Freon™ 410A

Refrigerant (R-410A)

Replacement for R-13B1: Properties and Operating Characteristics of Freon™ 410A Refrigerant in Very Low Temperature Systems

Technical Information

Freon™ 410A provides comparable performance to R-13B1 in most very low temperature, (VLT) applications. R-13B1 is an ozone-depleting refrigerant, and production has ceased as mandated by the Montreal Protocol and other legislation. Freon™ 410A offers similar performance to R-13B1 in existing systems, however, some equipment modifications may be required. In addition, new equipment can be designed to take advantage of the refrigeration properties of Freon™ 410A. This bulletin will discuss the general properties and operating characteristics of Freon™ 410A in VLT refrigeration applications that currently use R-13B1. These systems typically use single or multistage compressors, and many use cooling water, chilled water, or air for the condenser. Typical evaporator temperature range is from –40 °C (–40 °F) to –65 °C (–85 °F). In addition, some cascade systems use R-13B1 in the low stage. For these systems, Freon™ 95 (R-508B) is a better replacement than Freon™ 410A.

Properties

Freon™ 410A is safe to use when proper storage and handling practices are followed. It is a nonflammable, low toxicity mixture of HFC-32 and HFC-125 (50/50 wt%). Freon™ 410A has been classified as A1 by ASHRAE and assigned the ASHRAE number of R-410A. It has been listed as acceptable by the U.S. Environmental Protection Agency (EPA) under the Significant New Alternatives Program (SNAP). **Table 1** compares some of the general properties of Freon™ 410A and R-13B1.

Operating Characteristics

Freon™ 410A provides comparable performance to R-13B1 in certain VLT applications. **Table 2** summarizes the operating characteristics of Freon™ 410A and R-13B1 under conditions experienced in a VLT system.

Commercial Availability

Freon™ 410A is commercially available and can be obtained throughout the world through Chemours' refrigerant distribution system.

Retrofit Considerations

R-13B1 is currently used in a variety of VLT refrigeration systems, including freeze driers and environmental chambers. These types of systems typically have unique designs and are relatively complex compared to standard refrigeration equipment. Because of this, it is difficult to provide specific retrofit guidelines. A clear understanding of the equipment design and a working knowledge of the refrigerant properties are important for a successful retrofit.

CAUTION: Freon™ 410A will operate at higher discharge pressure than R-13B1; in some systems, this pressure may be significantly higher. Before retrofitting an existing piece of refrigeration equipment to any alternate refrigerant, always confirm the design working pressure with the OEM. Failure to do so could result in exceeding the OEM's maximum design working pressure and personnel injury or death.

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- Consult the equipment manufacturer and/or a knowledgeable contractor for advice when considering a retrofit.
- When retrofitting to Freon™ 410A, an HFC-type retrofit procedure (such as the Chemours' Freon™404A procedure) can be used as a general guideline.
- Before beginning the retrofit, the unit should be in good operating condition. Freon™ 410A will not correct pre-existing problems.
  - Baseline performance data should be recorded before and after the retrofit.
- The existing oil should be replaced with a high quality polyol ester (POE) lubricant, suitable for use in VLT systems. Residual mineral oil should be less than 5%. This might require three lubricant flushes.
- Because POEs are better solvents than mineral oils, some accumulated sludge in the system may be dissolved into the refrigerant/oil stream—depending on the age and condition of the system. Filters may need to be changed more frequently during the initial runs after the retrofit.
- Existing driers should be replaced with driers designed for HFC refrigerants.
- The mass flow rate of Freon™ 410A will be much lower than R-13B1 for a given cooling load. It may be necessary to reduce the orifice size of the TXV to ensure adequate control. Electronic expansion valves have demonstrated good performance with Freon™ 410A in these applications.
- O-rings have not been changed in most retrofits monitored by Chemours. However, based on the age and condition of the O-rings, they are a possible leak source. A thorough leak test should be conducted before and after the retrofit.
- Below evaporator temperatures of about –65 °C (–85 °F), the cooling capacity of Freon™ 410A is reduced vs. R-13B1. A thorough system evaluation is required at these very low temperatures.
- The compression ratio for Freon™ 410A will be higher than R-13B1; this could increase brake horsepower requirements.
- Recycle or recovery machines designed for use with high pressure refrigerants can be used with Freon™ 410A. However, mixing refrigerants should be avoided.

Table 1. General Properties of Freon™ 410A and R-13B1

Physical Property	Unit	Freon™ 410A	R-13B1
Molecular Weight, avg.	g/mol	72.58	148.92
Vapor Pressure at 25 °C (77 °F)	kPa abs psia	1652.9 239.73	1618.9 234.8
Boiling Point (1 atm)	°C °F	−51.53 −60.76	−57.8 −72.0
Critical Temperature	°C °F	72.13 161.83	67.0 152.6
Critical Pressure	kPa abs psia	4926.1 714.5	3964.5 575
Critical Density	kg/m^{3*} lb/ft^3	488.90 30.52	745 46.5
Liquid Density at 25 °C (77 °F)	kg/m^3 lb/ft^3	1062.4 66.32	1538 96
Density, Satd. Vapor at 25 °C (77 °F)	kg/m^3 lb/ft^3	65.92 4.12	132.43 8.27
Specific Heat, Liquid at 25 °C (77 °F)	kJ/kg·K Btu/lb·°F	1.84 0.440	0.870 0.208
Specific Heat, Vapor at 25 °C (77 °F)	kJ/kg·K Btu/lb·°F	0.823 0.199	0.468 0.112
Heat of Vaporization at Normal Boiling Point	kJ/kg Btu/lb	276.2 118.8	118.8 51.1
Flammability Limit in Air (1 atm)	vol%	None	None
Ozone Depletion Potential (ODP)	CFC-11 = 1.0	0	10
Inhalation Exposure Limit*	ppm (8- and 12-hr TWA)	1000	1000

*The exposure limit is calculated based on the Chemours Acceptable Exposure Limit (AEL) for each component of the refrigerant blend. AEL is an airborne exposure limit established by Chemours that specifies time-weighted average concentrations to which nearly all workers may be repeatedly exposed without adverse effects during an 8- or 12-hr workday and a 40-hr workweek.

Table 2. Theoretical Performance Comparison of Freon™ 410A and R-13B1

Physical Property	Freon™ 410A	R-13B1
Cooling Capacity (R-13B1 = 1)	0.88	1
Energy Efficiency (R-13B1 = 1)	1.02	1
Suction Pressure, kPa (psia)	104 (15)	138 (20)
Discharge Pressure	1484 (215)	1470 (213)
Discharge Temperature	128 (263)	92 (197)

Assumed Operating Conditions:

Evaporator Temp. = 51 °C (−60 °F)
Condensing Temp. = 21 °C (70 °F)
Subcooling = 5.5 °C (10 °F)
Superheat = 22 °C (40 °F)

Compressor Properties:
Single Stage Compressor
Clearance Volume = 3%
Isentropic Efficiency = 0.7

Note: This is a theoretical comparison, and actual performance will vary depending on the operating conditions, specific equipment design, and overall mechanical condition of the system.

For more information on Freon™ refrigerants, visit freon.com

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