Safe Use of HCFC Alternatives in Refrigeration and Air-Conditioning: Higher pressure refrigerants

Introduction

As the phase out of hydrochlorofluorocarbons (HCFCs) progresses, it is expected that there will be a considerably higher uptake, in particular in developing countries, of 'alternative refrigerants', such as hydrocarbons, ammonia, carbon dioxide, unsaturated hydrofluorocarbons (HFCs) –or HFOs. Many of these alternative refrigerants have particular characteristics in terms of toxicity, flammability and high pressure which are different from those used previously such as chlorofluorocarbons (CFCs) and HCFCs. When refrigeration and air-conditioning equipment is installed, serviced, repaired and dismantled, safety issues need to be carefully evaluated and considered particularly when servicing technicians have to deal with refrigerants with properties that they were previously not familiar with. It is therefore important that the refrigeration and air-conditioning industry adapts to both the technical and safety issues concerning these refrigerants.

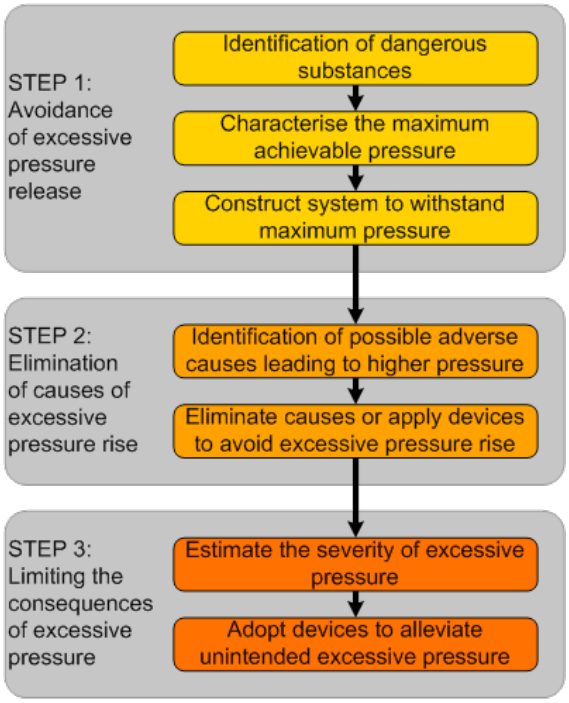
Although there are several refrigerants with a higher pressure than HCFC-22, most of these are within a pressure range which is not more than 50% greater. Carbon dioxide (R-744) has a substantially higher pressure – typically by a factor of six. For some others such as R-410A and HFC-32, the pressure is notably higher than what people are used to with HCFC- 22, so paying attention to the pressure aspects still remains important.

General risk assessment

With all refrigerants that operate under pressure (i.e., above atmospheric pressure, 1.01 bar, abs), there is always a risk of rapid release of pressure due to accidental opening or breakage of pressure containing parts. Such a release can result in physical damage to persons directly from the resulting pressure wave or, more often, indirectly through impact from projectiles. Refrigerants that operate under higher pressure have the potential to cause proportionally more severe consequences (assuming all other conditions are equal).

In principle, the general procedure for all refrigerants is to ascertain the maximum expected pressure levels under which the equipment – or different parts of the equipment – will be operating and then to design the piping and components to withstand that pressure (with safety factors). Any unanticipated operating conditions that may lead to a further rise in pressure have to be handled through the use of safety devices, which may terminate operation or relieve the pressure in a safe manner. Thus, subsequent to assessing the risk, mitigation measures are identified and applied in order to avoid or minimise the likelihood and consequences of unintended outcomes.

Generally, for refrigerants with higher pressures, more comprehensive mitigation measures are demanded.



Basic steps for high pressure risk assessment

Special requirements

For higher pressure refrigerants, appropriate design requirements – that are over and above what would normally be required for ordinary refrigerants – can be found in regulations, standards, codes of practice and industry guidelines. The main issues described in these sources to be addressed, include:

- Ensuring systems have a high level of leak tightness.
- Designing components and piping to withstand considerably higher pressures than normal
- Careful selection and application of additional pressure safety devices (such as pressure limiting switches and pressure relief valves)
- Applying the necessary warnings to accessible parts of the system to ensure that technicians are aware of the hazard (e.g., high pressure signage on the equipment)
- Including the necessary information relating to operating pressures in installation and operating documentation

Refrigerant gas detector for carbon dioxide (R-744)

TOOLS AND EQUIPMENT FOR HIGHER PRESSURE REFRIGERANTS

For technicians and engineers that are working directly with higher pressure refrigerants, it is essential that workers have available and use the appropriate tools and equipment. Whilst it is often the case that certain tools and equipment are equally applicable to most refrigerants, there are some that may ordinarily compromise safety and some specialised equipment is required.

Item	Remarks
Gas detectors	Should be electronic and intended for use with the refrigerant intended
Manifold/gauge/hose set	Materials must be able to withstand the maximum pressure; currently no digital models are available for very high pressures
Refrigerant cylinder adapters	Ensure that the correct type of cylinder adapter is present to enable safe removal of refrigerant from the cylinder
Recovery cylinder	Must be rated for the maximum pressure of the refrigerant being used and have the appropriate high pressure warnings where relevant (see also, also proper refrigerant cylinder handling rules must be adhered to
Venting hose	Due to the negligible environmental impact of direct releases for carbon dioxide, it is common practice to vent it instead of recovering; in this case, a venting hose with sufficient length to allow venting directly to a safe place in the open air is necessary.
Refrigerant recovery machine	Must be suitable for use with the type of refrigerant under consideration and also be designed appropriately to handle the high pressure of the refrigerant.
Personal protective equipment (PPE)	Normally standard items such as goggles and gloves are necessary

Manifold gauge set for use with carbon dioxide (up to 160 bar)

Basic protective equipment - goggles and gloves

KEY TOPICS FOR TRAINING

Topics
Basic principles
• How to carry out elevated pressure risk assessment for systems and installations
• Awareness of material safety data sheets (MSDS)
• Relevant safety standards and regulations that relate to equipment using flammable, higher toxicity and higher pressure gases
• Differences in refrigerant pressure compared to ordinary refrigerants and the implications on system design pressure and size and cylinder pressure ratings
System design and construction
• Classifications within refrigeration safety standard – flammability, toxicity, occupancies, locations, system types
• Requirements of safety standards – determination of charge size limits (or minimum room sizes), need for safety devices (such as pressure limiters, pressure relief, etc), gas detection, ventilation, etc
• Importance of leak minimisation and methods for avoiding leakage
• Information requirements such as equipment marking, labelling and signage
Working practices
• How to carry out a risk assessment for creating and maintaining a safe working area and for carrying out work on a system containing higher pressure refrigerants
• Selection and use of appropriate tools, equipment and personal protective equipment (PPE) when handling flammable, higher toxicity or higher pressure refrigerants
• Standard procedures for safe charging, recovery, evacuation, venting, etc
• Emergency response procedures, such as in the event of a major release or a fire or carrying out first aid
• Restriction on relocation of existing systems/equipment

Source:

- UNEP OzonAction - Safe Use of HCFC Alternatives in Refrigeration and Air-conditioning: An overview for developing countries, 2015

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