SUPER COLD TEMPERATURE & compressed gases

How to handle this hazardous combination

By KRIS CACKETTE

Using liquid nitrogen, helium and other gases to produce low temperatures is known as cryogenics. This process has many uses in industrial, medical and scientific markets. Whether tempering golf clubs for an accurate swing or preserving biological samples for medical research, it is important to recognize and prevent the hazards that arise from working with cryogenic liquids and gases under pressure.

Freezing cold

While the point at which refrigeration ends and cryogenics begins is not entirely defined, temperatures below -292° F, or the normal boiling (liquefying) point of gases like nitrogen and helium, are generally recognized as the dividing line between cryogenics and refrigeration.

The use of cryogenics in materials manipulation took off during World War II and has significantly evolved in the last 20 years. Extremely low temperatures can cause increased strength in the molecular structure of the material (like metal) or stop the biological clock of organic matter (like disease cells). Many diverse applications for the cryogenic process have surfaced, including:

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- Tempering metals for musical instruments or firearms for maximum performance.
- Flash-freezing foods such as fish.
- Cryopreservation of biological cells.
- Deflashing, the process of smoothing the edges of molded rubber or plastic.

Dangers of cold

Super-cold cryogenic liquids are stored in vacuum-insulated vessels known as dewars, which are similar in design to a coffee thermos. Named for the scientist James Dewar, who first liquefied hydrogen, dewars have a loose-fitting cap that allows pressure to escape while preventing air and moisture from entering the dewar. Moving and working with cryogenic liquids presents a number of safety and health hazards, so it is always important to ensure that anyone coming into contact with cryogenic liquids is both properly trained and wearing personal protective equipment (PPE.)

Photo courtesy of Airgas, Inc.

Safety hazards

Let's explore several of the safety hazards posed by cryogenic liquids.

Frostbite –Liquid nitrogen can freeze, harden and remove human tissue. Even brief exposure to cryogenic liquids or their cold vapors can cause painful blistering or frostbite. Safety glasses, gloves and aprons are recommended during the transfer or handling of cryogens. Cryogens have a low viscous nature and will penetrate woven materials, so gloves and aprons should be non-porous. Gloves should also be loose fitting so they can be removed quickly if cryogenic liquids are spilled into them. If splashing or spraying are a possibility, chemical goggles or a face shield should be worn for additional protection. Never allow any unprotected parts of your body to touch cryogenic pipes or vessels that are not insulated, as your skin might stick and tear when you attempt to withdraw it.

In the case of a cryogenic burn, flush the skin with lukewarm (not hot) water for at least 15 minutes, remove contaminated clothing and footwear, being sure to launder them before reuse. If the clothing is frozen, loosen it and massage frozen areas with gloved hands. If the skin is blistered or eyes have been exposed, seek immediate medical attention.

Suffocation – All cryogenic liquids produce large amounts of gas when they vaporize. For example, one volume of liquid nitrogen expands to 694 volumes of nitrogen gas at 70°F. In a closed area, this could cause an oxygen-deficient environment and, as a result, asphyxiation. To prevent this, use a process enclosure, local exhaust ventilation or other engineering controls to minimize exposure to air contaminates. In some cases, an air-purifying or air-fed respirator may be necessary. Respirator selection is

based on anticipated or known exposure levels and Occupational Safety and Health Standards (OSHA) 29 CFR 1910.134.

In the case of exposure, the rescuer needs to protect himself first by wearing the appropriate mask or self-contained breathing apparatus (SBCA) and then move the victim to fresh air and, in severe cases, get medical attention immediately.

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Explosion – The flammability of a cryogenic liquid depends on the properties of its gas. Nitrogen is not a fire hazard, while oxygen is a fire accelerant, and hydrogen is a fuel and is easily ignited. Proper ventilation reduces the risk of fire and should be constructed from materials compatible with the gas(es) used. When using oxygen, personal cleanliness and good housekeeping is an important factor, as grease or oil can react violently with oxygen, resulting in fire or explosion. In the case of fire, if you are properly trained and only if it is safe to do so, use a suitable extinguishing agent and shut off the flow immediately. Obviously, any container of pressurized gas is at risk of bursting if heated.

Another explosion risk is one from pressure. Cryogenic liquids rapidly move from liquid to larger volumes of gas with enormous power. The dewar cap must always be kept free of ice so the pressure can escape. Storage containers should always be protected from physical damage and handled with care. Cylinders should be moved using a hand truck, stored upright and firmly secured to prevent falling or being knocked over. The Compressed Gas Association offers a number of pamphlets on safe handling practices, including P-1 Safe Handling of Compressed Gases in containers and P-12 Safe Handling of Cryogenic Liquids for more information.

As with most workspace hazards, regular equipment maintenance is key in preventing accidents and injury. Always inspect incoming containers to make certain they are not damaged and are properly labeled. Maintaining the appropriate temperature, using the correct equipment and following a manufacturer's instructions for safe operation of the vessel and repairs will help to prevent accidents from occurring and optimize cryogen performance.

While low temperatures and compressed gas can create a challenging environment, work can be accomplished safely and efficiently when proper training, preventive maintenance and personal protection are used in compliance with national regulations and diligent safety practices.

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