How to Size Condensate Return Lines

The sizing of condensate return lines presents several problems that differ from those of sizing steam or water lines. The most significant of these is the handling of flash steam. Although a return line must handle both water and flash steam, the volume of flash steam is many times greater than the volume of condensate. For the values in Chart CG-26 the volume of flash steam is 96% to 99% of the total volume. Consequently, only flash steam is considered in Chart CG-26.

Condensate return lines should be sized to have a reasonable velocity at an acceptable pressure drop. Chart CG-26 is based on having a constant velocity of 7,000 feet per minute or below, using Schedule 40 pipe. Additional factors that should also be considered—depending on water conditions—are dirt, fouling, corrosion and erosion.

For a given supply pressure to the trap and a return line pressure, along with an assumed pressure drop per 100 feet of pipe (ΔP/L) and knowing the condensate flow rate, the proper pipe diameter can be selected from Chart CG-26.

How to Use Chart CG-26

Example 1: A condensate system has the steam supply at 30 psig. The return line is non-vented and at 0 psig. The return line is to have the capacity for returning 2,000 lbs/hr of condensate. What must be the size of the return line?

Solution: Since the system will be throttling the condensate from 30 psig to 0 psig, there will be flash steam (assuming no subcooling), and the system will be a dry-closed (not completely full of liquid and not vented to atmosphere) return. The data in Chart CG-26 can be used. A pressure of 1/4 psig per 100 feet is selected. In Chart CG-26 for a 30 psig supply and a 0 psig return for ΔP/L = 1/4, a pipe size for the return line of 2" is selected.

Example 2: A condensate return system has the steam supply at 100 psig and the return line is non-vented and at 0 psig. The return line is horizontal and must have a capacity of 2,500 lbs/hr. What size pipe is required?

Solution: Since the system will be throttling non-subcooled condensate from 100 psig to 0 psig, there will be flash steam, and the system will be a dry-closed return. Selecting a pressure drop of 1 psi per 100 feet yields from Chart CG-26 a non-recommended situation (a). Select a pressure drop of 1/4 psi per 100 feet and then a 2-1/2" pipe can be used for this system.

Chart CG-26. Flow Rate (lbs/hr) for Dry-Closed Returns

ΔP/L psi/100' / D, in	Supply Pressure = 5 psig, Return Pressure = 0 psig			Supply Pressure = 15 psig, Return Pressure = 0 psig			Supply Pressure = 30 psig, Return Pressure = 0 psig			Supply Presssure = 50 psig, Return Pressure = 0 psig		
	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1
1/2	240	520	1,100	95	210	450	60	130	274	42	92	200
3/4	510	1,120	2,400	210	450	950	130	280	590	91	200	420
1	**1,000**	**2,150**	**4,540**	**400**	**860**	**1,820**	**250**	**530**	**1,120**	**180**	**380**	**800**
1-1/4	2,100	4,500	9,500	840	1,800	3,800	520	1,110	2,340	370	800	1,680
1-1/2	3,170	6,780	14,200	1,270	2,720	5,700	780	1,670	3,510	560	1,200	2,520
2	**6,240**	**13,300**	**a**	**2,500**	**5,320**	**a**	**1,540**	**3,270**	**a**	**1,110**	**2,350**	**a**
2-1/2	10,000	21,300	a	4,030	8,520	a	2,480	5,250	a	1,780	3,780	a
3	18,000	38,000	a	7,200	15,200	a	4,440	9,360	a	3,190	6,730	a
4	**37,200**	**78,000**	**a**	**14,900**	**31,300**	**a**	**9,180**	**19,200**	**a**	**6,660**	**13,800**	**a**
6	110,500	a	a	44,300	a	a	27,300	a	a	19,600	a	a
8	228,600	a	a	91,700	a	a	56,400	a	a	40,500	a	a

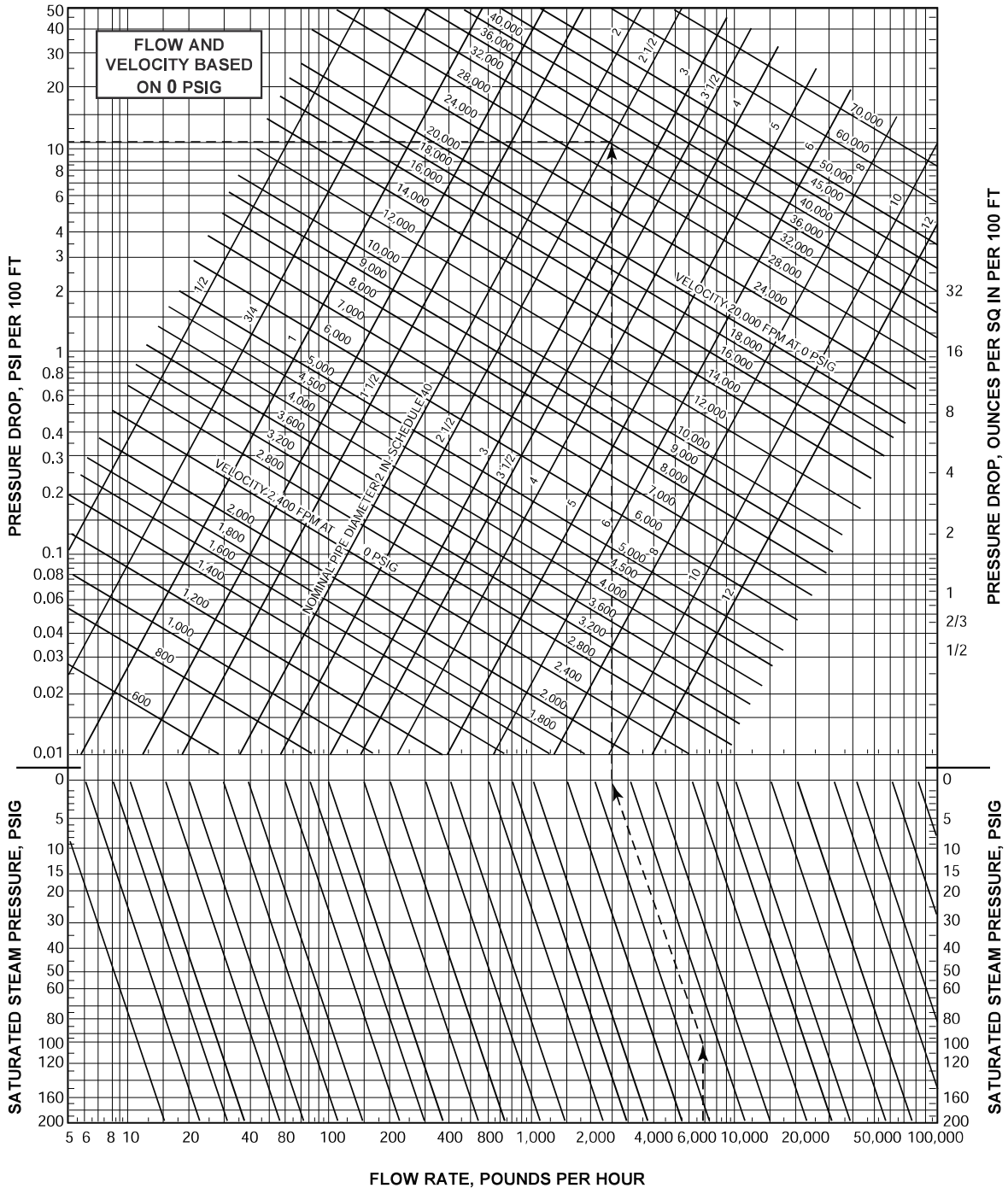
Chart CG-26. Flow Rate (lbs/hr) for Dry-Closed Returns

ΔP/L psi/100' / D, in	Supply Pressure = 100 psig, Return Pressure = 0 psig			Supply Pressure = 150 psig, Return Pressure = 0 psig			Supply Pressure = 100 psig, Return Pressure = 15 psig			Supply Presssure = 150 psig, Return Pressure = 15 psig		
	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1
1/2	28	62	133	23	51	109	56	120	260	43	93	200
3/4	62	134	290	50	110	230	120	260	560	93	200	420
1	**120**	**260**	**544**	**100**	**210**	**450**	**240**	**500**	**1,060**	**180**	**390**	**800**
1-1/4	250	540	1,130	200	440	930	500	1,060	2,200	380	800	1,680
1-1/2	380	810	1,700	310	660	1,400	750	1,600	3,320	570	1,210	2,500
2	**750**	**1,590**	**a**	**610**	**1,300**	**a**	**1,470**	**3,100**	**6,450**	**1,120**	**2,350**	**4,900**
2-1/2	1,200	2,550	a	980	2,100	a	2,370	5,000	10,300	1,800	3,780	7,800
3	2,160	4,550	a	1,760	3,710	a	4,230	8,860	a	3,200	6,710	a
4	**4,460**	**9,340**	**a**	**3,640**	**7,630**	**a**	**8,730**	**18,200**	**a**	**6,620**	**13,800**	**a**
6	13,200	a	a	10,800	a	a	25,900	53,600	a	19,600	40,600	a
8	27,400	a	a	22,400	a	a	53,400	110,300	a	40,500	83,600	a

[a] For these sizes and pressure losses the velocity is above 7,000 fpm. Select another combination of size and pressure loss.

Pipe Sizing Steam Supply and Condensate Return Lines

Chart CG-25. Flow Rate and Velocity of Steam in Schedule 40 Pipe at Saturation Pressure of 0 psig



Pipe Sizing Steam Supply and Condensate Return Lines

Sizing Charts

Chart CG-25, page CG-51, is the basic chart for determining the flow rate and velocity of steam in Schedule 40 pipe for various values of pressure drop per 100 ft, based on 0 psig saturated steam. Using the multiplier chart (Chart CG-24), Chart CG-25 can be used at all saturation pressures between 0 and 200 psig (see Example).

These Charts are based on the Moody Friction Factor, which considers the Reynolds number and the roughness of the internal pipe surfaces.

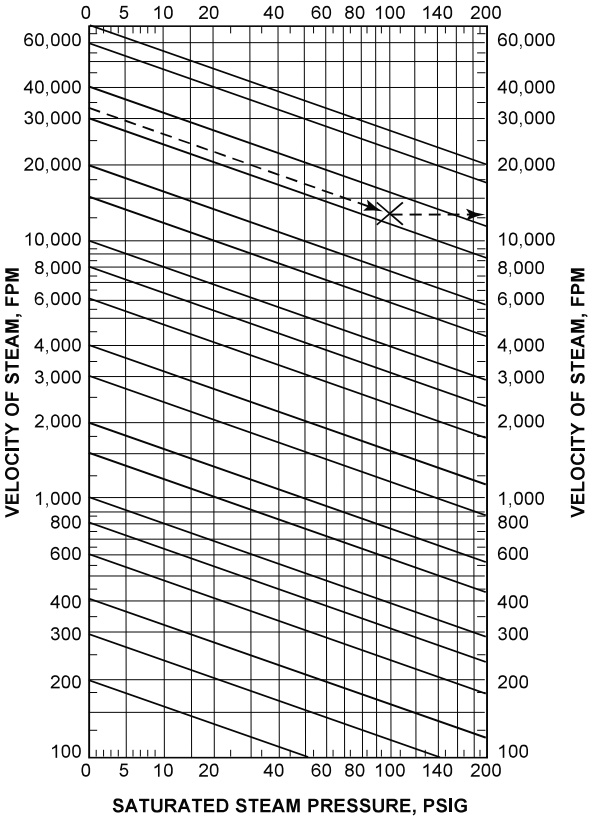
Notes: Based on Moody Friction Factor where flow of condensate does not inhibit the flow of steam. See Chart CG-24 for obtaining flow rates and velocities of all saturation pressures between 0 to 200 psig: see Example.

Pipe Sizing

Two principal factors determine pipe sizing in a steam system:

1. The initial pressure at the boiler and the allowable pressure drop of the total system. The total pressure drop in the system should not exceed 20% of the total maximum pressure at the boiler. This includes all drops—line loss, elbows, valves, etc. Remember, pressure drops are a loss of energy.
2. Steam velocity. Erosion and noise increase with velocity. Reasonable velocities for process steam are 6,000 to 12,000 fpm, but lower pressure heating systems normally have lower velocities. Another consideration is future expansion. Size your lines for the foreseeable future. If ever in doubt, you will have less trouble with oversized lines than with ones that are marginal.

Chart CG-24. Velocity Multiplier Chart for CG-25.



Use of Basic and Velocity Multiplier Charts

Example.
Given a flow rate of 6,700 lb/hr, an initial steam pressure of 100 psig, and a pressure drop of 11 psi/100 ft, find the size of Schedule 40 pipe required and the velocity of steam in the pipe.

Solution: The following steps are illustrated by the broken line on Chart CG-25 and Chart CG-24.

1. Enter Chart CG-25 at a flow rate of 6,700 lb/hr, and move vertically to the horizontal line at 100 psig.
2. Follow inclined multiplier line (upward and to the left) to horizontal 0 psig line. The equivalent mass flow at 0 psig is about 2,500 lb/hr.
3. Follow the 2,500 lb/hr line vertically until it intersects the horizontal line at 11 psi per 100 ft pressure drop. Nominal pipe size is 2-1/2 in. The equivalent steam velocity at 0 psig is about 32,700 fpm.
4. To find the steam velocity at 100 psig, locate the value of 32,700 fpm on the ordinate of the velocity multiplier chart (Chart CG-24) at 0 psig.
5. Move along the inclined multiplier line (downward and to the right) until it intersects the vertical 100 psig pressure line. The velocity as read from the right (or left) scale is about 13,000 fpm.

NOTE: Steps 1 through 5 would be rearranged or reversed if different data were given.

Condensate Pipe Sizing

The following is a very simple guide for condensate pipe sizing and is based on steel pipe. If Copper pipe is used you should go up a size.

There are many helpful charts on the internet for extremely accurate pipe sizing but the chart below will suffice for 99.99% of applications.

Pipe Size mm	15	20	25	32	40	50	65	80	100
Flow kg/hr	160	370	690	1500	2290	4390	8900	13,800	28,200