

An Explanation of the Refrigerant Designation Numbering System by Robert P. Scaringe, Ph.D., P.E. and Lawrence R. Grzyll

Because the chemical names of typical refrigerants are long and complex, a method of referring to refrigerants by number was developed by DuPont. The numbering system was released for general use in 1956 and has become an industry standard. A complete discussion of the number designation and safety classification of the refrigerants is presented in ASHRAE Standard 34-1989. Briefly, the method of designating a refrigerant by number is as follows. (Note that the numbering system begins on the right.)

First digit on the right	= Number of fluorine atoms
Second digit from the right	= Number of hydrogen atoms plus one
Third digit from the right	= Number of carbon atoms minus one (not used when equal to zero)
Fourth digit from the right	Number of unsaturated carbon-carbon bonds in the compound (not used when equal to zero)

When bromine is present in place of all or part of the chlorine, the same rules apply except that the capital letter "B" after the designation for the parent compound shows the presence of the bromine (Br). The number following the letter "B" shows the number of Bromine atoms present.

The lower-case letter that follows the refrigeration designation refers to the form of the molecule when different forms (isomers) are possible, with the most symmetrical form indicated by the number alone. As the form becomes more and more unsymmetrical, the letters a, b, and c (lower case) are appended (For example, HFC-134a).

If all of the carbon bonds are not occupied by fluorine or hydrogen atoms, the remainder are attached to chlorine.

Because the structure of a refrigerant, whether CFC, HCFC, or HFC, has become so important, they are often referred to in this way. For example, R-12 is CFC-12; R-22 is HCFC-22; R-134a is HFC-134a. This is simply a way of pointing out their chemical structure and therefore their relative ozone-depletion potential. Table 1 contains a complete list of refrigerants and their chemical formulation. Some examples are presented below.

Example 1. CHClF₂

Number of F atoms = 2

Number of H atoms + 1 = 2

Number of C atoms - 1 = 0

The refrigerant in Example 1 is designated HCFC-22. Because carbon has four bonds and the total of F and H = 3, there is one Cl atom.

Example 2. CCl₂FCClF₂

Number of F atoms = 3

Number of H atoms + 1 = 1

Number of C atoms – 1 = 1

The refrigerant in Example 2 is designated CFC-113. Because two carbon atoms connected together have six bonds remaining and the total of F and H = 3, there are three Cl atoms present.

Example 3. The Designation of Refrigeration Isomers

Isomer	Formula
CFC-216	CF ₃ CCl ₂ CF ₃
CFC-216a	CF ₂ ClCF ₂ CF ₂ Cl
CFC-216b	CF ₂ ClCFCICF ₃
CFC-216c	CFCl ₂ CF ₂ CF ₃

Table 1. Refrigerant Numbering System

METHANE SERIES			
NAME	FORMULA	SAFETY GROUP ^a	
		1988	1993
R-10	CCl ₄	2	B1
R-11	CCl ₃ F	1	A1
R-12	CCl ₃ F ₂	1	A1
R-12B1	CBrClF ₂		
R-12B2	CBr ₂ F ₂		
R-13	CClF ₃	1	A1
R-13B1	CBrF ₃	1	A1
R-14	CF ₄	1	A1
R-20	CHCl ₃		
R-21	CHCl ₂ F	2	B1
R-22	CHClF ₂	1	A1
R-22B1	CHBrF ₂		

R-23	CHF ₃		
R-30	CH ₂ Cl ₂	2	B2
R-30B1	CH ₂ BrCl		
R-31	CH ₂ ClF		
R-32	CH ₂ F ₂		
R-40	CH ₃ Cl	2	B2
R-41	CH ₃ F		
R-50	CH ₄	3a	A3

ETHANE SERIES

110	CCl ₃ CCl ₃		
111	CCl ₃ CCl ₂ F		
112	CCl ₂ FCCl ₂ F		
112a	CCl ₃ CClF ₂		
113	CCl ₂ FCClF ₂	1	A1
113a	CCl ₃ CF ₃		
114	CClF ₂ CClF ₂	1	A1
114a	CCl ₂ FCF ₃		
114B2	CBrF ₂ CBrF ₂		
115	CClF ₂ CF ₃	1	A1
116	CF ₃ CF ₃		
120	CHCl ₂ CCl ₃		
121	CHCl ₂ CFCI ₂		
121a	CHFCI ₂ CCl ₃		
122	CHCl ₂ CClF ₂		
122a	CHClFCCl ₂ F		
122b	CHF ₂ CCl ₃		
123	CHCl ₂ CF ₃		B1
123a	CHClFCClF ₂		
123b	CHF ₂ CCl ₂ F		
124	CHClFCF ₃		A1b
124a	CHF ₂ CClF ₂		
125	CHF ₂ CF ₃		A1b
130	CHCl ₂ CHCl ₂		
130a	CCl ₃ CH ₂ Cl		

131	CHClFCHCl ₂		
131a	CH ₂ ClCFCI ₂		
131b	CH ₂ FCCL ₃		
132	CHClFCHClF		
132a	CHCl ₂ CHF ₂		
132b	CH ₂ ClCCIF ₂		
132c	CH ₂ FCCL ₂ F		
133	CHFCICHF ₂		
133a	CH ₂ ClCF ₃		
133b	CH ₂ FCCLF ₂		
134	CHF ₂ CHF ₂		
134a	CH ₂ FCFF ₃		A1
140	CH ₂ ClCHCl ₂		
140a	CH ₃ CCl ₃		
141	CH ₂ ClCHClF		
141a	CH ₂ FCHCl ₂		
141b	CH ₃ CCl ₂ F		
142	CH ₂ ClCHF ₂	3b	
142a	CH ₂ FCHClF		
142b	CH ₃ CCIF ₂	3b	A2
143	CH ₂ FCHF ₂		
143a	CH ₃ CF ₃		
150	CH ₂ ClCH ₂ Cl		
150a	CH ₃ CHCl ₂		
151	CH ₂ ClCH ₂ F		
151a	CH ₃ CHClF		
152	CH ₂ FCH ₂ F		
152a	CH ₃ CHF ₂	3b	A2
160	CH ₃ CH ₂ Cl		
161	CH ₃ CH ₂ F		
170	CH ₃ CH ₃	3a	A3

PROPANE SERIES

216	CF ₃ CCl ₂ CF ₃
216a	CCIF ₂ CF ₂ CCIF ₂
216b	CF ₂ ClCFCICF ₃

216c	$\text{CFCl}_2\text{CF}_2\text{CF}_3$		
218	$\text{CF}_3\text{CF}_2\text{CF}_3$		A1
290	$\text{CH}_3\text{CH}_2\text{CH}_3$	3a	A3
C316	$\text{C}_4\text{Cl}_2\text{F}_6$		
C317	C_4ClF_7		
C318	C_4F_8	1	A1
600	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	3a	A3
600a	$\text{CH}(\text{CH}_3)_3$	3a	A3
610	$\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$		
611	HCOOCH_3	2	B2
630	CH_3NH_2		
631	$\text{C}_2\text{H}_5\text{NH}_2$		
702	H_2		A3
704	He		A1
717	NH_3	2	B2
718	H_2O		A1
720	Ne		A1
728	N_2		A1
729	Air		
732	O_2		
740	A		A1
744	CO_2	1	A1
744A	N_2O		
764	SO_2	2	B1
1112a	$\text{CCl}_2=\text{CF}_2$		
1113	$\text{CClF}=\text{CF}_2$		
1114	$\text{CF}_2=\text{CF}_2$		
1120	$\text{CHCl}=\text{CCl}_2$		
1130	$\text{CHCl}=\text{CHCl}$		
1132A	$\text{CH}_2=\text{CF}_2$		
1140	$\text{CH}_2=\text{CHCl}$		B3
1141	$\text{CH}_2=\text{CHF}$		
1150	$\text{CH}_2=\text{CH}_2$	3a	A3
1270	$\text{CH}_3\text{CH}=\text{CH}_2$	3a	A3

ZEOTROPES SERIES

400	R-12/114		A1
401	R-22/152a/124	A1	
402	R-125/290/22		A1

More Information on Blends

AZEOTROPES^c

500	R-12/152a(73.8/26.2) 1	A1
501d	R-22/12(75/25)	A1
502	R-22/115(48.8/51.2) 2	A1
503	R-23/13(40.1/59.9)	
504	R-32/115(48.2/51.8)	
505d	R-12/31(78.0/22.0)	
506	R-31/114 (55.1/44.9)	

a Both 1988 and 1993 ASHRAE 34 safety group classifications are listed. The new ASHRAE 34a-1993 standard includes two alphanumeric characters. The capital letter indicates the toxicity where A signifies non-toxic and B signifies toxic. The numeral denotes flammability where Class 1 indicates no flame propagation. Class 2 signifies refrigerants having moderate flammability (a lower flammability limit of more than 0.10 kg/m³ at 21°C and 101 kPa and a heat of combustion of less than 19,000 kJ/kg). Class 3 signifies refrigerants having high flammability (an LFL of less than or equal to 0.10 kg/m³ at 21°C and 101 kPa or a heat of combustion greater than or equal to 19,000 kJ/kg).

b Toxicity classification is based on recommended exposure limits provided by chemical suppliers. This rating is provisional and will be reviewed when toxicological testing is completed.

c All azeotropic refrigerants, by their nature, exhibit some segregation of components at conditions of temperature and pressure other than those at which they were formulated. The exact extent of this segregation depends on the particular azeotrope and hardware system configuration.

d The exact composition of this azeotrope is in question and additional experimental studies are needed.