# Liquefied Compressed Gases

## What Is a Liquefied Compressed Gas?

A liquefied compressed gas can be defined as a gas that becomes a liquid at ambient temperature when compressed in a container. Liquefied compressed gases can also be defined as those gases which become liquids to a very large extent in containers at ordinary temperatures and pressures ranging from 25 psig to 2,500 psig.

Liquefied gases are packaged under their own vapor pressure and are shipped under rules limiting the maximum amount that can be put into a container to allow for liquid expansion with rising temperatures. The Department of Transportation states in 49 CFR 173.304 that the liquid portion of a liquefied gas must not completely fill the packaging at any temperature up to and including 130°F.

### Table of Common Liquefied Gases

| Gas | Vapor Pressure @ 70°F (psig) | Fill Density (%) |
|---|---|---|
| Ammonia | 114 | 54 |
| Carbon Dioxide | 830 | 68 |
| Chlorine | 86 | 125 |
| Hydrogen Chloride | 613 | 65 |
| Hydrogen Sulfide | 247 | 62.5 |
| Methyl Chloride | 59 | 84 |
| Monomethylamine | 44 | 60 |
| Nitrous Oxide | 745 | 68 |
| Sulfur Dioxide | 34 | 125 |
| Sulfur Hexafluoride | 298 | 120 |

## Product Withdrawal

### Vapor-Phase Withdrawal

Liquefied compressed gases in containers exist at a temperature/pressure equilibrium between the gas and liquid phases. Thus, the first step in removing vapor is orienting the package to access the vapor phase of the product. When vapor is removed from the cylinder the equilibrium is disturbed and the product will react to reestablish the equilibrium. The liquid will vaporize enough product to replace the gas that was removed. But to vaporize, the liquid must give up its heat of vaporization. This heat can usually be recovered from the ambient air surrounding the cylinder. If the withdrawal rate of the gas is such that the energy required to vaporize the liquid cannot be recovered from the surrounding air, the liquid phase will begin to cool. This is called subcooling. It is common for vapor withdrawal to cool the cylinder to the point of condensing moisture on the cylinder. However, if the withdrawal of vapor is extreme, serious safety problems can arise. The vapor pressure can collapse to the point where back flow or suck back into the cylinder can occur. It is also possible to cool a cylinder below its temperature rating and actually embrittle the metal. If the metal becomes embrittled the cylinder could fail.

What can be done to improve the withdrawal rate of the gas phase? There are several options. The user can withdraw liquid phase to a vaporizer. This is the preferable method for high flow requirements. Another option is the changeover system where two cylinders are manifolded together and one is used while the other is warming. Two or more cylinders could also be manifolded together to achieve the required gas flow by withdrawing product from all cylinders simultaneously. Another commonly used method places the cylinders in a heated area, **without applying any direct heat to the cylinder**. The area temperature must never exceed 125°F. Sometimes none of the above methods are acceptable to end users and they want to heat the cylinder. This can be a very dangerous operation. Improper heating of the cylinder may cause failure of the relief device or the cylinder itself. **Under no circumstances must any part of the package be exposed to temperatures above 125°F**. If you need alternatives to the above solutions, please contact our Technical Information Center for assistance. They can be reached at **1-877-ASG-4-GAS**.

Another method commonly used to increase flow rates involves the placement of cylinders in heated water baths. This can be very dangerous. There are documented incidents of water baths corroding the exterior of cylinders to the point of failure. **Water baths should be avoided.**

Compressed Gas Association Pamphlet P-1 states in Section 3.3.3 “Compressed gas containers **SHALL NOT** be exposed to temperature extremes. High temperatures may result in excessive cylinder pressure. **NEVER** apply a flame or heat directly to any part of a gas container or allow it to come in contact with an electrically energized system. If ice or snow accumulate on a container, thaw at room temperature, or with water at a temperature not exceeding 125°F (51.7°C).” This pamphlet is cited by OSHA, thereby making it the law.

Also, National Fire Protection Association Standard NFPA 55 states in Section 6-10, “Compressed gas cylinders shall not be exposed to temperatures exceeding 125°F (51.7°C). Cylinders shall not be subjected to direct heating to increase vapor pressure.”