**Nitrogen and its application in steel plants**

Uploading... Nitrogen is a non-reactive component of the atmosphere that does not support life. The percentage of nitrogen in the air is 78.06% (by volume) or 77% (by weight). The composition of air is shown in Figure 1.

Figure 1 Composition of air

The element nitrogen was discovered in 1772 by Daniel Rutherford， a Scottish physician， as an isolable component of air. Around the same time， nitrogen was also studied by Carl Wilhelm Scheele， Henry Cavendish and Joseph Priestley， who referred to it as burnt air.

Through liquefaction and distillation of ambient air in cryogenic air separation plants， nitrogen is produced in large quantities in gas or liquid form and with high purity. It can also be produced on a commercial scale as a low purity gas by adsorption techniques (variable pressure adsorption， PSA) or by diffusion separation processes (permeation through specially designed hollow fibers). Gaseous nitrogen is abbreviated as GAN， while liquid nitrogen is abbreviated as LIN.

Liquid nitrogen is a cryogenic liquid. Cryogenic liquids are liquefied gases with a normal boiling point below -150 degrees Celsius， and liquid nitrogen has a boiling point of -195.8 degrees Celsius. Because of the large temperature difference between the product and its surroundings， it is necessary to isolate liquid nitrogen from the surrounding heat.

Nitrogen is usually stored in liquid form， although it is primarily used as a gas. Liquid storage is less bulky and less costly than high-pressure gaseous storage of the same capacity. A typical storage system consists of a cryogenic storage tank， one or more evaporators and a pressure control system. The cryogenic storage tank is in principle structured like a vacuum flask. There is an inner vessel surrounded by an outer vessel. Between the two vessels there is an annular space which contains an insulating medium from which all air has been removed. This space keeps the heat away from the liquid nitrogen in the inner vessel. The evaporator converts the liquid nitrogen into a gaseous state. A pressure control manifold then controls the gas pressure and feeds it to the process or application. Vessels used for liquid nitrogen service should be designed for the pressures and temperatures involved. Piping design should follow the specifications for such piping.

Uses of Nitrogen

Nitrogen is usually liquefied， which allows for more efficient transport and storage of large quantities. However， most applications use nitrogen after it has been evaporated into a gaseous state. Nitrogen is valued for its inertness. It is used to protect potentially reactive materials from contact with oxygen. Nitrogen is widely used in steel mills. The main uses of nitrogen in steel mills are listed below.

Used in the primary steelmaking process to produce steel (combined blowing and slag sparging in an alkaline oxygen furnace) and in the secondary steelmaking process (AOD process)

in blast furnaces for cooling the gearbox of the top charging equipment

for coal dust injection in blast furnaces

for dry quenching of hot coke pushed out of the coke oven cell

For protective gas during annealing of cold rolled steel

Blowdown of pipes， tanks and equipment

The cooling properties of liquid nitrogen are used to separate shrink-fit bearings from shafts. Conversely， liquid nitrogen can also be used in shrink fits. In a shrink fit， instead of heating the external metal part， liquid nitrogen is used to cool the internal part so that the metal will shrink and can be inserted. When the metal returns to normal temperature， it expands to its original size， producing a very tight fit.

Nitrogen is used for the purpose of filling. Nitrogen blankets are used to protect flammable or explosive solids and liquids from contact with air.

Nitrogen is used for the pneumatic transport of combustible materials.

Nitrogen is used for heat treatment of steel (nitriding).

Nitrogen is used for laser cutting， welding and brazing.

Properties of Nitrogen

The CAS number for nitrogen is 7727-37-9， while the UN number for the gas is UN1066 and UN1977 for liquid nitrogen.

Nitrogen is an element with the chemical symbol N and the atomic number 7. Under standard conditions of temperature and pressure， two nitrogen atoms combine to form nitrogen gas， which is a colorless， odorless gas. Nitrogen is a diatomic gas. Its chemical or molecular formula is N2， which means that one nitrogen molecule contains two nitrogen atoms. Its atomic mass is 14 and its molecular weight is 28 g/mol. The melting and boiling points of nitrogen are -210 degrees Celsius and -195.8 degrees Celsius， respectively. Its density is 1.16 kg/m3 at 21.1 degrees Celsius. The density of liquid nitrogen at atmospheric pressure and boiling point is 808.9 kg/m3. It is slightly lighter than air， with a vapor density of 0.967 (air = 1). The liquid-gas expansion of nitrogen is 1 to 694 at 20 degrees C. Because of its high expansion， nitrogen has high expansion.

The critical temperature and critical pressure of nitrogen are -146.9 degrees C and 34.59 kg/cm2， respectively.

Nitrogen is a non-reactive gas. It can be combined with other elements. This bonding is very efficient because nitrogen has very few electrons in its outermost electron shell. This is why it is sometimes used as a buffer gas.

Nitrogen condenses into a colorless liquid at its boiling point and is lighter than water. It is slightly soluble in water and has a solubility of 0.023 volume in water at 1 atm and 0 degrees Celsius， which is about 20 mg/l.

Nitrogen is non-combustible and does not support combustion. Although nitrogen is an inert gas， it is not truly inert. It forms nitrogen monoxide and nitrogen dioxide with oxygen， ammonia with hydrogen， and nitrogen sulfide with sulfur. Nitrogen compounds are formed naturally through biological activity. Compounds are also formed at high temperatures or with the help of catalysts at moderate temperatures. At high temperatures， nitrogen combines with reactive metals to form nitrides. Nitrogen is necessary for various biological processes.

Nitrogen in the air is the main cause of nitrogen oxide (NOx) production in various furnaces during combustion. NOx is a greenhouse gas that contributes to global warming.

Nitrogen is compatible with all common building materials. Consider pressure requirements when selecting materials and designing systems.

Safety issues related to the use of nitrogen

Because nitrogen is odorless， colorless， tasteless and non-irritating， it has no warning properties. There are no human senses that can detect the presence of nitrogen. Contact with rapidly expanding nitrogen near the point of release can result in frostbite， redness， a change in skin color to gray or white， and blisters. Nitrogen can be dangerous because it can dissolve in the blood and body fat. Liquid nitrogen can cause some burns in the body.

Nitrogen is sometimes erroneously considered harmless because it is non-toxic and essentially inert. However， it can act as a simple asphyxiant， displacing oxygen from the air to levels below those needed to support life. In addition， nitrogen stored in pressurized containers and systems is stored energy that can cause serious injury if released in an uncontrolled manner.

Nitrogen can replace oxygen in the air， reducing the percentage of oxygen to below safe levels (below 19.5 %). At low oxygen concentrations， unconsciousness and death may occur within seconds and without warning.

No adverse uptake effects are expected， but nitrogen is a simple asphyxiant. The effects of hypoxia from simple asphyxiants may include shortness of breath， decreased mental alertness， impaired muscle coordination， lapses in judgment， depression of all senses， emotional instability， and fatigue. As asphyxia progresses， nausea， vomiting， deficiency and loss of consciousness may occur， eventually leading to convulsions and coma.

No first aid measures are required for gas. If frostbite is suspected， flush the eyes with cool water for 15 minutes and seek immediate medical attention. For frostbite， the skin should be immersed in warm water. Hot water should not be used.

In cases of inhalation and overexposure， prompt medical attention is required. Rescuers should be equipped with self-contained breathing apparatus. Victims should be helped to an uncontaminated area so that they can inhale fresh air. Prompt removal from the contaminated area is paramount. Unconscious persons should be moved to an uncontaminated area， and if breathing stops， artificial respiration and supplemental oxygen should be administered.

To prevent oxygen deprivation， the area where nitrogen is used needs to be adequately ventilated. Depending on the size of the room， the amount of nitrogen， and the presence of an oxygen monitoring system， fresh air changes should be provided at least four to six times per hour. Design features should also include pressure relief devices to vent nitrogen to a safe area outside.

Oxygen detectors are to be used in areas where nitrogen concentrations are expected. Systems that are under pressure are to be checked periodically for leaks. A work permit system is to be used in areas where any work is to be performed.

Nitrogen cylinders are to be used only in a ventilated area. Handle them with care and do not lift them with valve protection caps. To protect them from physical damage， they should not be dragged， rolled， slid or dropped. A special trolley should be used to move them. Gas cylinders should be secured with chains or clamps to prevent them from falling over. Nitrogen cylinders should be stored upright with valve protection caps in place and securely fastened in a well-ventilated storage area or compound to prevent dropping or being knocked over. The temperature of the nitrogen cylinder should not exceed 52 degrees Celsius.

Containers containing liquid nitrogen must not be sealed because of the risk of explosion. Any cap/lid must be vented with sufficient aperture to prevent blockage by ice.

Nitrogen is non-flammable. Nitrogen cylinders may vent rapidly or rupture violently due to pressure in the event of a fire involving them. In the event of a fire， use an extinguishing agent suitable for the surrounding fire. Although most cylinders and containers are designed to vent their contents at high temperatures， be aware that the pressure in the container will increase due to heat and may rupture if the pressure relief device fails. Firefighters should wear respiratory protection (SCBA) and full armor or Bunker gear. Containers exposed to fire should continue to cool until long after the flames have been extinguished.