

Glossary and References

This Fact Sheet provides definitions of terms and acronyms used in OzonAction Kigali Fact Sheets together with a list of links to useful sources of information. The Fact Sheet is split into 3 sections:

- Part A:** Glossary of terms related to fluid properties
- Part B:** Glossary of other terms used in the Kigali Fact Sheets
- Part C:** References to further information sources

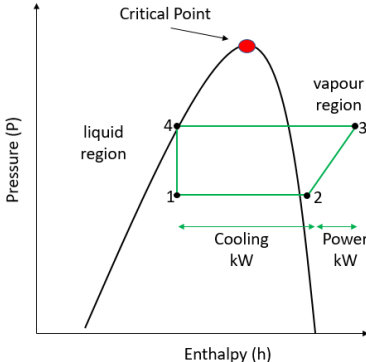
Part A: Fluid properties

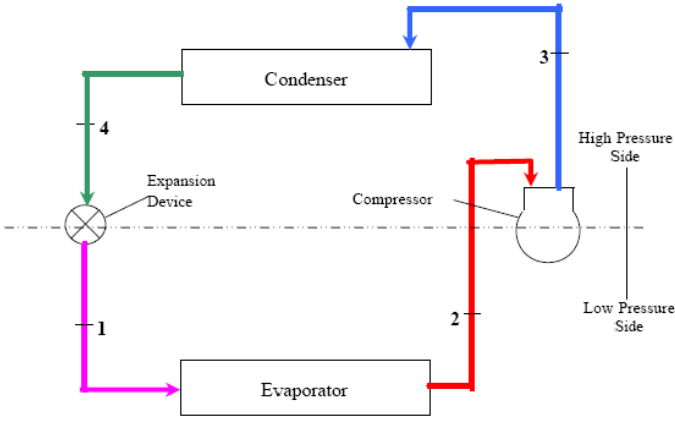
Term / Acronym	Definition
Fluorocarbons	
CFC	Chlorofluorocarbon: a family of chemicals containing chlorine, fluorine and carbon.
HCFC	Hydrochlorofluorocarbon: a family of chemicals containing hydrogen, chlorine, fluorine and carbon.
HFC	Hydrofluorocarbon: a family of chemicals containing hydrogen, fluorine and carbon.
HFO	Hydrofluoroolefin: a family of chemicals containing hydrogen, fluorine and carbon, with a double bond in the molecule.
Other fluids	
HC	Hydrocarbon: a family of chemicals containing hydrogen and carbon.
DME	Dimethyl ether: an HFC alternative used in foams and aerosols
Non-organic fluids	Non-organic chemicals e.g. ammonia (R-717) and CO ₂ (R-744)
Environmental impacts	
GHG	Greenhouse gas A gas that makes a contribution to global warming.
GWP	Global Warming Potential. The GWP compares the global warming impact of a gas to CO ₂ which is defined as having a GWP of 1. The GWPs of fluorocarbons are not certain and have been updated by scientists on a regular basis during the last 20 years. The Intergovernmental Panel on Climate Change has published a number of sets of GWPs in their Assessment Reports. The GWP values used in the Kigali Amendment and in the Kigali Fact Sheets are based on the 100 year AR 4 (Assessment Report 4) values.
GWP-weighted	An alternative term for tonnes CO ₂ e (see definition below)

Term / Acronym	Definition
ODP	Ozone Depletion Potential The ODP compares the impact on the ozone layer of a gas compared to CFC-11 which is defined as having an ODP of 1.
ODP tonnes	A way of presenting the total amount of ozone damage caused by a quantity of an ODS. ODP tonnes = tonnes of gas x ODP
ODS	Ozone Depleting Substance A gas that can cause damage to the stratospheric ozone layer.
Tonnes CO ₂ equivalent	A way of presenting the total contribution to climate change caused by a quantity of a GHG. Tonnes CO ₂ e = tonnes of gas * GWP
Safety related terms (from refrigeration safety standards)	
Toxicity classes	Refrigeration safety standards use 2 toxicity classes: A lower toxicity e.g. HFC-134a; HC-290 B higher toxicity e.g. R-717 (ammonia)
Flammability categories	Refrigeration standards (e.g. ISO 5149) use 4 flammability categories: 1 No flame propagation e.g. HFC-134a; R-410A 2L lower flammability e.g. HFC-32; HFO-1234yf; R-717 2 flammable e.g. HFC-152a 3 higher flammability e.g. HC-290; HC-600a Category 2L fluids are distinguished from Category 2 by having a low flame velocity (<10 cm/s). The 2L category has only recently been added to ISO 5149 and EN 378 and is not yet referred to in some older standards. Aerosol and foam markets use different flammability categories
BV	Burning velocity
EN	Euro-Norm
HoC	Heat of combustion
IEC	International Electrotechnical Commission
ISO	International Standards Organisation
LFL	Lower flammability limit
MEI	Minimum ignition energy
UFL	Upper flammability limit

Part B: Other terms used in the Kigali Fact Sheets

Term / Acronym	Definition
Article 5 (A5)	Parties meeting the definition given in Article 5 of the Montreal Protocol – in general these are economically developing countries
BAU	Business as usual
Cascade refrigeration cycle	A type of refrigeration cycle, usually used for very low temperature applications, using two separate circuits, each with a different refrigerant.
Condensing unit	A combination of a condenser and compressor. Used in split systems connected to an evaporator in a separate location.
Critical temperature	<p>The critical temperature is a property of a refrigerant fluid. Above the critical temperature there is no distinction between liquid and vapour.</p> <p>Most refrigerants operate below the critical temperature, with change of phase from liquid to vapour an important aspect of the system design.</p> <p>R-744 (CO₂) has a very low critical temperature (31°C) and when used in a vapour compression refrigeration cycle may need to reject heat at a temperature above the critical temperature.</p>
HAT	High ambient temperature. Used in reference to the HAT exemption in the Kigali Amendment, recognising the potential difficulties of designing air-conditioning systems for operation at very high ambient temperatures.
Hermetically sealed	A factory built refrigeration system with all brazed or welded joints. Usually this refers to domestic refrigerators or small stand-alone commercial systems.
HPMP	HCFC phase-out management plan
INDC	<p>Intended Nationally Determined Contribution</p> <p>A country's declared targets for reduction of GHG emissions under the Paris Agreement of the UN FCCC</p>
IPCC	Intergovernmental Panel on Climate Change
MAC	Mobile air-conditioning. This refers to any air-conditioning system used in a vehicle including MACs in cars, buses and trains.
MDI	Metered Dose Inhaler. A specialised aerosol used to deliver respiratory drugs. MDIs use HFC aerosol propellants.
MLF	Multi-lateral fund of the Montreal Protocol
NIK	Not-in-kind. Used to refer to alternative technologies that can replace HFC applications.
Non-Article 5 (non-A5)	Parties not meeting the definition given in Article 5 of the Montreal Protocol – in general these are economically developed countries

Term / Acronym	Definition
<p>Pressure-enthalpy (P-h) diagram</p>	<p>P-h diagrams are widely used by RACHP system designers to represent a refrigeration cycle and to illustrate performance parameters. The vertical axis shows the pressure and the horizontal axis shows “enthalpy” which is related to energy content of the refrigerant. Each refrigerant has a unique P-h diagram, the curved black line representing the boundary between liquid and vapour. The refrigerant under the curve is a mixture of liquid and vapour. The top of the curve is referred to as the critical point. The green lines plotted on the P-h diagram represent a vapour compression refrigeration cycle (see definition and diagram below, which uses the same 4 numbers to represent different parts of the cycle. The enthalpy difference between points 1 and 2 represent the amount of cooling being carried out and the enthalpy difference between points 2 and 3 represent the electric power used by the compressor.</p> 
PU foam	Polyurethane insulation foam
RACHP	Refrigeration, air-conditioning and heat pumps
Split system	<p>A type of refrigeration or air-conditioning system with a cooling evaporator in one location and a compressor / condenser in a different location.</p> <p>Usually used with reference to small air-conditioning systems that use an indoor unit and an outdoor unit.</p>
Stand-alone system	<p>Small factory built refrigeration units that simply need to be connected to an electricity supply. A domestic refrigerator is a stand-alone system. Various types of stand-alone unit are used in food retail and food service.</p>
Sub-critical refrigeration cycle	<p>A refrigeration system with both the evaporator and the condenser operating at a temperature below the critical temperature.</p> <p>Most refrigeration systems operate in this way.</p>
TEAP	Technical and Economic Assessment Panel of the Montreal Protocol
Transcritical refrigeration cycle	<p>A refrigeration system where the evaporator operates below the critical temperature, but the condenser operates as a gas cooler at above the critical temperature.</p> <p>CO₂ systems operate in transcritical mode when the ambient temperature is above around 20°C. They can operate in sub-critical mode at lower ambient temperatures.</p>
UN FCCC	United Nations Framework Convention on Climate Change

Term / Acronym	Definition
<p>Vapour compression cycle</p>	<p>Most refrigeration and air-conditioning systems operate with a vapour compression cycle. The simplest designs consist of 4 main components as shown in the diagram. Low temperature liquid refrigerant (at low pressure) is fed to an evaporator (point 1). It provides cooling as liquid is boiled to vapour (point 2). The vapour is compressed (point 3) and is then able to reject heat in a condenser as it turns from vapour to liquid (point 4). The high pressure liquid passes through an expansion device where the pressure and temperature fall (and a proportion of the liquid flashes off into vapour). The cycle is then repeated.</p>  <p>The diagram illustrates the vapour compression cycle with four main components: a Condenser at the top, an Expansion Device on the left, a Compressor on the right, and an Evaporator at the bottom. The cycle is divided into a High Pressure Side (top and right) and a Low Pressure Side (bottom and left). The refrigerant flows clockwise through the cycle. Point 1 is at the evaporator inlet, point 2 is at the evaporator outlet, point 3 is at the compressor inlet, and point 4 is at the condenser inlet. The refrigerant is shown as a liquid at point 1, a vapour at point 2, a compressed vapour at point 3, and a liquid at point 4.</p>
<p>VRF</p>	<p>Variable refrigerant flow: a type of split system air-conditioning system used in medium and large sized air-to-air applications. One or more condensing units are connected to a number of indoor units (up to 64). Each indoor unit can be selected for either cooling or heating. Variable speed compressors provide control flexibility.</p>
<p>XPS foam</p>	<p>Extruded polystyrene insulation foam</p>

Part C: References and Source Material

A significant amount of useful background material can be found on the following two websites:

UN Environment OzonAction Website: www.unep.org/ozonaction

Montreal Protocol Ozone Secretariat Website: www.ozone.unep.org

From the **Montreal Protocol Ozone Secretariat**, some documents of particular interest:

Full text of the Montreal Protocol, including the Kigali Amendment:

<http://ozone.unep.org/en/handbook-montreal-protocol-substances-deplete-ozone-layer/5>

15 Technical Fact Sheets about low GWP alternatives to HFCs

<http://ozone.unep.org/en/hfc-management-documents-2014-onwards>

Briefing Note on Ratification of the Kigali Amendment:

http://conf.montreal-protocol.org/meeting/oewg/oewg-39/presession/briefingnotes/ratification_kigali.pdf

Frequently asked questions relating to the Kigali Amendment to the Montreal Protocol

http://ozone.unep.org/sites/ozone/files/pdfs/FAQs_Kigali_Amendment.pdf

What's next for the Kigali deal to curb potent greenhouse gases?

<http://web.unep.org/newscentre/whats-next-kigali-deal-curb-potent-greenhouse-gases>

Decision XXVII/4: TEAP Task Force Update Report Further Information on Alternatives to Ozone-Depleting Substances

http://conf.montreal-protocol.org/meeting/mop/mop-28/presession/Background%20Documents%20are%20available%20in%20English%20only/TEAP_TFXXVII-4_Report_September2016.pdf

From **UNEP OzonAction**, some documents of particular interest:

Good Servicing Practices Phasing out HCFCs in the Refrigeration and Air-Conditioning Servicing Sector (2015)

<http://www.unep.fr/ozonaction/index.asp#>

GTZ Proklima, Good Practices in Refrigeration, second edition 2010

http://www.unep.fr/ozonaction/information/mmcfiles/7431-e-GTZ_refrigeration_manual_2010.pdf

Safe Use of HCFC Alternatives in Refrigeration and Air-conditioning: An Overview for Developing Countries (2015)

<http://www.unep.fr/ozonaction/information/mmcfiles/7740-e-SafeUseofHCFCAlternativesinRefrigerationandAir-conditioning.pdf>

<p>International Standards in Refrigeration and Air-Conditioning - An introduction to their role in the context of the HCFC phase-out in developing countries (2014)</p> <p>http://www.unep.org/ozonaction/Portals/105/documents/7679-e-International_Standards_in_RAC.pdf</p>
<p>National Certification Schemes for Refrigeration and Air-Conditioning Service Technicians: Examples of strategies and requirements for their establishment and operation. (2015)</p> <p>http://www.unep.org/ozonaction/Portals/105/documents/7756-e-UNEP_ASHRAE_National_Certification_Schemes.pdf</p>
<p>Lower-GWP Alternatives in Commercial and Transport Refrigeration: An Expanded Compilation of Propane, CO₂, Ammonia and HFO Case Studies (2016)</p> <p>http://www.unep.org/ozonaction/Portals/105/documents/oewg37/1611979_UNEP%20CCAC_2016.pdf</p>
<p>Barriers to the use of Low-GWP Refrigerants in Developing Countries & Opportunities to Overcome These (2010)</p> <p>http://www.unep.fr/ozonaction/information/mmcfiles/7476-e-Report-low-GWPbarriers.pdf</p>
<p>Establishing an HCFC Import Quota System. 2012</p> <p>http://www.unep.fr/ozonaction/information/mmcfiles/7531-e-HCFC_Quota_system.pdf</p>

ODP values used

The Montreal Protocol has incorporated agreed ODP ‘reporting values’ into the text of the Protocol which provides standardisation. The ODP values used in these factsheets are taken from text of the Protocol. The 2014 *Report of the Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee* (2014 Assessment) is used as 2nd priority.

<http://ozone.unep.org/sites/ozone/files/Publications/Handbooks/Montreal-Protocol-English.pdf>

GWP values used

Following the 2016 Kigali Amendment, the Montreal Protocol has adopted standard ‘reporting values’ for GWPs of HFCs and selected HCFCs and CFCs which have been incorporated into the text of the Protocol (in Annexes A, C and F). The GWP values used in these factsheets are taken from the text of the Protocol, where available. The 2014 *Report of the Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee* (2014 Assessment) is used as a 2nd priority (100 year time horizon).

<http://ozone.unep.org/sites/ozone/files/documents/RTOC-Assessment-Report-2014.pdf>

GWP values for HFO-1234yf and HFO-1234ze(E) are taken from the World Meteorological Organization Scientific Assessment of Ozone Depletion: 2010

http://ozone.unep.org/en/Assessment_Panels/SAP/Scientific_Assessment_2010/00-SAP-2010-Assement-report.pdf

For some hydrocarbons and HFOs, GWP values are taken from the Fourth Assessment Report adopted by the Intergovernmental Panel on Climate Change

https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2.html

In some cases (e.g. HC-601, HC-601a and cyclopentane), the widely accepted or “default” values of GWPs are applied, although not sourced from the literature.

Values will be updated as required.

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