Industrial Gases

Industrial gases are a group of gases that are specifically manufactured for use in a wide range of industries, which include oil and gas, petrochemicals, chemicals, power, mining, steelmaking, metals, environmental protection, medicine, pharmaceuticals, biotechnology, food, water, fertilizers, nuclear power, electronics and aerospace. Their production is a part of the wider Chemical Industry (where industrial gases are often seen as “speciality chemicals”).

This article describes the production and uses of six common industrial gases - acetylene, hydrogen, carbon dioxide, nitrogen, oxygen and argon. In the coming weeks, we will discuss each of these industrial gases indepth. In this article we overview of the production and uses of each of the gases listed above.

Acetylene

Acetylene (useful for oxy-acetylene welding) is produced by reacting Calcium carbide (CaC2) with water. Calcium carbide is generated by the carbothermic reduction of lime (CaO) at 2000C. Lime can be produced by reducing limestone (calcium carbonate) in a furnace at 900C-1000C. Once lime has been produced however, one does not need to continue to harvest more limestone to keep making acetylene. The reaction of calcium carbide with water produces acetylene and calcium hydroxide (Ca(OH)2). The hydroxide dissociates back into water and lime at 512C. Carbon however, which is burned as acetylene, must be continually provided. Only the calcium is preserved.

Acetylene is mainly used in oxy-acetylene flames for cutting mild steel and for welding. Approximately 80 percent of the acetylene produced annually in the United States is used in chemical synthesis. The remaining 20 percent is used primarily for oxyacetylene gas welding and cutting due to the high temperature of the flame. Acetylene is also used in the acetylene (‘carbide’) lamp, once used by miners (not to be confused with the Davy lamp), on vintage cars, and still sometimes used by cavers. Acetylene is sometimes used for carburization (that is, hardening) of steel when the object is too large to fit into a furnace.

Hydrogen

Hydrogen is the lightest and most common element in the cosmos. Its atomic number is 1. In its elemental state, hydrogen is rare. But it is one of the components of water and vital to life. Hydrogen is not a source of energy; it is an energy carrier. Before it can be used, it must be separated from the molecules containing it. Hydrogen can be produced from water, from hydrocarbons such as coal, crude oil and natural gas, and from biomass.

The majority of the hydrogen is sold to the edible fats and oils industry where it is used to hydrogenate vegetable oils to make margarine. Other applications include, Commercial fixation of nitrogen from the air in the Haber ammonia process. Methanol production, in hydrodealkylation, hydrocracking, and hydrodesulphurization. Rocket fuel, welding, production of hydrochloric acid, reduction of metallic ores, for filling balloons (hydrogen gas much lighter than air; however it ignites easily), and liquid H2 is important in cryogenics and in the study of superconductivity since its melting point is only just above absolute zero.

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Exploring Industrial Gases

Carbon dioxide

Carbon Dioxide, a colorless, odorless gas composed of carbon and oxygen. Carbon dioxide does not burn nor does it support the combustion of most other substances. The gas is soluble in water, with which it forms carbonic acid. Carbon dioxide is about 1 1/2 times as heavy as air and makes up about 0.03 per cent of the atmosphere by volume. Carbon dioxide is needed by photosynthetic organisms (most plants and algae, and some bacteria) to manufacture food.) For commercial use, carbon dioxide is obtained primarily from gas wells and as a by-product of fermentation, the manufacture of ammonia, or the combustion of fossil fuels. For some uses, carbon dioxide is liquefied or solidified.

Carbon dioxide is used widely in the food industry for applications such as removing the caffeine from coffee beans to make decaffeinated coffee and for carbonating beverages such as beer, soft drinks etc. In baking, it leavens dough. A major use of carbon dioxide is in enhanced oil recovery; the gas is pumped into largely exhausted petroleum deposits to force petroleum to the surface. Carbon dioxide is also used in extinguishing fires and in the manufacture of a number of chemical products.

Liquid carbon dioxide is used in processes that involve chilling; it is used, for example, to achieve cooling of certain plastics in molds and rapid freezing of foods. Solid carbon dioxide (dry ice) is used for refrigeration, especially when transporting perishable items.

Nitrogen

Nitrogen, a chemical element that forms compounds that are essential to life. Free nitrogen (nitrogen not combined with other elements) is a gas at ordinary temperatures and pressures, with no taste, odor, or color. It is the most abundant element in the atmosphere, accounting for 78 per cent of the volume and 75 per cent of the weight of the atmosphere. Nitrogen does not combine readily with other elements. It dissolves in water.

Nitrogen is produced in commercial quantities from liquid air. Nitrogen boils away from liquid air at a lower temperature than oxygen, the other main ingredient of air. Therefore when the liquid air is at the correct temperature, the nitrogen turns to vapor while the oxygen remains liquid. The nitrogen is then further treated to remove small amounts of the inert gases (particularly argon), which turn to vapor with the nitrogen.

Nitrogen is used to replace ordinary air and provide an unreactive atmosphere for such industrial processes as the production of chemicals, the refining of metals, and the manufacture of electronic equipment. Nitrogen also helps provide an unreactive atmosphere in incandescent lamps. Nitrogen is pumped underground to raise the pressure in petroleum deposits and thus increase the production of petroleum from the deposits. Liquid nitrogen is used for the rapid freezing of meat and other food products; as it is sprayed over the food, the nitrogen quickly evaporates, absorbing heat from the food.

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Ammonia, a compound of nitrogen and hydrogen, is used in the manufacture of fertilizers, dyes, plastics, explosives, and many other substances. Hydrazine, which also contains hydrogen and nitrogen, is used in a variety of products and processes, including the manufacture of pesticides. Nitrous oxide is an anesthetic. Nitrates, which contain the radical NO-3, include such substances as nitroglycerin and are used as explosives and medicines. Silver nitrate is used in the manufacture of photographic film.

Oxygen

Oxygen is one of the basic chemical elements. In its most common form, oxygen is a colorless gas found in air. It is one of the life-sustaining elements on Earth and is needed by all animals. Oxygen is also used in many industrial, commercial, medical, and scientific applications. It is used in blast furnaces to make steel, and is an important component in the production of many synthetic chemicals, including ammonia, alcohols, and various plastics.

Oxygen and acetylene are combusted together to provide the very high temperatures needed for welding and metal cutting. Industries use the gas for cutting, welding and melting metals. The gas is capable of generating temperatures of 3000 C and 2800 C. This is required for oxy-hydrogen and oxy-acetylene blow torches. A typical welding process goes like this: metal parts are brought together. When oxygen is cooled below -297° F (-183° C), it becomes a pale blue liquid that is used as a rocket fuel.

Argon

Argon is the third most common gas in the Earth's atmosphere, at 0.93%, making it more common than carbon dioxide. Nearly all of this argon is radiogenic argon-40 derived from the decay of potassium-40 in the Earth's crust. In the universe, argon-36 is by far the most common argon isotope, being the preferred argon isotope produced by stellar nucleosynthesis in supernovas. The name "argon" is derived from the Greek word αργον meaning "lazy" or "the inactive one", a reference to the fact that the element undergoes almost no chemical reactions. Argon is highly unreactive and so, like nitrogen, can be used as a protective blanket to prevent substances from oxidizing.

Argon is produced industrially by the fractional distillation of liquid air. Argon is mostly used as an inert shielding gas in welding and other high-temperature industrial processes where ordinarily non-reactive substances become reactive; for example, an argon atmosphere is used in graphite electric furnaces to prevent the graphite from burning. Argon gas also has uses in incandescent and fluorescent lighting, and other types of gas discharge tubes. Argon makes a distinctive blue-green gas laser.

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