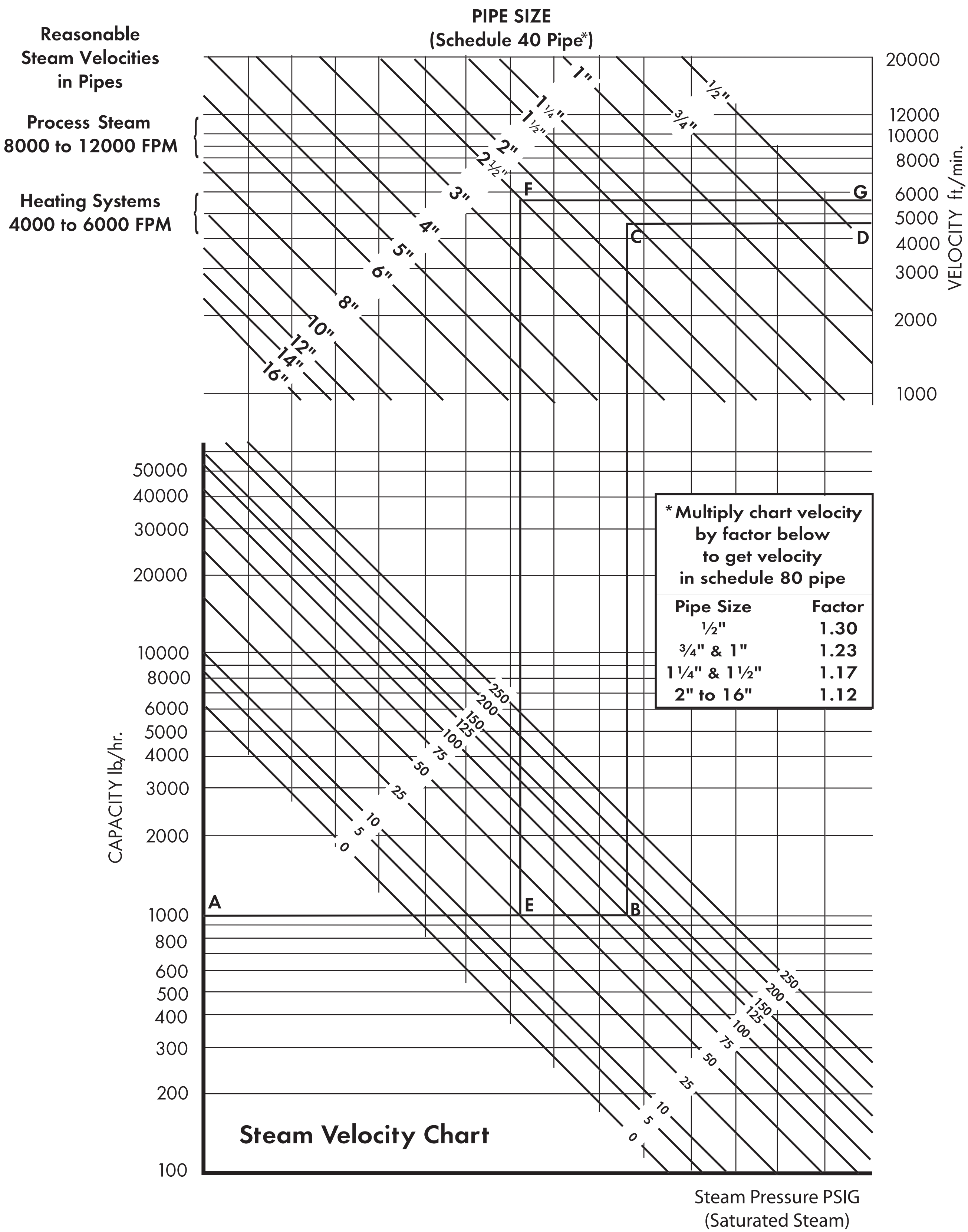
* Area in sq ft equals diameter of tank in feet multiplied by length of tank in feet.

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

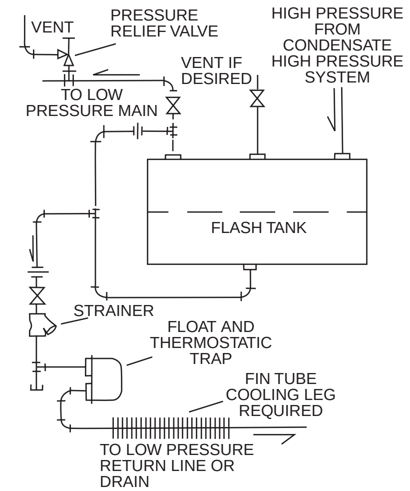


Figure 1 *A typical flash tank piping diagram discharging to atmosphere.*

NOTE: Omit trap if condensate is discharged into vented pump receiver.

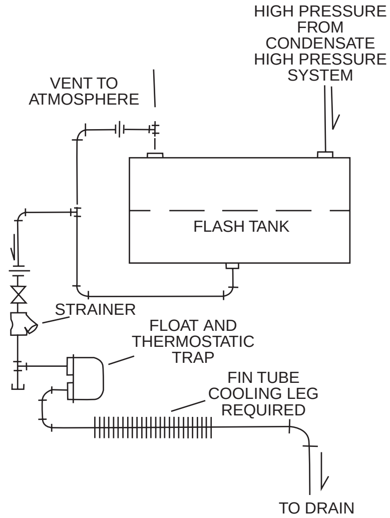


Figure 2 *A typical flash tank piping diagram with flash discharging to low-pressure steam system.*

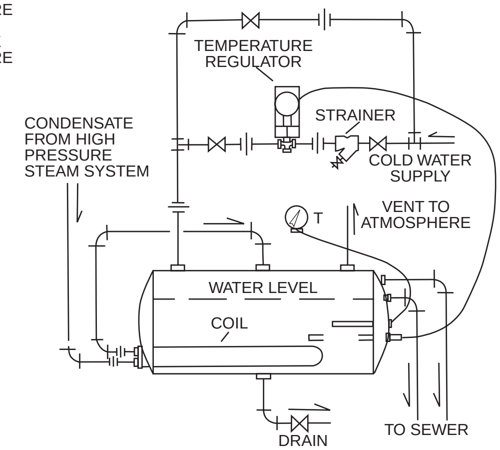


Figure 3 *This diagram depicts a combination flash tank installation with subcooling condensate.*

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.

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.

Problem: 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.

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