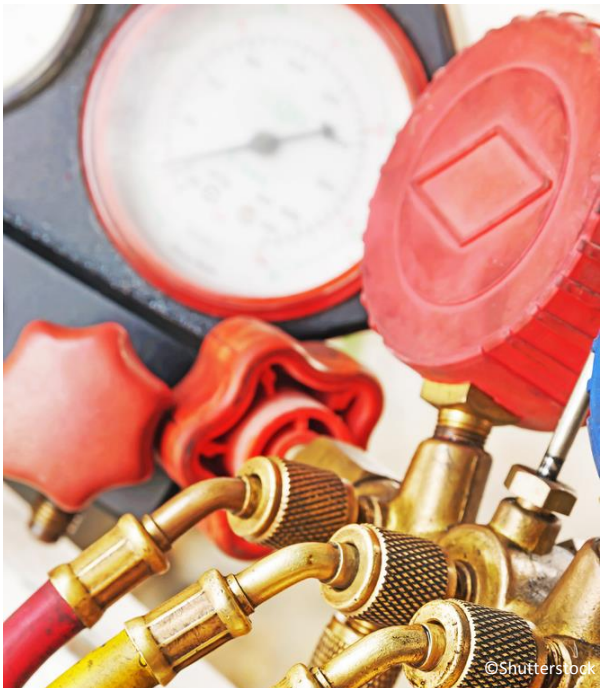
Refrigerant Blends: Calculating Global Warming Potentials

INTRODUCTION

The number of single component refrigerants with different thermodynamic properties suitable for different types of equipment is limited. Growing demand for refrigeration and air-conditioning with diversified applications has led to a continued search for suitable refrigerant blends. A number of such blends have been developed by mixing two or more single component refrigerants in different proportions. The resulting blend, has entirely different properties from that of its components.

While it is common to use the term '*blends*' in the context of the Montreal Protocol, it is important to note that the term '*mixtures*' is also used to describe refrigerants which are comprised of more than one component. The terminology '*mixtures*' is specifically used in the World Customs Organization classification Harmonized Commodity Description and Coding System, also known as the Harmonized System (i.e. HS codes).



TYPES OF REFRIGERANT BLEND

A refrigerant blend or mixture of refrigerants is made up of two or more single component refrigerants. These blends can be of two types: 'Azeotropic' and 'Zeotropic'

Azeotropic blends

These blends behave like a single component refrigerant, in that they boil and condense at a constant temperature at a given pressure. In the ASHRAE refrigerant designation, these blends are assigned numbers (or ASHRAE codes) in the 500 series, e,g R-509A.

Zeotropic blends

These blends boil and condense through a range of temperatures at a given pressure. This range of temperatures is called the 'temperature glide'. Zeotropic blends are assigned ASHRAE codes in the 400 series, e.g. R-401A, R-406A, etc.

GWP

Global warming potential (GWP) is a measure which enables comparisons of the global warming effects of different gases. It compares the amount of heat trapped by a certain mass of a gas to the amount of heat trapped by a similar mass of carbon dioxide over a specific period of time. Carbon dioxide was chosen by the Intergovernmental Panel on Climate Change (IPCC) as the reference gas and its GWP is taken as 1.

The higher the GWP value, the more that particular gas warms the Earth compared to carbon dioxide.

GWP values for ozone depleting substances can range, for example, from 2 up to about 14,000. The GWPs of commonly used HFCs can range from <1 to about 12,500.

GWP values for some common refrigerants

Substance	GWP value†
CFC-12	10 300
HCFC-22	1780
HCFC-124	527
HCFC-142b	2070
HFC-143a	5080
HFC-152a	148
HFC-23	12 500
HFC-32	704
HFC-125	3450
HFC-134a	1360
HFC-1234ze(E)	<1
HFC-1234yf	<1
R-290 (Propane)	5

CALCULATION OF GWP OF BLENDS

As refrigerant blends are formed simply by mixing two or more single component refrigerants, the GWP of a refrigerant blend is the mass-weighted average of GWPs of individual components in the blend. That is, to calculate the GWP of a blend, one simply adds the GWP of the individual components in proportion to their mass.

The GWP of blends are therefore calculated as follows:

GWP of Blend	=	Proportion by % mass of component **A** x GWP of **A**	+	Proportion by % mass of component **B** x GWP of **B**	+	Proportion by % mass of component **C** x GWP of **C**

Example: R-401A

R-401A is a blend composed of **53%** HCFC-22, **13%** HFC-152a and **34%** HCFC-124 (mass %). The GWP value for HCFC-22 is 1780, for HFC-152a is 148) and for HCFC-124 is 527.

ODP of Blend (R-401A)	=	Proportion by mass of **HCFC-22** x ODP of **HCFC-22**	+	Proportion by mass of **HFC-152a** x ODP of **HFC-152a**	+	Proportion by mass of **HCFC-124** x ODP of **HCFC-124**
	=	**0.53 (53%)** x 1780	+	**0.13 (13%)** x 148	+	**0.34 (34%)** x 527
	=	943.4	+	19.2	+	179.2
	=	1141.8 (rounded to 1100)				

SOME EXAMPLE BLEND GWPs

ASHRAE designation	Composition, substances*	Composition (Mass %)	GWP of components†	Blend GWP
Zeotropic Refrigerant Blends				
R-401A	HCFC-22/HFC-152a/HCFC-124	53/13/34	1780/148/527	1100
R-404A	HFC-125/HFC-143a/HFC-134a	44/52/4	3450/5080/1360	4200
R-407A	HFC-32/HFC-125/HFC-134a	20/40/40	704/3450/1360	2100
R-407C	HFC-32/HFC-125/HFC-134a	23/25/52	704/3450/1360	1700
R-407F	HFC-32/HFC-125/HFC-134a	30/30/40	704/3450/1360	1800
R-410A	HFC-32/HFC-125	50/50	704/3450	2100
R-417A	HFC-125/HFC-134a/HC-600	46.6/50/3.4	3450/1360/4	2300
R-444B	HFC-32/HFC-1234ze(E)/HFC-152a	41.5/48.5/10	704/1/148	310
R-446A	HFC-32/HFC-1234ze(E)/HC-600	68/29/3	704/1/4	480
R-449A	HFC-134a/HFC-125/HFC-1234yf/HFC-32	26/25/25/24	1360/3450/1/704	1400
R-452A	HFC-1234yf/HFC-32/HFC-125	30/11/59	1/704/3450	2100
Azeotropic Refrigerant Blends				
R-507A	HFC-125/HFC-143a	50/50	3450/5080	4300
R-513A	HFC-1234yf/HFC-134a	56/44	1/1360	600

Notes

* HCFC = hydrochlorofluorocarbon, HFC = hydrofluorocarbon, PFC = perfluorocarbon, HC = hydrocarbon

† The GWP values used in this factsheet are taken from the *2014 Scientific Assessment of Ozone Depletion, World Meteorological Organization* *(100 year time horizon values)*. These are the same values as reported in the *Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee 2014 Assessment Report*, which also provides (rounded) GWP values for a range of refrigerant blends. *http://ozone.unep.org/en/assessment-panels*

National/specific reporting requirements may necessitate the use of GWP values from other sources (e.g. IPCC Assessment Reports).

OzonAction
United Nations Environment Programme (UNEP)
Division of Technology, Industry and Economics
1 rue Miollis, Building VII
Paris 75015, France

www.unep.org/ozonaction
ozonaction@unep.org

OZFS/16/04-10

Prepared by: R.S. Agarwal & Ezra Clark