

STUDY ON CARBON DIOXIDE

For properties see Carbon dioxide (properties)

Carbon dioxide is an atmospheric gas comprised of one carbon and two oxygen atoms. It is a very widely known chemical compound and it is frequently called by its formula CO₂. In its solid state, it is commonly known as dry ice.

Chemical and physical properties

Carbon dioxide is a colorless gas which, when inhaled at high concentrations (a dangerous activity because of the associated asphyxiation risk), produces a sour taste in the mouth and a stinging sensation in the nose and throat. These effects result from the gas dissolving in the mucous membranes and saliva, forming a weak solution of carbonic acid.

Its density at 25 °C is 1.98 kg m⁻³, about 1.5 times that of air. The carbon dioxide molecule (O=C=O) contains two double bonds and has a linear shape. It has no electrical dipole. As it is fully oxidized, it is not very reactive and, in particular, not flammable.

At temperatures below -78 °C, carbon dioxide condenses into a white solid called dry ice. Liquid carbon dioxide forms only at pressures above 5.1 atm; at atmospheric pressure, it passes directly between the gaseous and solid phases in a process called sublimation.

Water will absorb its own volume of carbon dioxide, and more than this under pressure. About 1% of the dissolved carbon dioxide turns into carbonic acid. The carbonic acid in turn dissociates partly to form bicarbonate and carbonate ions.

Test For Carbon Dioxide. When a lighted splint is inserted into a test tube containing carbon dioxide, the flame is immediately extinguished, as carbon dioxide does not support combustion. (Certain fire extinguishers contain carbon dioxide to extinguish the flame). Of course if you are genuinely unsure what gas you are testing (hydrogen, natural gas etc) igniting with a lighted splint may not be a good idea. This method is inconclusive because other gases can quench a flame.

To further confirm that the gas is carbon dioxide, the gas may be bubbled into calcium hydroxide solution (Lime water). The calcium hydroxide turns milky because of the formation of calcium carbonate.

Uses

Liquid and solid carbon dioxide are important refrigerants, especially in the food industry, where they are employed during the transportation and storage of ice cream and other frozen foods. Solid carbon dioxide is called "dry ice" and is used for small shipments where refrigeration equipment is not practical.

Carbon dioxide is used to produce carbonated soft drinks and soda water. Candy called Pop Rocks is pressurized with carbon dioxide gas at about 600 PSI. When you put the candy in your mouth, it melts (just like other hard candy) and releases the gas bubbles with an audible "pop". Traditionally, the carbonation in beer and sparkling wine comes about through natural fermentation, but some manufacturers carbonate these drinks artificially.

The leavening agents used in baking produce carbon dioxide to cause dough to rise. Baker's yeast produces carbon dioxide by fermentation within the dough, while chemical leaveners such as baking powder and baking soda release carbon dioxide when heated or exposed to acids.

Carbon dioxide is often used as an inexpensive, nonflammable pressurized gas. Life jackets often contain canisters of pressured carbon dioxide for quick inflation.

Steel capsules are also sold as supplies of compressed gas for airguns, paintball markers, for inflating bicycletires, and for making seltzer.

Rapid vaporization of liquid CO₂ is used for blasting in coal mines.

Carbon dioxide extinguishes flames, and some fire extinguishers, especially those designed for electrical fires, contain liquid carbon dioxide under pressure.

Carbon dioxide also finds use as an atmosphere for welding, although in the welding arc, it reacts to oxidize most metals. Use in the automotive industry is common despite significant evidence that welds made in carbon dioxide are brittle than those made in more inert atmospheres, and that such weld joints deteriorate over time because of the formation of carbonic acid. It is used as a welding gas primarily because it is much less expensive than more inert gases such as argon or helium.

Liquid carbon dioxide is a good solvent for many organic compounds, and is used to remove caffeine from coffee. First, the green coffee beans are soaked in water. The beans are placed in the top of a column that's seventy feet high. The carbon dioxide fluid at about 93 degrees Cel. enters at the bottom of the column. The caffeine diffuses out of the beans and into the carbon dioxide.

It's used by some dry cleaners for this reason. (See green chemistry.)

A common type of industrial gas laser, the carbon dioxide laser, uses carbon dioxide as a medium.

Carbon dioxide is commonly injected into or adjacent to producing oil wells. It will act as both a pressurizing agent and, when dissolved into the underground crude oil, will significantly reduce its viscosity, enabling the oil to flow more rapidly through the earth to the removal well. In mature oil fields, extensive pipe networks are used to carry the carbon dioxide to the injection points.

Dry Ice

Dry ice is a genericized trademark for solid ("frozen") carbon dioxide.

Dry ice at normal pressures does not melt into liquid carbon dioxide but rather sublimates directly into carbon dioxide gas at $-78.5\text{ }^{\circ}\text{C}$ ($-109.3\text{ }^{\circ}\text{F}$). Hence it is called "dry ice" as opposed to normal "wet" ice (frozen water).

Dry ice is produced by compressing carbon dioxide gas to a liquid form, removing the heat produced by the compression (see Charles' law), and then letting the liquid carbon dioxide expand quickly. This expansion causes a drop in temperature so that some of the CO₂ freezes into "snow", which is then compressed into pellets or blocks.

Uses

Cooling foodstuffs, biological samples, and other perishable items.

Producing "dry ice fog" for special effects. When dry ice is put into contact with water, the frozen carbon dioxide sublimates into a mixture of cold carbon dioxide gas and cold humid air. This causes condensation and the formation of fog; see fog machine. The effect of fog by the mixture of dry ice with water, is best formed when the water is warm, rather than cold.

Tiny pellets of dry ice (instead of sand) are shot at a surface to be cleaned. Dry ice is not as hard as sand, but it speeds processing by sublimating to a gas and does not produce nearly as much lung-damaging dust.

Increasing precipitation from existing clouds or decreasing cloud thickness by cloud seeding.

Producing carbon dioxide gas as needed in such systems as the fuel tank inerting system in the B-47 aircraft.

Brass or other metallic bushings are buried in dry ice to shrink their size so they will fit inside a machined hole. When the bushing warms back up, it expands and makes an extremely tight fit.

As a cooling supplement for overclocking a central processing unit, a graphics processing unit, or another type of hardware.

Handling

Because of its particular characteristics, dry ice requires special precautions when handling. It is extremely cold and there should be no direct contact with skin (i.e., wear proper insulating gloves). It is constantly sublimating to carbon dioxide gas, so it cannot be stored in a sealed container as the pressure buildup will quickly cause the container to explode. The sublimated gas must be ventilated; otherwise, it may fill the enclosed space and create a suffocation hazard. Special care for ventilating vehicles is needed as well because of the small space. People who handle dry ice should also be aware that carbon dioxide is heavier than air and will sink to the floor.

Concentrations of CO₂ in Atmosphere

Despite its small concentration, CO₂ is a very important component of Earth's atmosphere, because it absorbs infrared radiation and enhances the greenhouse effect.

Capturing/Extracting CO₂

Methods of CO₂ extraction/separation include:

Amine extraction

Metal-organic frameworks(MOF's) [1]

Mineral storage

Calcium oxide Carbon Dioxide reacts with quicklime(calcium oxide), to form limestone(calcium carbonate). [2]

Serpentine The metamorphic mineral serpentine(magnesium silicate hydroxide), is composed of magnesium, silicon and oxygen.

Olivine [3] [4]

Molecular Sieve

Polymer membrane gas separators [5] [6]

Porous carbon

Reversing heat exchangers

Regenerative Carbon Dioxide Removal System(RCRS)

The RCRS on the space shuttle Orbiter uses a two-bed system that provides continuous removal of CO₂ without expendable products. Regenerable systems allow a shuttle mission a longer stay in space without having to replenish its sorbent canisters. Older lithium hydroxide (LiOH)-based systems, which are non-regenerable, are being replaced by regenerable metal-oxide-based systems. A metal-oxide-based system primarily consists of a metal oxide sorbent canister and a regenerator assembly. This system works by removing carbon dioxide using a sorbent material and then regenerating the sorbent material. The metal-oxide sorbent is regenerated by pumping air heated to around 400° F at 7.5 scfm through its canister for 10 hours.

Source : http://engineering.wikia.com/wiki/Carbon_dioxide