CO2 A Silent Killer

NEXT MEDIA ANIMATION News Direct

TITLE: McDonald's death caused by CO2 leak

DATE: Thursday, Sept 15, 2011

DESCRIPTION: The death of a woman killed by toxic fumes in a Georgia McDonalds restaurant last week has been attributed to a carbon dioxide leak. Authorities said the leak came from an unconnected bleed valve used to supply the restaurant's soda fountain. The leaking gas built up within the wall cavity and from there seeped into the ladies restroom, where 80-year-old Anne Felton was overcome by the fumes and died.
Source: WSAV.com

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Two Deaths

- In January, 2005 at a Sanford, Florida McDonald's two employees died from exposure to carbon dioxide CO_2 that was being delivered from a tank truck to a stationary storage tank on premises. Sufficient CO_2 was released to cause both employees to lose consciousness and the ability to escape from the confined area. As with carbon monoxide, there is no warning and rescue must be made by a person with an oxygen supply mask.

Fatality

- In Cincinnati, Ohio a delivery driver succumbed to carbon dioxide asphyxiation while dispensing CO_2 from his tractor-trailer. Restaurant employees started to look for the driver and found him unconscious and lying face up at the bottom of the stairwell; they immediately called 911.
- The paramedical team had to use SCBAs to remove the victim from the stairwell.
- The paramedics were unable to revive him and he was declared dead at the local hospital.

Near Miss

- On May, 31 2011 at a Phoenix AZ McDonalds an employee was found at the top of a stairwell that leads to the basement storage area.”
- A FF and an Engineer went into the basement to see if the patient had tripped or slipped on something.
- after entering the basement both men became lightheaded and exited the basement.
- Upon exiting the basement, the Engineer fell and both members reported dizziness and a bitter taste in their mouths.

It Happened Here!

- The most recent incident caused by faulty carbonated beverage systems, occurred Saturday August 25, 2012 1:34 pm At the McDonalds located at 549 Clairton Blvd. The source of the leak was determined to be the beverage system.
- One patient complained of dizziness.

General Information

- Carbon dioxide (CO_2) is a colorless, odorless, non-flammable gas that is a product of cellular respiration and burning of fossil fuels.
- It has a molecular weight of 44.01g/mol (NIOSH 1976).
- Although it is typically present as a gas, carbon dioxide also can be a solid form as dry ice and liquefied, depending on temperature and pressure (Nelson 2000).
- Occupations that are most at risk from CO_2 exposure include miners, brewers, carbonated beverage workers, and grain elevator workers (CCOHS 2005; Nelson 2000).

General Information

- Some sources of hazardous concentrations of carbon dioxide are:
  - Carbon dioxide storage containers that are not properly vented to a well-ventilated area outside of the building not just into walls or ceilings;
  - Leaking fittings, connections, piping/tubing/hoses, or storage container plumbing.
  - Leaking carbonators, syrup pumps, bag in box (BIB) racks (i.e., any equipment using carbon dioxide); and
  - Leaking beer keg connections and equipment."

CO2

- Carbonated or fizzy drinks are widely available in many venues, from bars to restaurants to night clubs, from sports venues to airports to cinemas.
- Anywhere supplying such drinks is doing so using carbon dioxide or CO_2, a toxic gas which is, in the event of a leak, dangerous to humans.

How CO2 affects the human body

- CO_2 is heavier than air, and therefore in the event of a leak in an enclosed space, such as a walk-in cooler or backroom, anyone entering can be put at risk.
- As little as 5% concentration of CO_2 can quickly cause problems.
- As an odorless and colorless gas, a human will not detect it, and the risks are exacerbated because rising levels of the gas affect the human body with symptoms that could easily be attributed to other factors.

How CO_2 affects the human body

- CO_2 may act as an oxygen displacer in confined spaces and cause a number of reactions.
- These reactions include, but are not limited to, dizziness, disorientation, suffocation, and under certain circumstances, death. Death occurs when there is a depression of the central nervous system (CNS) with prolonged exposure to high levels of CO_2 and the body's compensatory mechanisms are overwhelmed or fail (Farrar et al. 1999; IVHHN 2005; Nelson 2000; NIOSH 1976; NIOSH 1996).

How CO_2 affects the human body

- Even small increases in the concentration of the gas can rapidly increase the risks to humans.
- Initially exposure to low level CO2 can cause problems concentrating, an increased heart rate and breathing issues.
- Higher concentrations of the gas and longer exposure can lead to headaches or dizziness.
- The risks to humans continue to escalate, with higher concentrations causing more severe reactions which can occur much more quickly.

How CO_2 affects the human body

- In terms of worker safety, Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) for CO^2 of 5,000 parts per million (ppm) over an 8-hour work day, which is equivalent to 0.5% by volume of air.
- A value of 40,000 ppm is considered immediately dangerous to life and health based on the fact that a 30-minute exposure to 50,000 ppm produces intoxication, and concentrations greater than that (7-10%) produce unconsciousness (NIOSH 1996; Tox. Review 2005).
- Additionally, acute toxicity data show the lethal concentration low (LC^{Lo}) for CO^2 is 90,000 ppm (9%) over 5 minutes (NIOSH 1996).

How CO_2 affects the human body

- The true concentration of CO_2 could be substantially higher if the oxygen deficiency is due to displacement rather than consumption of the oxygen in the confined space.
- Because oxygen represents only about one-fifth of the total volume of fresh air, every 5 percent of a displacing gas that is introduced into a confined space reduces the oxygen concentration by only 1 percent.
- As an example, consider an oxygen deficiency due to the introduction of CO_2 into an enclosed space.
- In this case, a reading of 19.5 percent O_2 would not be indicative of 1.4 percent CO_2, it would be indicative of 5 X 1.4 percent = 7.0 percent (= 70,000 ppm) CO_2.

How CO2 affects the human body

- The bottom line is that if you wait until the oxygen deficiency alarm is activated, and the deficiency is due to the presence of CO_2, you will have substantially exceeded the toxic exposure limit long before leaving the affected area.

Toxicology of CO_2

- CO^2 is considered to be a potential inhalation toxicant and a simple asphyxiate (Aerias 2005; NIOSH 1976; Priestly 2003).
- It enters the body from the atmosphere through the lungs, is distributed to the blood, and may cause an acid-base imbalance, or acidosis, with subsequent CNS depression (Nelson 2000; Priestly 2003).
- Acidosis is caused by an overabundance of CO^2 in the blood. Under normal physiological circumstances, there is a higher concentration of CO^2 in the blood than in the lungs, forming a concentration gradient, where blood CO^2 diffuses into the lungs and then is exhaled.
- An increase in inhaled CO^2 and subsequent reaction with water in the blood forms carbonic acid (H^2CO^3), which then dissociates into hydrogen ions [H^+] and bicarbonate [HCO^{3-}]. The excess CO^2 shifts the equilibrium toward the creation of more hydrogen ions, thus creating an acidic environment.
- During respiratory acidosis, the pH of the blood becomes less than 7.35 (Priestly 2003).

Toxicology of CO_2

- Electrolyte imbalance occurs due to decreased blood plasma chloride, potassium, and calcium and increased blood plasma sodium.
- Furthermore, the oxygen depleted environment does not allow for cells in the body to obtain the oxygen they need to survive. Fortunately, the body compensates for the excess in H^+ ions by binding of the protons to hemoglobin.
- In addition, the lungs attempt to compensate by removing the excess CO_2, which is the reason rapid breathing is apparent during acute CO_2 exposure.
- After prolonged exposure, the kidney begins to balance blood pH by retaining bicarbonate and excreting hydrogen ions to correct acidosis (Priestly 2003).

Toxicology of CO_2

- Treatment to high exposures of this compound involves removing the victim from the confined space or oxygen inadequate environment, and increasing the oxygen supply to the exposed individual (MSDS for CO_2 2003; Nelson 2000; Priestly 2003).
- The condition of acidosis is reversible upon removal from a high CO_2 environment.

The value of a CO2 alarm

- Because CO_2 was not considered to be a toxic hazard, rather than directly measuring the CO_2 in the workplace environment, it was seen as adequate to simply measure the oxygen concentration.
- As it becomes more feasible (and affordable) to directly measure CO_2 by means of compact, portable, gas detectors equipped with miniaturized infrared sensors for the direct measurement of this gas, the only way to safely monitor CO_2 is by using a CO_2 detector.

The value of a CO2 alarm

- Because CO2 is undetectable by human senses, the only way to safely monitor CO2 is by using fixed or portable alarm systems.
- Alarms are available that have been purposely designed for the hospitality industry.
- The alarm monitors the level of CO2 in the air.

The value of a CO2 alarm

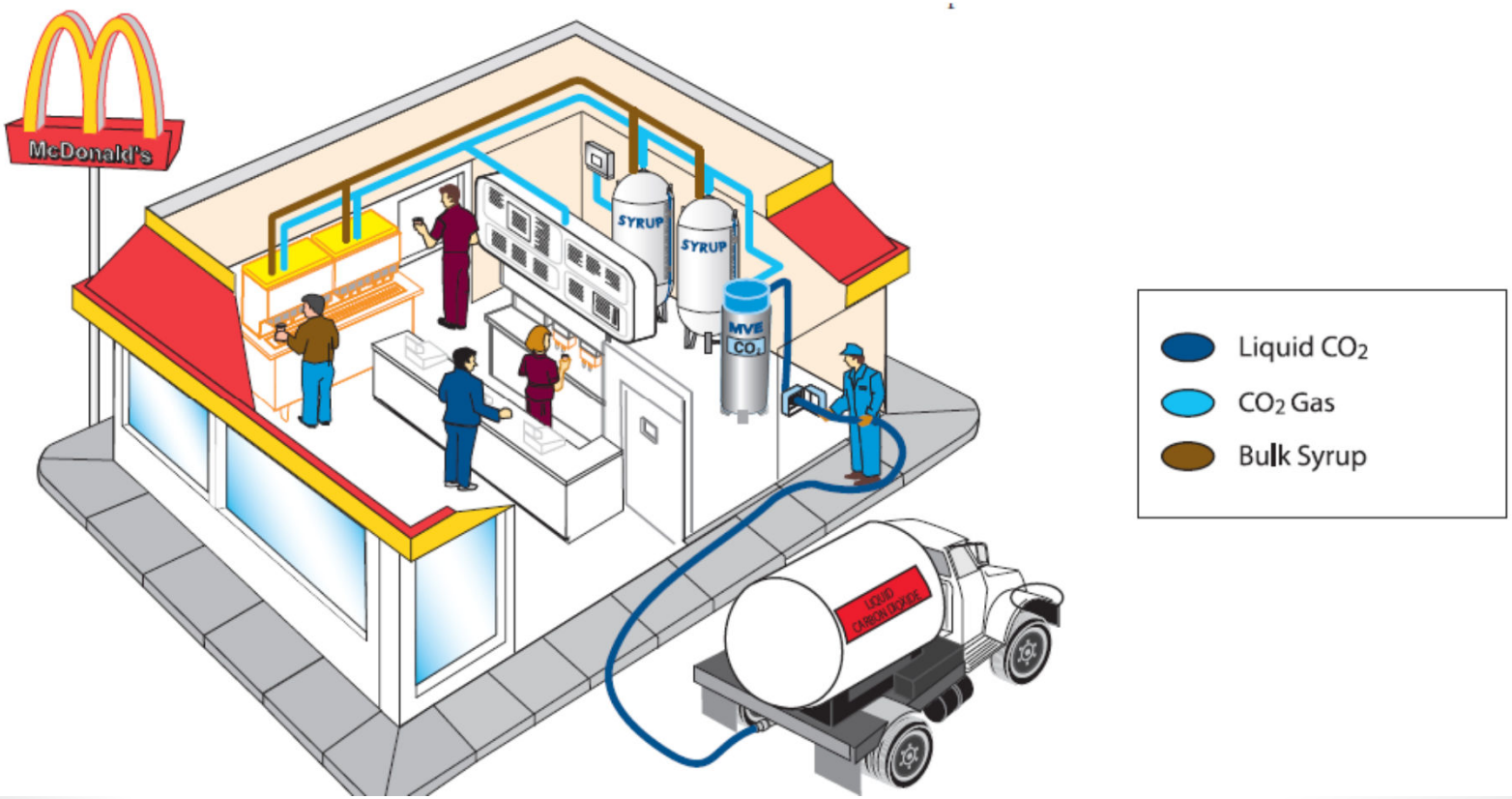
- CO2 being heavier than air means that a leak will lead to rising levels of CO2 if the gas is unable to disperse.
- The advice for wall-fixed CO2 alarms is to install approximately 18 inches above floor level to ensure detection before people accessing the space are put at risk.
- Portable alarms are suitable for many people working with CO2, especially for those delivering the gas who may be entering walk-ins or backrooms at a number of different venues.
- Employers can ensure the safety of their own staff by supplying them with portable personal alarms. Again alarms have been designed specifically for the hospitality industry, and as well as monitoring high CO2 levels, there are now products available which incorporate a man down alarm which will sound if the unit detects no movement for a set amount of time.
- This could prove vital in alerting others in the premises if a person has collapsed.

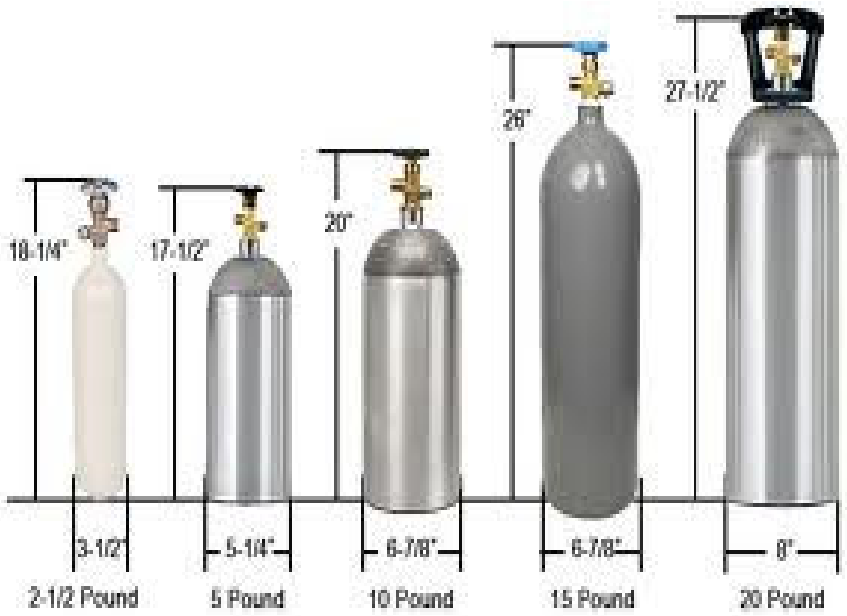
Bulk CO2 and Syrup Systems

How Does It Work?

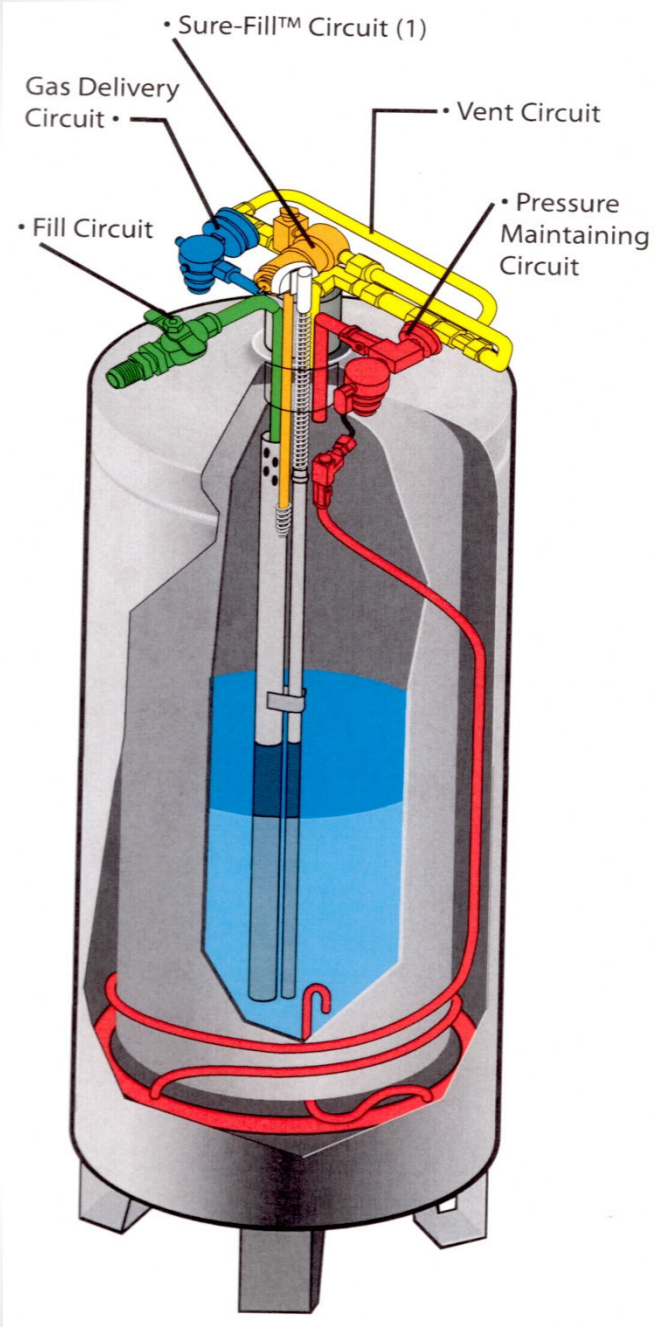
The Bulk CO2 tank stores carbon dioxide as a cold liquid, which requires less space and lower, safer pressure.

When the store needs CO2, the Bulk CO2 tank converts the liquid to gas and supplies CO2 gas to the carbonator, BIB pumps, bulk syrup or wherever needed.





- A bulk CO2 system replaces numerous high-pressure cylinders.
- A bulk CO2 system eliminates the handling of heavy tanks, minimizing store damage and personal injury.
- Low tank pressure creates a safer work environment.



A bulk CO2 system is a single storage vessel that provides a continuous supply of CO2 to the beverage machine.

The bulk CO2 tank is located conveniently inside the restaurant.

The CO2 delivery truck connects the hose to a fill box located outside the restaurant, and fills the bulk tank without entering the store.

The Bulk Syrup system consists of two or more bulk syrup tanks permanently installed inside the restaurant. Each tank holds 80 gallons of syrup and replaces bag-in-a-box and other syrup packages.

Syrup is withdrawn from one syrup tank at a time and fed to the beverage machine upon demand. When one tank is completely empty, the system switches to the next full tank.

The empty tank is automatically sanitized by the Clean-In-Place (CIP) panel system and ready for its next delivery of syrup.

Safety Guidelines for Preventing Potential Carbon Dioxide CO_2 Asphyxiation When Filling Stationary Low Pressure CO_2 Supply Systems.

Safety Guidelines

- 1. Personnel handling liquid carbon dioxide should be thoroughly familiar with the hazards associated with this product.
- 2. When new carbon dioxide receptacles are installed (as in new construction or remodeling), they should be installed at ground level in an open area.
- If feasible, it is recommended that existing CO_2 fill stations be relocated to above grade locations in order to prevent dangerous accumulations of CO_2 in below grade areas.
- Where fill stations are located in confined spaces, the requirements of the permit in the required confined space standard must be followed.

Safety Guidelines

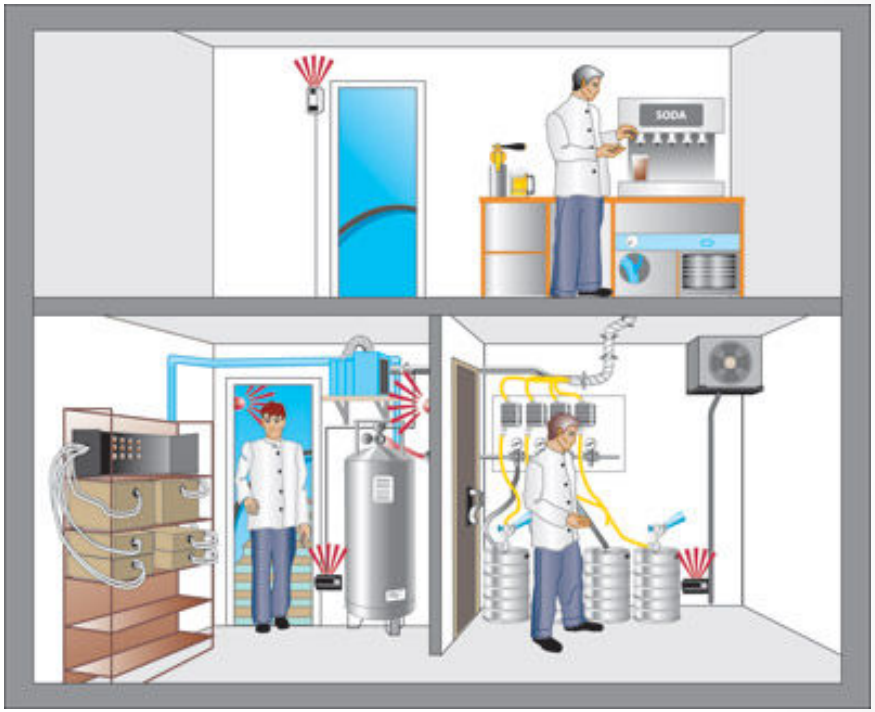
- 3. Even when carbon dioxide is delivered in enclosed areas or below grade locations that are not confined spaces, it is necessary to ventilate such areas adequately to maintain a safe working environment for personnel.
- Since gaseous carbon dioxide is 1.5 times denser than air, it will be found in greater concentrations at low levels.
- Therefore, ventilation systems should be designed to exhaust from the lowest level and allow make-up air to enter at a higher point.

Safety Guidelines

- 4. Develop and implement a procedure to monitor the atmosphere for CO_2 and provide local ventilation where levels may exceed the PEL.
- **Do not** depend on measuring the oxygen content of the air because elevated levels of carbon dioxide can be toxic, even with adequate oxygen for life support.

Safety Guidelines

- 5. A Carbon Dioxide Detection device, and notification system should be provided to alert employees and the public of a hazardous condition.
- Two notification methods are recommended, audible and visual. They should be provided near the area or room where the carbon dioxide cylinders are located, as well as the common area where the public gathers.
- The Carbon Dioxide gas detection systems should send a signal to an approved central station to notify the fire department when the gas detection device reaches 30000 ppm



Safety Guidelines

- 6. Appropriate warning signs should be affixed outside of those areas where high concentrations of carbon dioxide gas can accumulate. Recommended language is shown below:
  - CAUTION - CARBON DIOXIDE GAS

    Ventilate the Area.

    A High CO_2 Gas Concentration May Occur in this Area and May Cause Suffocation.

Safety Guidelines

- 7. Establish a procedure for inspection and maintenance, at regular intervals, of all piping tubing, hoses, and fittings. The entire system should be maintained by qualified personnel in accordance with the manufacturer's instructions.
  8. Provide adequate lighting to enable workers to use these systems safely.

Summery

- The employer needs to be aware of the risks of working with CO_2, especially when it is stored in an enclosed space such as a walk-in cooler or enclosed backroom.
- It is paramount that employers ensure that all their staff, whatever their level and experience, understand the risks from working with CO_2, and know the symptoms which could indicate that the gas is leaking.
- Installation of gas analysis equipment is a simple move which any proprietor can take to ensure that staff and customers are safe and lower their risk management.

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