

Removal Of Gaseous Chlorine From Cylinders And Ton Containers



General

Elemental chlorine is supplied commercially as a liquefied gas under pressure in pressurized containers (cylinder - 150 pounds, tons, railcars, barges, tank trucks). The flow of chlorine as a liquid or a gas from these containers depends upon the internal container pressure, and the pressure at the point of feed. The pressure in the container is also dependent upon the temperature of the liquid chlorine. A container may be artificially pressurized. Artificial pressurization, known as "padding", is common for chlorine supplied from railcars and barges.

Liquid chlorine is vaporized by absorbing heat. The heat of vaporization may be artificially applied, as in a vaporizer or provided from the container and its environment.

Vaporization Process

Any available heat is utilized to convert liquid chlorine to gas. As the liquid vaporizes, liquid chlorine cools and draws heat from the remaining liquid in the container. When the liquid cools sufficiently to lower container surface temperature to the dew point of the surrounding air, moisture in the air will condense on the container surface. When the liquid cools further to about 32°F (0°C), the condensed moisture on the outer walls will freeze. A buildup of frost and ice will then appear. Ice is a good insulator and reduces the further transmission of external heat into the vaporizing liquid. This reduces the rate of vaporization.

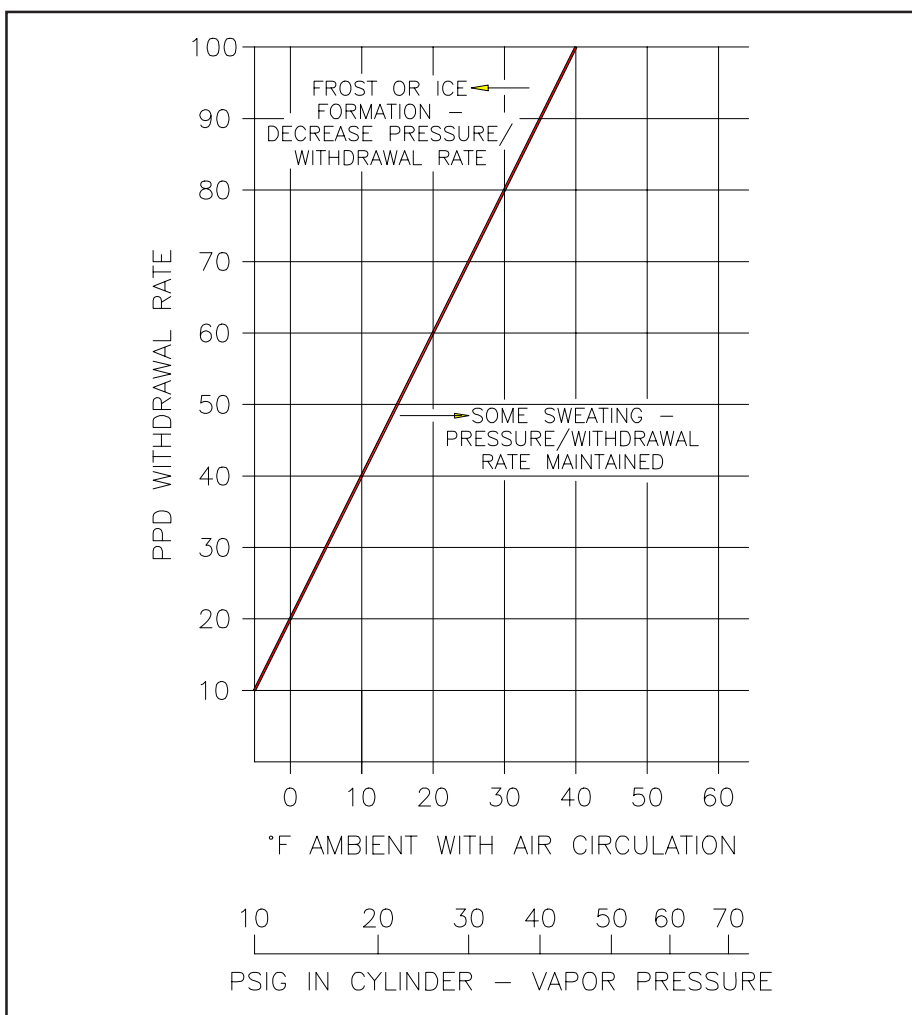


Figure 1 - Withdrawal Rate of Chlorine With Air Circulation

The Chlorine Institute states that the maximum dependable, continuous discharge rate of chlorine gas from a single 150 pound cylinder is approximately 1.5 lb/day/°F (1.1 kg/day/°C). This discharge rate assumes an ambient temperature of at least 60°F (15°C) and natural air circulation. It further assumes that the pressure against which the cylinder is discharging is about 35 psig (241 kPag). The maximum dependable discharge rate for a ton container under similar conditions is about 7.5 lb/day/°F (5.4 kg/day/°C).

Some comments:

1. If sweating can be tolerated, the withdrawal rate can be increased up to double the rate. The moisture that condenses on the cylinder does not restrict the transfer and vaporization rate.
2. Discharge rates may be increased by forced circulation of the air around the container.
3. Chlorine gas fed from containers is for industrial uses and would normally discharge into a gas manifold. Thus, a discharge against 35 psig (2.4 bar) is normal. In water and wastewater treatment applications, gas feeders are used with the gas feeder (chlorinator) mounted on a cylinder valve. With this condition, the gas discharges into a negative pressure in the chlorinator at about one to two pounds below atmospheric pressure.

Frequently Asked Questions

Consider the following when using direct cylinder mounted gas chlorinators.

1. "To withdraw 100 pounds per day from a single 150 pound cylinder, the cylinder will have to be changed every day or day and a half."

True - but the use of the vacuum type, automatic switchover provides two cylinder mounted chlorinators; one in service and one on standby. The automatic switchover system can also be used with a pair of independent multiple cylinder sources thus greatly increasing the quantity of chlorine available.

2. "If gas is withdrawn from a cylinder at too high a rate, the cylinder (or chlorine) will freeze."

False - liquid chlorine freezes at about -150° F (-102° C). The chlorinator system will not lower the temperature to this value.

The misconception of "freezing chlorine" is derived from the observation of frost on the container. At 32° F (0° C), the pressure inside the cylinder is about 38 psig (2.6 bar). (Figure 1)

3. "Valves and other parts will freeze."

False - frost may form on the outside caused by expanding gas at points of pressure reduction through valves and other restrictions.

The curves shown in Figures 2 and 3 are flow data of gaseous chlorine from a 150 pound cylinder. The data was obtained by starting with full 150 pound cylinders at a room temperature of 70° F (21° C). Each cylinder was emptied at maximum possible withdrawal rates, with no back pressure.

4. "High feed rates are not attainable."

Very high withdrawal rates are obtainable during the first two hours of operation (see Figure 2). About 35 pounds of chlorine can be withdrawn during the first half hour, and a total of 55 pounds during the first hour. This is important for installations where a large quantity of chlorine is needed for a short period of time such as:

- Shock treatment of cooling water.
- Disinfecting water mains.
- Disinfecting process equipment during washdown periods.
- Shock treatment of swimming pools.

The feed rate diminishes rapidly after the first hour.

5. "Air circulation is the only factor in increasing feed rates."

Air circulation is one of the single most important factors in achieving dependable and continuous withdrawal of gaseous chlorine from cylinders and ton containers. Other factors governing withdrawal rates include air temperature, container wall thickness, humidity, volume of liquid chlorine remaining, and the surface area of the liquid chlorine in the container.

Considering the increased liquid volume and surface area, the flow of gaseous chlorine from a ton container can be several times greater than the rates shown in Figures 2 and 3. Flows of 500 PPD (10 kg/h) at room temperatures of 70°F (21°C), are readily attainable (Table II).

6. "I can increase feed rates with external air circulation."

True. If the ability to withdraw gaseous chlorine at very high rates is important, providing air circulation is a must. Circulated air should be directed against the liquid filled portion of the container. For example, circulating air under a ton container produces better results than circulating air over the top of the ton container. Figures 2 and 3 show the effect of circulating air at 70°F (21°C) or room temperature.

7. "I can increase feed rates by increasing the room temperature?"

True. The warmer the area in which cylinders/ton containers are used, the greater the feed rate can be achieved. The lower the temperature, the lower the potential feed rate. A room or use area at 65° to 70° F (18° to 21° C) is ideal.

Never apply heat directly to a chlorine cylinder or ton container.

System Operating Temperature (150 pound cylinder)

The system operating temperature is largely dependent upon the withdrawal rate of chlorine from the cylinder and is a function of the existing ambient temperature.

Table I, based upon chlorine feed from a 150 pound cylinder, should serve as a guide in determining whether the chlorinator can be installed outdoors or indoors.

Table I - Flow of Gaseous Chlorine From a 150 Pound Cylinder

Maximum Chlorinator Withdrawal Capacity		Minimum Ambient Temperature	
PPD	g/h	°F	°C
100	2000	40	4
50	1000	15	09
25	500	0	-18
10	200	-5	-21
4	75	-20	-29

System Operating Temperature (2000 pound Ton Container)

The system operating temperature is largely dependent upon the withdrawal rate of chlorine from the ton container and is a function of the existing ambient temperature.

Table II, based upon chlorine gas feed from a 2,000 pound, horizontal ton container, should serve as a guide in determining whether the chlorinator can be installed outdoors or indoors.

Table II - Flow of Gaseous Chlorine From a Ton Container

Maximum Chlorinator Withdrawal Capacity		Minimum Ambient Temperature	
PPD	kg/h	°F	°C
500	10	40	4
200	5	15	-9
150	2.5	0	-18
100	2	-5	-21
50	1	-20	-29

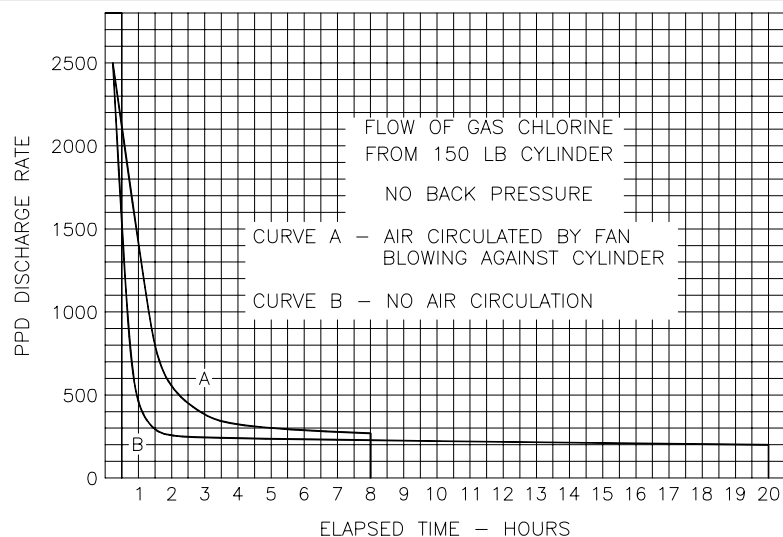


Figure 2 - Flow Data of Gaseous Chlorine (PPD) From a 150 Pound Cylinder

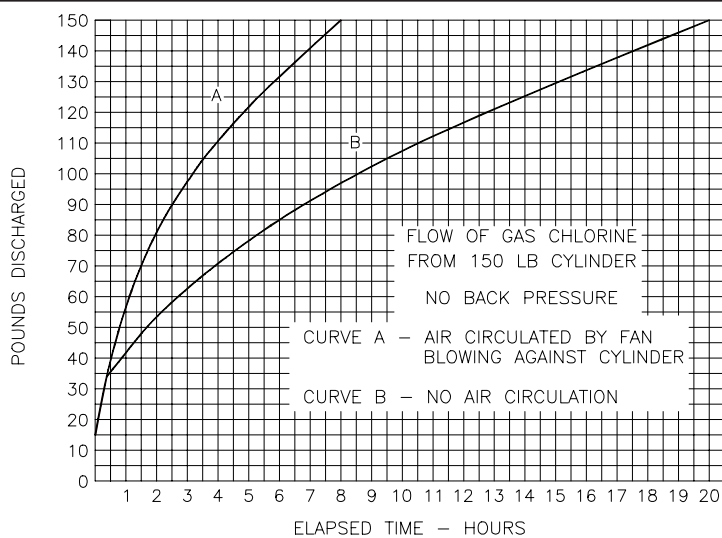


Figure 3 - Flow Data of Gaseous Chlorine (pounds) From a 150 Pound Cylinder

Design improvements may be made without notice.

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