# Carbon dioxide – Handle with care

By **Sam A. Rushing** on Feb 24, 2011

When producing and using CO2 in the almost endless number of applications, we should first consider the safety requirements and hazardous effects of this versatile product; whether this is a liquid, a vapour, or ice.

Liquid and vapour represent a large share of the merchant market in terms of applications for cryogenic freezing, cooling, modified gas packaging and cleaning uses. Dry ice sublimates under a normal atmospheric pressure at -78°C and when in contact with fingers, for example, this means the frostbite of human flesh and of course we have the ever constant hazardous potential with airborne CO2 in environments which are not sufficiently vented.

All of us recognise the potential or actual hazard associated with pressurised vessels, the transport of pressurised gases, the potential for asphyxiation by CO2, and the physical handling of the liquid, gas, or solid forms of CO2. Much of this is most familiar or was well known for the long-term employees in the industry, and sometimes not well considered.

However, it would be useful to review safety and hazardous facts associated with carbon dioxide, in terms of packaging, usage, delivery methodology, production and storage, from time-to-time.

Safety orientation should be a matter of course when hiring new employees who will have direct contact with the commodity. When safely handled and with sufficient precautions, the commodity, CO2, in whatever phase or form, can be safe to handle, utilise, and encounter. This represents lower insurance rates, liability in check, and a safe, accident-free working environment for the CO2 industry employees.

**Airborne CO2 used in industry**

I have discussed the many applications and benefits from carbon dioxide, the use of heavier-than-air CO2 rich vapour from sublimation in the theatre – promoting the 'fog effect' which has the potential hazardous side effects to consider.

Further along these lines, and at the extreme end of the spectrum, CO2 vapour is used as an asphyxiant in cattle kill operations such as we find in hog-kill plants here in the US. Returning to the theatre fog effect case, it is worthwhile noting atmospheric CO2 content can run near 0.0387%, and unhealthy for humans can be near 0.5%.

Further still, if near 1% content, drowsiness can occur and at 7-10% severe visual dysfunction, an unconscious state – and even death can result. In all cases, ventilation is absolutely essential and should be well monitored, particularly in settings such as modern food processing plants where the product is heavily used. Therefore, exhaust blowers or fans are essential in the permanent food processing plants. When CO2 liquid is generated into a snow or 'flashed' and brought down to atmospheric pressure, a significant amount of vapour results, as well as snow.

In this example, food plants have exhaust systems to remove and exchange the CO2 concentrated air, however, food processing plants are not unique to this caution. The application of CO2 in a system which is not closed, or where there is significant leakage, particularly in settings where contained buildings or areas are not well ventilated, must take care to limit personnel working in such environments.

This means to improve ventilation, or make other changes with the actual CO2 application, when such concerns should exist. This can result from sublimation in dry ice manufacturing settings, or where dry ice is stored or used in large quantities. Once again, the best cure for this is to improve on ventilation.

We must also employ caution in other environments where CO2 is used in industry, which potentially have this problem, such as closed (or poorly ventilated) rooms which may have the potential for CO2 leakage from stored liquid, ice, and liquid CO2 piping environments.

This could also include environments where CO2 is used in cleaning applications, such as dry cleaning solvent and blast cleaning with (rice style) dry ice – many more settings can offer such a hazard too.

**Process, storage and transportation**

As I mention elsewhere in this article, there is a strong focus on safety and hazard-related information, standards, and testing to prevent accidents and the failure of pressurised vessels and equipment; and many publications to support this as necessary.

Storage and pressure vessels require coding and testing, and over-the-road transports require hydro testing, five-year tests, and ongoing safety checks. Should the operators not fill pressurised CO2 vessels properly, such as overfill, usually a series of valves

(starting with 'bleeder' valves) initially relieve excess pressure. Should the pressure rise further due to overfill or loss of storage tank refrigeration, larger safety relief valves open at a set value, much as a function of the vessel type and design pressure.

Built-in safety features exist in viable vessels and equipment, and safety protocols must be followed to ensure a safe environment. Numerous publications by the CGA methodically outline everything from safe handling to testing, as well as cylinder filling safety; and a great number of precautions and definitions surrounding methodology related to safe procedures and handling.

Common failures with bulk customer storage vessels would be urethane insulated vessels losing refrigeration, thus resulting in pressure increases, and safeties bleeding or venting. Much can be accomplished by taking care when working in these environments, including using the right tools, safety devices, and thinking ahead of anything which might lead to an accident.

**Safety data sheets, CGA, OSHA**

Every gas producer should provide material safety data sheets along with their CO2 as required. The document generally includes the producer name and company information, commodity composition, hazardous identification and effects, first aid remedies, accidental release measures, handling and storage, exposure info, properties, stability data, toxicology, transport info, regulatory info, and hazard codes.

The so-called 'bible' in North America might be the Compressed Gas Association (CGA), which provides many specific manuals, with significant definitions surrounding the safety and handling of carbon dioxide. The CGA characteristics and safe handling of carbon dioxide is usually sold to members and customers; and details everything from safety procedures, venting requirements, safe practices for CO2 and dry ice, physiological effects, as well as physical properties, sources, and uses.

OSHA, a US federal agency has its take on CO2 safety-related requirements in various work settings. Comparable agencies, publications and oversight for CO2 in the safety and hazard prevention arena of course exist in other regions of the world.

**Promote safety and handle with care**

With respect to the title of this piece, the above mentioned hazardous effects when applying or using CO2 in contained areas, which potentially can lead to suffocation and even worse if left unchecked, are perhaps the greatest of offenders in terms of the hazardous effects resulting from unsafe CO2 use today.

This can be a chronic marginal CO2 application in a food processing plant, such as generating CO2 snow with inadequate ventilation, which simply results in laboured respiration, due to high CO2 levels. Marginally high CO2 levels in the work place can be chronic in many plants, as I personally have observed in the industry.

The same situation can include dry ice storage overnight in a storage or depot facility and after the building is opened and ventilated in some manner, the air becomes easier to breathe. On the other hand, it is quite rare to have actual suffocation or asphyxiation take place with CO2 in industry, since this worst case scenario would generally include the most extreme accidents or cases of poor judgment – such as someone locked in a closed facility with dry ice sublimating, or CO2 vapour being let to the atmosphere for a given application.

The goal is to review the material safety data sheets provided by the gas manufacturers or suppliers, and post the appropriate signs and notices in CO2 production and consuming environments, generally according to law; as well as to follow practices outlined by oversight entities and gas standard organisations such as OSHA, the CGA.

In the end, comfort, safety and pleasant working environments, and less enforcement of violations will be enjoyed, and the business of producing and applying CO2 safely in industry will flourish.

**About the author**

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