Methane Gas

INCIDENT

In 2016, a 58-year-old coal miner died from injuries he sustained during an explosion of methane gas. He was working above ground at the time of the incident. The explosion took place underground, in a 753-foot-deep shaft.

The victim was standing on expanded metal grating which covered the opening of the shaft. He and another employee were working to repair loose guarding on a pump that feeds down into the shaft. The second worker had just stepped off the grating to grab a tool when the incident occurred.

The second worker remembers hearing a noise, loud like a jet engine, coming from inside the shaft. He yelled for his co-worker, the victim, to run. But the victims were standing in the direct line of fire. He was still on the grating of the shaft cover.

The noise that the witness heard was a methane explosion, traveling upward and out of the shaft. After an investigation, it was determined that the explosion took place because sparks and slag from their welding work had fallen into the shaft. The sparks and slag made contact with excessive levels of methane.

The methane ignited, and created an intense fire and explosion. The victim received first aid on site, was evacuated via helicopter, and died at the hospital several days later.

NEED TO KNOW

Methane (a gas composed of carbon and hydrogen) is produced two ways. The first is through biologic decomposition of organic matter at shallow depths. Swamps, landfills, and even shallow bedrock are some settings where this occurs. Methane can also be derived over millions of years by high pressure and high temperature processes that produce fossil fuels deep underground. Examples include coal deposits and oil and natural gas accumulations.

Under the right conditions, methane gas can migrate into water wells along with the groundwater. High concentrations of methane in water wells can accumulate in confined spaces and act as an asphyxiant or become flammable. These dangers can be mitigated through enhanced venting of the well casing or venting confined spaces (like basements) and removing any ignition sources.

What are the potential health effects of methane?

Main Routes of Exposure: Inhalation.

- **Inhalation:** Low concentrations are not harmful. A high concentration can displace oxygen in the air. If less oxygen is available to breathe, symptoms such as rapid breathing, rapid heart rate, clumsiness, emotional upsets and fatigue can result. As less oxygen becomes available, nausea and vomiting, collapse, convulsions, coma and death can occur. Symptoms occur more quickly with physical effort. Lack of oxygen can cause permanent damage to organs including the brain and heart.
- **Skin Contact:** Not irritating. Direct contact with the liquefied gas can chill or freeze the skin (frostbite). Symptoms of mild frostbite include numbness, prickling and itching. Symptoms of more severe frostbite include a burning sensation and stiffness. The skin may become waxy white or yellow. Blistering, tissue death and infection may develop in severe cases.
- **Eye Contact:** Not irritating. Direct contact with the liquefied gas can freeze the eye. Permanent eye damage or blindness can result.
- **Ingestion:** Not a relevant route of exposure (gas).
- **Effects of Long-Term (Chronic) Exposure:** Not harmful.
- **Carcinogenicity:** Not a carcinogen.

First aid measures for methane

Inhalation: Take precautions to prevent a fire (e.g. remove sources of ignition). In case of oxygen deficiency: take precautions to ensure your own safety before attempting rescue (e.g. wear appropriate protective equipment). Move victim to fresh

air. Keep at rest in a position comfortable for breathing. If breathing is difficult, trained personnel should administer emergency oxygen. If the heart has stopped, trained personnel should start cardiopulmonary resuscitation (CPR) or automated external defibrillation (AED). Immediately call a Poison Centre or doctor. Treatment is urgently required. Transport to a hospital.

Skin Contact: Not applicable (gas). Liquefied gas: quickly remove victim from source of contamination. DO NOT attempt to rewarm the affected area on site. DO NOT rub area or apply direct heat. Gently remove clothing or jewelry that may restrict circulation. Carefully cut around clothing that sticks to the skin and remove the rest of the garment. Loosely cover the affected area with a sterile dressing. DO NOT allow victim to drink alcohol or smoke. Immediately call a Poison Centre or doctor. Treatment is urgently required. Transport to a hospital.

Eye Contact: Not applicable (gas). Liquefied gas: immediately and briefly flush with lukewarm, gently flowing water. DO NOT attempt to rewarm. Cover both eyes with a sterile dressing. DO NOT allow victim to drink alcohol or smoke. Immediately call a Poison Centre or doctor. Treatment is urgently required. Transport to a hospital.

Ingestion: Not applicable (gas).

First Aid Comments: Some of the first aid procedures recommended here require advanced first aid training. All first aid procedures should be periodically reviewed by a doctor familiar with the chemical and its conditions of use in the workplace.

Fire hazards and extinguishing media for methane

Flammable Properties: FLAMMABLE GAS. Can easily ignite. Can readily form explosive mixture with air at room temperature. Can be ignited by static discharge.

Suitable Extinguishing Media: Dry chemical powder and high-expansion foam. Foam manufacturers should be consulted for recommendations regarding types of foams and application rates.

Unsuitable Extinguishing Media: DO NOT use carbon dioxide, low expansion foams, and direct application of water on liquefied gas.

Specific Hazards Arising from the Chemical: Gas or vapour may travel a considerable distance to a source of ignition and flash back to a leak or open container. Gas or vapour may accumulate in hazardous amounts in low-lying areas especially inside confined spaces, resulting in a health hazard. Can displace oxygen in the air, causing suffocation. Direct addition of water to liquefied gas will cause flash vaporization resulting in an explosion (either immediately or delayed) known as a "boiling liquid, expanding vapour explosion (BLEVE)". Heat from fire can cause a rapid build-up of pressure inside cylinders. Explosive rupture and a sudden release of large amounts of gas may result. Cylinder may rocket. In a fire, the following hazardous materials may be generated: very toxic carbon monoxide, carbon dioxide.

Know the stability and reactivity hazards of methane

- **Chemical Stability:** Normally stable.
- **Conditions to Avoid:** Open flames, sparks, static discharge, heat and other ignition sources.
- **Incompatible Materials:** Increased risk of fire and explosion on contact with: strong oxidizing agents (e.g. perchloric acid), halogens (e.g. chlorine). Not corrosive to: aluminum alloys, carbon steel.
- **Hazardous Decomposition Products:** None known.
- **Possibility of Hazardous Reactions:** None known.

Accidental release measures for methane are:

Personal Precautions: Evacuate the area immediately. Isolate the hazard area. Keep out unnecessary and unprotected personnel. Eliminate all ignition sources. Use grounded, explosion-proof equipment.

Methods for Containment and Clean-up: Stop or reduce leak if safe to do so. Knock down vapour with fog or fine water spray. Ventilate the area to prevent the gas from accumulating, especially in confined spaces.

Handling and storage practices used when working with methane

Handling: Eliminate heat and ignition sources such as sparks, open flames, hot surfaces and static discharge. Post “No Smoking” signs. If used in a confined space, check for oxygen deficiency before worker entry and during work. Secure cylinder in an up-right position. Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. Prevent accidental contact with incompatible chemicals. Additional information for handling refrigerated liquefied methane: ensure that cryogen dewar can withstand extremely low temperature. Cool the receiving container prior to transfer. Slowly fill containers or put objects into liquefied gas to minimize boiling and splashing. Do not overfill portable dewars.

Storage: Store in an area that is: cool, well-ventilated, temperature-controlled, out of direct sunlight and away from heat and ignition sources, clear of combustible and flammable materials (e.g. old rags, cardboard), separate from incompatible materials. Always secure (e.g. chain) cylinders in an upright position to a wall, rack or other solid structure.

The engineering controls for methane

Engineering Controls: Use local exhaust ventilation, if general ventilation is not adequate to control amount in the air. Use non-sparking ventilation systems, approved explosion-proof equipment and intrinsically safe electrical systems in areas where this product is used and stored. Do not allow product to accumulate in the air in work or storage areas, or in confined spaces. For large scale use of this product: use stringent control measures such as process enclosure to prevent product release into the workplace.

Personal Protective Equipment (PPE) is needed when working with methane

Eye/Face Protection: Wear chemical safety goggles and face shield when contact is possible.

Skin Protection: Always wear insulated protective clothing, if contact with refrigerated gas is possible.

Respiratory Protection: Not normally required.

In areas of potential oxygen deficiency or where equipment failure may cause an immediate high concentration of methane, approved respiratory protection should be readily available.

Emergency or planned entry into unknown concentrations or into an area where there is less than 18% oxygen.

BUSINESS / REGULATIONS

The control of chemical hazards and toxic substances

It is OSHA's long-standing policy that engineering and work practice controls must be the primary means to reduce employee exposure to toxic chemicals, where feasible. Respiratory protection is required to be used if engineering or work practice controls are infeasible or while engineering controls are being implemented.

Requirements for respirator use

When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used. Employers must provide appropriate respiratory protection at no cost to workers, provide appropriate training and education regarding its use, and ensure that workers use it properly. **(See 29 CFR 1910.134 or OSHA's Respiratory Protection Safety and Health Topics Page)**

Information relating to specific chemicals

First, explore this **Safety and Health Topic webpage** that includes links to much of the related information available from **OSHA**, in addition, near the top of this page is a list of other Safety and Health Topic pages which address specific chemicals. Other sections contain information or links on subjects such as laboratory safety, and Hazard Communication or Process Safety. The **OSHA Occupational Chemical Database** compiles information from several government agencies and organizations. Information available on the pages includes chemical identification and

physical properties, exposure limits, sampling information, and additional resources.

STATISTICS

In 2017, 41 U.S. workers died on the job after a single episode of inhaling chemicals and chemical products—7 more fatal injuries than in 2016. This number ranged between 33 and 55 fatal injuries each year from 2011 to 2017, with a total of 297 fatalities across the 7-year span.

Inhaling carbon monoxide led to the most fatalities during this time period (116 fatal injuries) followed by inhaling hydrogen sulfide (46 fatal injuries).

Of the fatal single episode inhalations of chemicals and chemical products from 2011 through 2017, 37 percent occurred in a confined space (110 fatal injuries). All fatal single inhalations of methane gas involved a confined space (9 fatal injuries).

Other chemicals and chemical products that led to fatal injury after a single inhalation in spaces that were confined and not confined were toluene (5 fatalities), solvents and degreasers (7 fatalities), dichloromethane (8 fatalities), and coal, natural gas, petroleum fuels and products (11 fatalities).

These data are from the Injuries, Illnesses, and Fatalities program and include workers in the private sector and government. To learn more, see "National Census of Fatal Occupational Injuries in 2017." We also have more charts on fatal work injuries. For more on related Occupational Safety and Health Administration regulations, visit "Chemical Hazards and Toxic Substances" and "Confined Spaces."

In 2009, 784 people died of unintentional injuries due to non-fire exposure to gases. Anoxia, which is injury involving oxygen deprivation, accounted for 33,600 injuries reported to hospital emergency rooms in 2012, including 16,800 with no fire involvement.

During 1999–2010, a total of 5,149 deaths from unintentional

carbon monoxide poisoning occurred in the United States, an average of 430 deaths per year. The average annual death rate from carbon monoxide poisoning for males (0.22 per 100,000 population) was more than three times higher than that for females (0.07). The death rates were highest among those aged ≥65 years for males (0.42) and females (0.18). The rates were the lowest for males (0.08) and females (0.04) aged <25 years

PREVENTION

The incident report does not specify what type of clothing the victim was wearing. Flame-resistant materials may have protected him some. But his death was attributed to “internal burns.” It’s also reported that he received burns and lacerations to his face.

There are, however, different kinds of PPE and safety equipment that could have prevented this incident. In this particular case, the presence of methane was a known potential. And even though the area was abundant with “no smoke or open flame” signs, nothing was done to prevent sparks from falling down into the shaft. Welding blankets would have prevented that. A gas monitor could have been used as well, to detect the presence of methane.

7 Methane Gas Safety Tips

Methane gas is one of the worst greenhouse gases. Methane can also be dangerous, just like any other gas. That means you need to take precautions when around methane for your own safety.

1 – Ventilation

You’re likely to find most methane when you’re around a livestock manure pile. Any area like this needs to be well ventilated, even if it means the odor will be spread on the air. If you have to close the area off, be sure to wear safety goggles when you enter, as the gas will have accumulated. If it’s a large area, wear a breathing mask when you first enter.

2 – Personal Safety

Personal protection is important when you’re around methane gas.

Always wear safety goggles and a breathing mask. You don’t want to breathe in the methane gas so it enters your lungs, where it can burn.

3 – Dangers

Be aware that methane gas can asphyxiate. This is why it’s so important to have the area well-ventilated or have breathing equipment. It’s easy for the methane gas to displace the oxygen in the bloodstream. It can happen before you know you, and the result will be serious injury or even death.

4 – Explosions

Be aware that methane gas can be very explosive when it’s concentrated. When you’re around methane you should never smoke or have a naked flame-that’s just asking for trouble. The flash point for methane gas is very low. You should keep it away from oxygen, halogens and interhalogens to keep it safer. It’s vital that you not only treat methane with respect but also remain aware of just how volatile it can be.

5 – Manure Pits

If there’s a manure pit it should be well signposted and fenced off. No one should smoke in the vicinity of a manure pit because of the danger of an explosion and fire. Methane gas is lighter than air so it can spread very easily. When methane gas burns it produces both carbon dioxide and carbon monoxide, both of which can kill.

6 – Storage

It’s important to have the safe storage of methane gas. Containers of methane gas have to be in well-ventilated areas and away from all heat sources, including direct sunlight. If a fire does occur it’s vital to cut off the methane gas supply and keep other containers cool by soaking them in water.

7 – Frostbite

When working with methane gas containers that are under pressure, always wear heavy gloves. This is because methane can cause frostbite on exposed skin, with all the pain. It will turn exposed skin white or pale yellow. The pain will soon decrease, but with care it can be avoided altogether.

When working with methane gas containers, cover all exposed skin, and have safety goggles and breathing equipment. This will give you ample protection in the event of an accident. Work slowly and methodically and keep the methane containers in ventilated areas for safety.