

This is from liquid refrigerant coming into contact with the skin. This was caused by R22 released onto the fingers when removing the manifold set. This person injured himself and then took over 48 hours to let anyone know. Only then did he seek/receive medical attention. And then a day later we have this! (See picture below)

He had received training on refrigerant safety but ignored the advice.

This is a good opportunity to revisit refrigerant safety and the need for personnel to be aware of the dangers. The South African Refrigeration and Air Conditioning Contractors' Association (SARACCA)/South African South Qualification and Certification Committee (SAQCC) Gas safe handling training and registration was put in place to address this and many other issues. I will go over the basics with you.

So let us start with the possible hazards when working with refrigerant, which are:

- **Inhalation of refrigerant:** Refrigerant does not contain any oxygen. This means that if the air in the workplace is replaced by refrigerant vapour due to refrigerant release the danger exists that asphyxiation occurs.

This will cause paralysis and, if the person is not removed from the workplace in time, death.

- **Spillage of refrigerant on the skin or the eyes:** At atmospheric pressure almost all refrigerants boil at a very low temperature. Spillage of this very cold refrigerant can cause frostbite.



- **Ingestion:** Refrigerant, if swallowed can cause injury to a person's stomach or lungs.

- **Explosions:** Excessive system / cylinder pressures. Ammonia is explosive at concentrations between 16 and 27%.

- **Fire:** We have R290 and R600a, which are flammable and under certain conditions can even be explosive. In the automotive sector we have 1234YF, also a flammable refrigerant being introduced.

Make sure you adhere to safe working procedures according to workshop/worksite procedures, and do not play with refrigerants. Apprentices and learners, please take a good look at these pictures!

Let us consider some of these aspects in more detail.

Effect of inhalation:

Almost all refrigerants will be in vapour form when exposed to atmospheric pressures. Refrigerant vapour is heavier than air and will collect close to the ground. High concentrations can occur when the area is not adequately ventilated. As refrigerants do not contain any oxygen these high concentrations will cause the oxygen percentage in the air to be reduced. This causes asphyxiation in human beings; breathing will appear normal but as insufficient oxygen is absorbed in the body paralysis and loss of consciousness will result.

Added to the danger is the fact that most of the refrigerants are colourless and odourless which means that dangerous concentrations cannot be detected without instrumentation.

The effect of inhalation of ammonia (R717) is that the lungs will start producing moisture that will eventually “drown” the person. However, ammonia has a very pungent odour even if the concentration of ammonia in the air is far below the lethal level. When ammonia is smelt it is best to immediately leave the area and inform the fire department or any other department that will be able to handle the situation.

Effect of spilling refrigerant on the body. (See picture above)

The temperature of liquid refrigerants at atmospheric pressure is very low. The table below gives an indication of the temperatures of some of the commonly used refrigerants:

| Refrigerant | type | container colour | Boiling point | flammable | ODP | GWP |
|-------------|------|----------------------|---------------|-----------|-------|------|
| R22 | HCFC | light green | -40.8 | no | 0.055 | 1700 |
| R134a | HFC | light blue | -26.2 | no | 0 | 1300 |
| 1234yf | HFO | | -29.55 | Slightly | 0 | 5 |
| R290 | HC | Silver with red band | -42.1 | yes | 0 | 3.3 |
| R404A | HFC | orange | -45 | no | 0 | 3260 |
| R407C | HFC | choc. brown | -43.9 | no | 0 | 1525 |
| R410A | HFC | Light pink | -53 | no | 0 | 1725 |
| R507A | HFC | aqua blue | -47.1 | no | 0 | 3850 |
| R600a | HC | Silver with red band | -11.7 | slightly | 0 | 4 |

As can be seen from the table, the temperatures of liquid refrigerant at atmospheric pressure at sea level are very low. If liquid refrigerant is released from a plant or a container and spilt on the body frostbite will result. Frostbite has the same effect on the body as burns by high temperature liquids. Both frostbite and burns can lead to serious injury and even death.

Personal protection equipment to be used when handling refrigerants.

While working with refrigerants (particularly in the liquid phase) personnel should wear the following appropriate safety equipment:

- Safety goggles to protect the eyes;
- Gloves made from non-absorbent material to protect the hands;
- Clothing (overalls) to cover the body, arms and legs to protect against liquid splashes;
- Safety shoes;
- A gas mask, when working with ammonia.

Let us look at **work site procedures and safety precautions** to be established before starting work on a refrigeration plant.

Because there are risks involved with working with refrigerants it is important that certain safety precautions be established before starting work on a refrigeration plant.

If no work site procedures are in place the following general precautions must be observed:

- Locate other personnel working in the vicinity and inform them that you are going to work on the plant so that if there is any emergency they know that you are working in the plant room.
- Adhere to the safety policy of the plant owner.
- Adhere to the safety requirements of the particular site.
- Obtain a permit to work if necessary. Assess any risks involved in working in the area, e.g. if a major refrigerant leak occurred, could it harm others.

- Check the level of ventilation in the plant room in order to prevent the build-up of refrigerant vapour that can cause asphyxiation.

Check the location of the following:

The electrical isolator for the plant so that the plant can be switched off in case of an emergency or for normal maintenance work.

- The emergency exits for quick exit if required.
- The positions of the fire extinguishers in case of fires.
- The nearest first aid equipment for emergency use.
- The nearest telephone to phone rescue services if required.
- The telephone numbers of the rescue services.
- The above constitutes the minimum good practice as the information above will be needed should an emergency arise.

Identify the work situations in which at least two competent persons are required to be present and explain the reasons for this. As explained earlier, refrigerant gases do not contain any oxygen and if refrigerant is leaking from a plant there is a danger of an excessive build-up of refrigerant vapour, which can cause asphyxiation. For this reason, **there are work situations in which it is essential that two competent persons are required to be present.** They are, as follows:

- When working in an enclosed area.
- When working in a basement.
- When working in a badly ventilated area.

In all the above situations, there can be a build-up of refrigerant when there is a leak. The second person must stay outside the working area and observe the person inside all the time; if he/she sees the person is in distress he/she must remove the person from the area immediately, apply the appropriate safety procedures and obtain medical assistance, if necessary.

The procedures to be followed in the event of an accident or fire when working with refrigerants.

Inhalation of refrigerant:

- Remove patient to fresh air, keep warm and at rest.
- Apply artificial respiration if breathing has ceased or shows signs of failing.
- If breathing is difficult, give oxygen.
- In the event of cardiac arrest apply external cardiac massage.
- Obtain immediate medical attention.

Spillage of refrigerant on the skin:

- Remove contaminated clothing.
- Wash areas of skin that were in contact with refrigerant with plenty of water for fifteen (15) minutes.
- If irritation or blistering occurs obtain immediate medical attention.

Eye contact:

- Immediately irrigate eyes with eyewash solution or clean water, holding the eyelids apart for at least ten (10) minutes.
- Obtain immediate medical attention.

Ingestion (swallowing):

- If the person is conscious, wash out the mouth with water and give 200 to 300 ml of water to drink.
- Do not induce vomiting because the hazard of the refrigerant getting into the lungs is greater than swallowing it.
- Obtain immediate medical attention.

In case of fires:

- Locate fire-fighting equipment and extinguish.
- Inform the safety officer and if necessary the fire department immediately.
- Evacuate other people working in the area.

As R600a and R290 are now being used quite extensively, let us consider the ***additional hazards that can be encountered when working with hydrocarbon refrigerants (HCs)***.

Hydrocarbons are flammable when mixed with air in certain proportions and exposed to a source of ignition. When working with hydrocarbon refrigerants the following additional safety precautions must be taken:

- Reduce refrigerant emission to a minimum.
- Ensure that there is adequate ventilation so as to dilute the refrigerant gas with the air to below the lower flammability limit.
- Eliminate all possible ignition sources in the working area. This includes open flame, electrical switch-gear and open motors.
- Have a dry powder fire extinguisher available.

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