

Refrigerants: Understanding their properties and associated risks

i For immediate help, call 911 and refer to the [first aid section](#).
For technical help, call CANUTEC at 613-996-6666 and refer to the [spill response section](#).

Refrigerants are useful in commercial products in homes and industries. It's important to understand their properties and their dangers.

This article summarizes information about refrigerants from CANUTEC Emergency Response Advisors.

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Introduction

Refrigeration plays a key role in daily life. It keeps homes cool on hot summer days and keeps in industrial chillers and ice rinks cold.

Refrigeration lowers the temperature of an enclosed space like a home or a car by transferring heat from the inside of the space to the outside using a refrigerant. This whole process is a constantly moving cycle. For it to work, it needs refrigerants and other mechanical parts, like compressors and expansion valves.

Refrigeration systems are built for safety and must follow standards. However, it's important to understand that refrigerants can be or can contain chemicals with risks and dangers.

Refrigeration works the same way in different devices, like the refrigerator in your home and the air conditioner in your car. However, they often use different types of refrigerants. Refrigerants are usually gases at room temperature and include:

- non-flammable refrigerants
- flammable refrigerants
- toxic refrigerants

Some other systems require a liquid coolant. These are liquids at room temperature. They act like secondary refrigerants to help transfer heat elsewhere in a system.

Potential hazards

Common refrigerants in homes and industries are often named using the R numbering system (for example, R-134 A). This system tells us the molecular structure of the refrigerants and their contents. Potential hazards depend on the type of refrigerant.

Non-flammable refrigerants

Common non-flammable refrigerants include:

- R-134 A (composed of 1,1,1,2-tetrafluoroethane)
- R-404 A (composed of pentafluoroethane; 1,1,1-tetrafluoroethane and 1,1,1,2-tetrafluoroethane)
- R-410 A (composed of difluoromethane and pentafluoroethane)
- R-422 B (composed of 1,1,1,2,2-pentafluoroethane; 1,1,1,2-tetrafluoroethane, and isobutane)
- R-448 A (composed of a blend of multiple refrigerants)
- R-449 A (composed of a blend of multiple refrigerants)
- R-744 (also known as carbon dioxide)

These refrigerants are gases. They are usually colourless and often contain various hydrofluorocarbons. Some of the individual gases making up these refrigerants are flammable. However, mixing various gases in different ratios can result in non-flammable refrigerants.

The main hazard of non-flammable refrigerants is asphyxiation (lack oxygen). If there is an uncontrolled release of a refrigerant, it can displace the oxygen in the air, which leads to oxygen deprivation. Non-flammable refrigerants usually consist of non-toxic gases, but exposure to high enough concentrations for a long time can lead to death.

Symptoms of asphyxiation are:

- deeper breathing
- dizziness
- weakness
- nausea
- loss of coordination
- unconsciousness

- increased heart rate

Refrigerant leaks can also cause frostbite if the leak hits exposed skin.

Flammable refrigerants

The two most common flammable refrigerants are:

- R-600 A (composed of isobutane)
- R290 (composed propane)

Isobutane and propane are both colourless gases. They are highly effective as refrigerants but are fire hazards. Designers usually limit the amount of these refrigerants used in a system to reduce the safety risks.

Flammable refrigerants usually have a high vapour density. This means they tend to stay close to the ground and can accumulate in pits and depressions. They also need to reach a certain concentration in the air before they are considered flammable and can ignite. This makes removing potential ignition sources and continuous ventilation important in a leak.

Although R-600a and R290 aren't considered toxic, they will displace oxygen and could lead to asphyxiation.

Toxic refrigerants

Early refrigerants, such as ammonia and sulfur dioxide, were toxic and corrosive. When used as refrigerants, ammonia is named R-717 and sulfur dioxide is R-764. These gases are becoming less common for domestic refrigeration. However, some old fridges and commercial refrigeration systems (like ice rinks and meat chillers) might still use ammonia.

Ammonia is considered flammable when released in significant quantities in an enclosed space. Under these conditions, it can be a fire risk with a source of ignition. Even with its risks, ammonia is attractive for industrial

refrigeration because of its efficiency, cost, and low global warming potential.

Exposure to toxic refrigerants can be fatal. It is important to understand their chemical properties and their dangers. The most common ways to be exposed are:

Inhalation

Sulfur dioxide and ammonia are hydrophilic (attracted to water). When you inhale these gases, they will react with moisture in your airways to form an acidic compound (sulfurous acid) or a basic compound (ammonium hydroxide). These compounds are corrosive and can burn the nose, throat, and lungs. Symptoms of inhalation exposure are:

- coughing
- chest tightness
- wheezing
- difficulty breathing
- immediate burning feeling in nose, throat and respiratory tract

Some symptoms, such as pulmonary edema, may appear later. They can be delayed up to 24 to 48 hours after exposure. Pulmonary edema is buildup of liquid in the lungs. This causes chest pain and shortness of breath. Especially with ammonia, symptoms can appear hours after exposure and worsen with physical activity. Severe short-term exposure may lead to lasting damage.

Skin and eye contact

These gases will form the acid or base mentioned above when they contact the sweat and moisture on your skin. Depending on the concentration of the gases in air, skin contact can cause skin irritation, blisters and severe

burns. Ammonia and sulfur dioxide also burn the eyes. Depending on the concentration, the gases will cause eye irritation and lacrimation (watery eyes). In high concentrations, they can cause severe eye damage.

Liquid refrigerants (coolants)

Liquids like ethylene glycol and propylene glycol can be used in refrigeration systems. These liquids are usually called coolants, secondary refrigerants, or heat-transfer fluids. They are completely soluble (dissolve) in water and are often mixed in ratios of around 50% coolant and 50% water.

Because coolants are liquid at room temperature, they present fewer hazards than typical refrigerants do. Both ethylene glycol and propylene glycol produce minimal vapours at room temperature. Propylene glycol is generally used as a safer alternative to ethylene glycol in coolant systems due to its low toxicity but isn't as effective as a coolant.

Conditions to avoid

Fire or heat

When a refrigerant system or refrigerant container contacts a source of heat or fire, pressure can build up in the system. This causes a risk of explosion.

For non-flammable refrigerants

Most non-flammable and non-toxic refrigerants are hydrofluorocarbon gases. When they contact fire, these gases can decompose into toxic gases such as hydrogen fluoride, carbon monoxide, carbon dioxide, and carbon fluorides.

For flammable refrigerants

Static charges, sparks, open flames and other ignition sources can cause a fire when flammable refrigerants are released. This is a bigger concern in enclosed spaces. This is why effective ventilation in and around refrigeration systems is very important.

Incompatibilities

For non-flammable refrigerants

Refrigerants are incompatible (react dangerously) with and shouldn't contact products such as:

- potassium
- calcium
- powdered aluminum
- magnesium
- zinc

Some refrigerants may react violently in contact with alkali metals and alkaline earth metals such as sodium, potassium, or barium.

Non-flammable gases don't react with air at normal temperature and pressure. However, under high pressure, they can have an explosive reaction.

For flammable gases

Incompatible products include oxidizing agents (like peroxides) or chlorine-based products (like bleach and other cleaning products). Oxidizers increase the risk of fire and explosion. These products can strengthen a fire and make an incident worse.

Coolants

Both ethylene glycol and propylene glycol are incompatible with perchloric acid and strong bases. These products can be found in etching products and cleaning products like strong drain cleaners. Coolants can react with those products on contact. These reactions can produce excessive heat and sometimes flammable hydrogen gas.

First aid

For moderate to serious exposures, call 911 or the Poison Control Centre in your area and seek medical treatment.

First aid will depend on the type of gas and how the person was exposed; by skin or eye contact, inhalation, or ingestion.

Consult the refrigerant's safety data sheets (SDS) for specific first aid instructions.

If exposure occurs, follow these steps:

Non-flammable and flammable refrigerants

Inhalation:

- immediately move to fresh air
- seek medical attention

Skin:

- remove contaminated clothing
- quickly flush skin with water until all chemicals are removed
- if there are signs of frostbite, bathe (don't rub) with lukewarm (not hot) water
- if water is not available, cover with a clean, soft cloth or similar covering
- seek medical attention if symptoms persist

Eyes:

- immediately flush eyes with large amounts of lukewarm water for at least 15 minutes
- seek medical attention if symptoms persist

Toxic refrigerants**Inhalation:**

- immediately move to fresh air
- seek medical attention immediately
- some symptoms may be delayed and appear up to 24 to 48 hours after exposure

Skin:

- remove contaminated clothing
- if irritation develops, rinse the affected area with lukewarm, gently running water for 5 minutes
- if the irritation continues, rinse again
- seek medical attention if symptoms are present or persist

Eyes:

- immediately flush eyes with large amounts of lukewarm water for at least 15 minutes
- seek medical attention if symptoms are present or persist

Liquid refrigerants (coolants)**Inhalation:**

- immediately move to fresh air
- seek medical attention if needed

Skin:

- remove contaminated clothing
- flush the affected area with lukewarm, gently running water for 5 minutes
- seek medical attention if symptoms persist

Eyes:

- immediately flush eyes with large amounts of lukewarm water for 5 minutes
- seek medical attention if symptoms persist

Ingestion:

- rinse mouth thoroughly with water
- don't induce vomiting
- seek medical attention

Storage and handling

You can avoid many incidents involving refrigerants by following the proper storage and handling guidelines. Storage recommendations include:

- storing refrigerant cylinders in a cool area out of direct sunlight
- making sure storage areas are well ventilated
- making sure cylinders and their fittings are protected from physical damage
- keeping incompatible materials and chemicals away from stored cylinders
- keeping refrigerant in its original packaging, if possible

Follow the standard safety precautions for handling and using compressed gas cylinders when you handle cylinders or devices containing refrigerants (like refrigerators). Check the manufacturer's standard for precise guidelines.

Consider these general rules:

- avoid breathing vapors and liquid contact with eyes, skin or clothing
- tightly close valve after use and when cylinders or devices are empty
- avoid puncturing or dropping cylinders or devices
- don't expose cylinders to open flames or excessive heat
- store refrigerants in appropriate, compatible cylinders and devices

Fire response

Don't try to extinguish a fire involving refrigerants. Contact the fire department and evacuate the area.

Every type of refrigerant that is stored in a cylinder will be under pressure. In a fire, pressure will build up inside the cylinder and it could explode. Keep a safe distance from a heated or burning cylinder. Spraying water can cool down the container.

For non-flammable and flammable refrigerants

Use any standard agent to put out the fire. These refrigerants can produce corrosive and toxic gases when heated.

For toxic refrigerants

Water spray can knock down the vapours. However, runoff water will be corrosive and should be contained.

For liquid refrigerants (coolants)

Use extinguishers with agents like carbon dioxide, dry chemical powder, appropriate foam and water spray or fog. Alcohol resistant "multipurpose" firefighting foams also work.

Spill and leak response

For technical advice, contact CANUTEC at 1-888-226-8832 (Canada and US only), 613-996-6666, or *666 (cellular only).

For **small refrigerant leaks**, ventilate the area by opening windows and doors. Keep any flame or flammable material away from the spill. Remove any other ignition sources. Keep incompatible materials away from the spilled product.

For a **coolant spill**, absorb the liquid spill with:

- a rag
- a towel
- a mop
- sand

Place the absorbed product in a plastic container for disposal. Cleaning tools can be rinsed and washed as normal. Residue can be washed with water.

For **large refrigerant leaks**, contact the fire department and evacuate the area. Contact a dangerous goods contractor to clean up the spill. Some manufacturers also have specialised teams you can contact. Their emergency contact information is usually on their website.

Disposal

Spilled gases will dissipate in the air. Dispose of the container (either full or with residue) in an appropriate waste management facility following local or provincial regulations.

Spilled liquid coolants are considered chemical waste. Dispose of them according to local or provincial regulations. Store the waste in an appropriate container. You can bring the waste to a local hazardous waste facility for disposal. In some cases, you can contact a local hazmat contractor or similar to pick up the waste.

Conclusion

It's important to be aware of the potential dangers of refrigerants in every situation.

This article has general guidelines and highlights the potential dangers of certain refrigerants. For precise information, it's best to check the safety data sheets from the manufacturers.

References

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