UEE11 Electrotechnology

Training Package

UEENEEJ108A Recover, pressure test, evacuate, charge and leak test refrigerants

Learner Workbook

Version 1

Training and Education Support
Industry Skills Unit
Meadowbank

Product Code: 5628

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Section 1 - Refrigerants

Purpose

In this section, you will learn about the function and purpose of a refrigerant used in a basic refrigeration system. You will also learn about the desirable properties and general requirements of the various refrigerants and the affects on the ozone layer of ozone depleting substances.

Topics

- Purpose of a refrigerant
- Function of a refrigerant
- Refrigerant characteristics and properties
  - Ideal properties of refrigerants
  - General characteristics
- Refrigerant terminology
  - Primary refrigerant types
- Refrigerants and their effects on the ozone layer
  - The ozone layer – its function and benefit
  - Position and composition of ozone
  - Effects of ozone depleting substances
  - Alternative refrigerants
  - New generation Ozone friendly refrigerants – High capacity, high pressure refrigerants.

Learning Objectives

At the end of this section, you should be able to:

- State the function and purpose of a refrigerant
- List and briefly explain the various general, desirable and ideal properties of a refrigerant
- Differentiate between primary, secondary and expendable refrigerants
- Differentiate between pure, azeotropic and zeotropic refrigerants
- State the function and purpose of the Ozone layer
- State the composition of Ozone and the position of the Ozone layer
- Briefly, explain effects of Ozone depleting substances on the Ozone layer and the affects of ozone depletion
- List the benefits of the Ozone layer
- Understand the concept of Ozone safe and environmentally friendly alternative refrigerants.

References

You will find the technical information to undertake this section in the following references:

- Australian Refrigeration and Air Conditioning, 4th Edition, Volume 1, Chapter 1
- AIRAH, The Refrigerant Selection Guide
- AS/NZS1677.1 - Refrigeration Systems
- Australian and New Zealand Refrigerant Code of Practice.

Learner exercises

Skill Practice 1.1: Protecting the Future

Additional Information

Purpose of a refrigerant

The purpose of a refrigerant is to act as a heat transfer medium between the product load and a point where it can be rejected.

Function of a refrigerant

A refrigerant is a substance used in refrigeration systems to absorb heat in the evaporator, by changing state from a liquid to a vapour, and to reject this absorbed heat in the condenser as it changes back to a liquid. Refrigerants can be classed as primary, secondary or expendable refrigerants.

Primary refrigerants are substances that change state twice (once in the evaporator and once in the condenser) and produce refrigeration (cooling) by vaporisation. Primary refrigerants transfer the bulk of the heat through a latent heat process. They are used in refrigeration systems such as vapour compression and absorption refrigeration systems.

Secondary refrigerants absorb heat and change temperature in order to transfer heat from the substance/product to be cooled. They usually do not change state in the cooling cycle but change temperature by absorbing sensible heat. A typical example of a secondary refrigerant is chilled water.

Expendable refrigerants change state once and are lost by either vaporisation, sublimation or melting. Typical examples and the temperature at which these occur are liquid nitrogen (–196°C), liquid CO_2 (–79°C), dry ice [solid CO_2] (–79°C) and ice (0°C).

Refrigerant characteristics and properties

Ideal properties of refrigerants *(ARAC, 4th Edition, Volume 1, Chapter 1 – see the General Requisites of Refrigerants and Properties/Performance Table)*

All refrigerants have different properties, some good and some bad. An **"Ideal"** refrigerant would have the all the good characteristics and properties and none of the bad. Unfortunately no one refrigerant can offer this and so each refrigeration or air conditioning system will use a refrigerant that best suits its requirements.

General characteristics *(ARAC, 4th Edition, Volume 1, Chapter 1)*

Refrigerants have special characteristics to enable them to be useful in industry. Most of these characteristics are referred to and defined in ARAC. It should be noted that not all the characteristics described are held by all the refrigerants used in the refrigeration or air conditioning industry.

Refrigerant terminology *(ARAC, 4th Edition, Volume 1, Chapter 1; AS/NZS1677.1 Section 1 and the Refrigerant Selection Guide)*

There are many terms and abbreviations used in this module that you will need to know about. Keeping a list for yourself will make it easier for you to understand this module. You will need to understand the definitions in AS/NZS1677.1, Section 1. Below are some of the more common abbreviations and terms associated with refrigerants.

CHEMISTRY TERMS

Symbol	Chemical	Symbol	Chemical
Cl	Chlorine	He	Helium
H	Hydrogen	Hg	Mercury
F	Fluorine	Cu	Copper
C	Carbon	Fe	Iron
Br	Bromine	O	Oxygen
N	Nitrogen		

Symbol	Meaning
Mono	One
Di	Two
Tri	Three
Tetra	Four
Penta	Five

REFRIGERANT TYPES AND TERMS

Abbreviation	Type	Meaning
CFC	Chlorofluorocarbon	Fully halogenated halocarbon, with no H
HCFC	Hydrochlorofluorocarbon	Halocarbon, containing H, Cl, F and C
HFC	Hydrofluorocarbon	Halocarbon, containing only H, F and C
HC	Hydrocarbon	Hydrocarbon, containing only H and C
PFC	Perfluorocarbon	Halocarbon, containing only F and C

GENERAL TERMS

Abbreviation	Meaning
AEL	Acceptable (allowable) Exposure Limit
EEL	Emergency Exposure Limit
GWP	Greenhouse Warming Potential
ODS	Ozone Depleting Substance
ODP	Ozone Depletion Potential
TEWI	Total Equivalent Warming Impact

Also, look at the Refrigerant Selection Guide for further information on terminology used with refrigerants and associated items.

Primary refrigerant types

All primary refrigerants fall into one of the three basic types, as explained below:

- **Pure**: Consists of one chemical compound. Examples of pure refrigerants include: R134a, R22, and R123.
- **Azeotropic**: Consists of a mixture of two or more chemical compounds, in this instant volatile substances. Azeotropic refrigerants are characterised by: remaining in the same proportions throughout the refrigeration cycle boiling at a constant temperature as the mixture evaporates.

  Examples include the R500 family, R500, R502, R503, R507, R508A, R508B, R509A.
- **Zeotropic (or near-azeotropic)**: Consists of a mixture of two or more chemical compounds, often known as **Blends**. They are a mixture of volatile substances, which changes in composition as it evaporates. Consequently the evaporating temperature changes (known as glide) as the more volatile component distils out of the less volatile components (fractionates). Examples include the R400 family, R401A, R404A etc.

  Two basic types of zeotrope exist; they are **Binary** and **Ternary Blends**. Binary blends consist of a mixture of two pure refrigerants; ternary blends consist of a mixture of three pure refrigerants.

Remember:

- In the workshop always wear: safety glasses, safety boots, hair protection and suitable clothing.
- Know where the First Aid station is.
- No running or horseplay.
- Be careful how you lift heavy objects.
- Be careful of tools with sharp points.
- Keep work area and floor area clear: then there will be fewer accidents.

Refrigerants and their effect on the ozone layer

The ozone layer – its function and benefit

The ozone layer absorbs ultra–violet radiation emitted by the sun, especially UVB radiation. UVB is that part of the solar/electromagnetic spectrum that is capable of harming biological organisms (ie. plant and animal life).

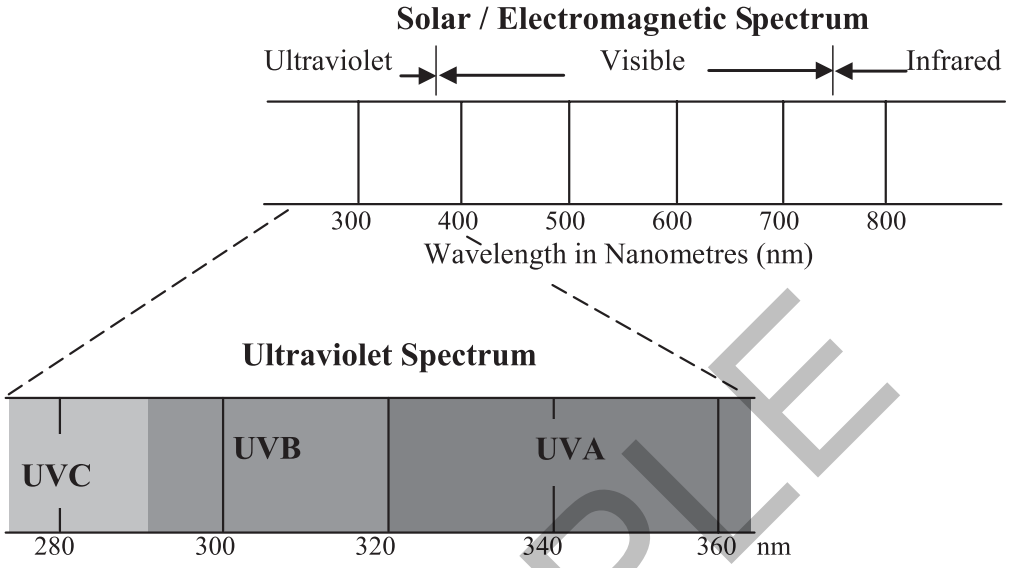


Diagram showing the ultraviolet portion of the solar spectrum

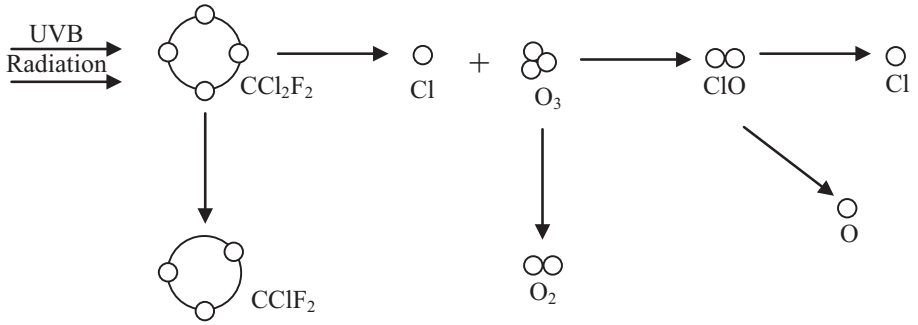
It is imperative that we protect the ozone layer from destruction or changes will take place that will have catastrophic consequences to the planet, and life, as we know it.

Position and composition of ozone *(ARAC, 4th Edition, Volume 1, Chapter 1)*

The ozone layer is positioned within the stratosphere, between 5 and 40 kilometres above the earth. Ozone is a triple bonded chemical that is a compound of oxygen (O_3). It has a distinctive pungent odour and is extremely poisonous.

Effects of ozone depleting substances *(ARAC, 4th Edition, Volume 1, Chapter 1)*

All refrigerants break down when they reach the stratosphere due to the affects of radiation, especially UVB. Refrigerants containing chlorine atoms breakdown releasing chloride ions and this free chloride acts as a catalyst thereby breaking down the ozone. The greater the breakdown of the ozone layer, the more UVB reaching the Earth's surface. The more UVB the greater the biological damage.



Alternative refrigerants *(ARAC, 4th Edition, Volume 1, Chapter 1)*

Australia is a signature to the Montreal Protocol, which set out a time frame for the phase out of ozone depleting substances. Alternative refrigerants are being developed that are environmentally friendly. They have low or nil ozone depletion and greenhouse warming potential and lower TEWI. (See the Refrigerant Selection Guide for further details).

New generation Ozone friendly refrigerants – High capacity, high pressure refrigerants

Originally these refrigerants were designed to replace ozone unfriendly ultra-low temperature refrigerants such as R13B1, as they were capable of operating at positive pressure at very low temperatures. Industry found a new use for these new generation ozone friendly high pressure refrigerants. They found that they where capable of replacing phasing out refrigerants like R22. These refrigerants are able to provide the further benefit of higher capacities as well as higher Energy Efficiency Rating (between 5 – 6%). The higher capacities and efficiencies enable the design of smaller, more compact equipment to be used but higher system operating pressures offset these benefits at normal operating conditions for R22 and similar refrigerants.

Higher system pressures mean that the system equipment, tools and containers for these refrigerants (ie R410A – see appendix 4 for further details on this refrigerant) have to be designed to much higher pressure ratings. The equipment that must be capable of withstanding these higher pressure ratings include:

- Shipping containers
- Cylinders
- Storage tanks
- Tank trailers
- Refrigeration and air conditioning equipment, including the copper tubing.
- Service tools – ie gauges, manifolds and gauge lines.