The liquification of gases engineering essay

Liquification of gases includes a number of phases used to convert a gas into a liquid state. The processes are used for scientific, industrial and commercial purposes. Many gases can be put into a liquid state at normal atmospheric pressure by simple cooling; a few, such as carbon dioxide, require pressurization as well. Liquification is used for analyzing the fundamental properties of gas molecules (intermolecular forces), for storage of gases, for example: LPG, and in refrigeration and air conditioning. There the gas is liquefied in the condenser, where the heat of vaporization is released, and evaporated in the evaporator, where the heat of vaporization is absorbed. Ammonia was the first such refrigerant, but it has been replaced by compounds derived from petroleum and halogens.

Liquification of Gases – History

Pioneer work on the liquification of gases was carried out by the English scientist Michael Faraday (1791-1867) in the early 1820s. Faraday was able to liquify gases with high critical temperatures such as chlorine, hydrogen sulphide, hydrogen bromide, and carbon dioxide by the application of pressure alone. It was not until a half century later, however, that researchers found ways to liquify gases.

What the liquid nitrogen is :

The liquification of air is a process in which composition is mainly a mixture of two diatomic gases, 78% N2 and 21% O2. Liquid nitrogen is nitrogen in a liquid state at a very low temperature. It is produced industrially by fractional distillation of liquid air. Liquid nitrogen is a colourless clear liquid. At atmospheric pressure, liquid nitrogen boils at 77 K.

The liquification point of a mixture of gases with different boiling points will typically be between the boiling points of the pure gases. The boiling point of pure oxygen, O2, is 90. 6 K and the boiling point of nitrogen, N2, is 77 K. If air is cooled at atmospheric pressure, it remains a gas until the temperature reaches 81. 6 K, 9 K below the liquification temperature of pure oxygen. It will be completely liquified at about 79 K, 2K above the liquification point of pure nitrogen. Plunging an air-filled balloon into liquid nitrogen will lead to the liquification of almost all the air in the balloon. Thus the liquid can be clearly seen inside the balloon. Liquid nitrogen can be stored and transported.

{For example in vacuum flasks, there the very low temperature is held constant at 77 K by slow boiling of the liquid, resulting in the evolution of nitrogen gas. Depending on the size and design, the holding time of vacuum flasks ranges from a few hours to a few weeks.}

Liquification of Gases – Practical Applications

The most important advantage of liquifying gases is that they can then be stored and transported in much more compact form than in the gaseous state. Two kinds of liquefied gases are widely used commercially for this reason, liquefied natural gas (LNG) and liquefied petroleum gas (LPG). LPG is a mixture of gases obtained from natural gas or petroleum that has been converted to the liquid state. The mixture is stored in strong containers that can withstand very high pressures. LPG is used as a fuel in motor homes, boats, and homes that do not have access to other forms of fuel. Liquefied natural gas is similar to LPG, except that it has had almost everything except methane removed. LNG and LPG have many similar uses.

In principle, any gas can be liquefied, so their compactness and ease of transportation has made them popular for a number of other applications. For example, liquid oxygen and liquid hydrogen are used in rocket engines. Liquid oxygen and liquid acetylene can be used in welding operations. And a combination of liquid oxygen and liquid nitrogen can be used in aqualung devices.

Liquification of gases is also important in the field of research known as cryogenics. Liquid helium is widely used for the study of behavior of matter at temperatures close to absolute zero-0K (-459°F [-273°C]).

Nitrogen gas is an industrial gas produced by the fractional distillation of liquid air, or by mechanical means using gaseous air.

To preserve the freshness of packaged or bulk foods.

In ordinary incandescent light bulbs as an inexpensive alternative to argon.

On top of liquid explosives as a safety measure.

The production of electronic parts such as transistors, diodes, and integrated circuits.

Dried and pressurized, as a dielectric gas for high voltage equipment.

The manufacturing of stainless steel.

Use in military aircraft fuel systems to reduce fire hazard.

Filling automotive and aircraft tires due to its inertness and lack of moisture or oxidative qualities.

Liquification of Gases – Making A Gas Work Against Internal Forces

In some ways, the simplest method for liquifying a gas is simply to take advantage of the forces that operate between its own molecules. This can be done by forcing the gas to pass through a small nozzle or a porous plug. The change that takes place in the gas during this process depends on its original temperature. If that temperature is less than some fixed value, known as the inversion temperature, then the gas will always be cooled as it passes through the nozzle or plug.

In some cases, the cooling that occurs during this process may not be sufficient to cause liquification of the gas. However, the process can be repeated more than once. Each time, more energy is removed from the gas, its temperature falls further, and, eventually, it changes to a liquid. This kind of cascade effect can, in fact, be used with either of the last two methods of gas liquification.

Liquification of Gases – Methods of Liquification

In general, gases can be liquefied by one of three general methods:

(1) By compressing the gas at temperatures less than its critical temperature

(2) By making the gas do some kind of work against an external force, causing the gas to lose energy and change to the liquid state.

(3) By making gas do work against its own internal forces, also causing it to lose energy and liquify.

In the first approach, the application of pressure alone is sufficient to cause a gas to change to a liquid. For example, ammonia has a critical temperature of 406K (271. 4°F [133°C]). This temperature is well above room temperature, so it is relatively simple to convert ammonia gas to the liquid state simply by applying sufficient pressure. At its critical temperature, that pressure is 112. 5 atmospheres; although the cooler the gas is to begin with, the less pressure is needed to make it condense.

The picture is taken from (http://ameslib. arc. nasa. gov/randt/1999/aero/img/rtl/14RTL. GIF)

Liquification of Gases – Critical Temperature And Pressure

Two important properties of gases are important in developing methods for their liquification: critical temperature and critical pressure. The critical temperature of a gas is the temperature at or above which no amount of pressure, however great, will cause the gas to liquify. The minimum pressure required to liquify the gas at the critical temperature is called the critical pressure.

For example, the critical temperature for carbon dioxide is 304K (87. 8°F [31°C]). That means that no amount of pressure applied to
a sample of carbon dioxide gas at or above 304K (87. 8°F [31°C]) will cause the gas to liquify. At or below that temperature, however, the gas can be liquefied provided sufficient pressure is applied. The corresponding critical pressure for carbon dioxide at 304K (87. 8°F [31°C]) is 72. 9 atmospheres. In other words, the application of a pressure of 72. 9 atmospheres of pressure

on a sample of carbon dioxide gas at 304K (87. 8°F [31°C]) will cause the gas to liquify.

Differences in critical temperatures among gases means that some gases are easier to liquify than are others. The critical temperature of carbon dioxide is high enough so that it can be liquefied relatively easily at or near room temperature. By comparison, the critical temperature of nitrogen gas is 126K (-232. 6°F [-147°C]) and that of helium is 5. 3K (-449. 9°F [-267. 7°C]). Liquifying gases such as nitrogen and helium obviously present much greater difficulties than does the liquification of carbon dioxide.