DuPont

Suva®
refrigerants

ART-29

Suva HP62 Refrigerant—A Comparison with HCFC-22 Refrigerant for New Equipment

Introduction

Suva HP62 refrigerant is a member of the family of Suva refrigerant alternatives to CFCs. When compared to HCFC-22, Suva HP62 offers superior properties for both low temperature and medium temperature refrigeration applications. Suva HP62 replaces and maintains many of the favorable properties of CFC-based R-502, the product it is designed to replace.

Like all Suva refrigerants, Suva HP62 is nonflammable, noncorrosive, and has a very low level of toxicity. Its atmospheric boiling point is –46.5°C (–51.6°F). It has no ozone depletion potential, and a direct halocarbon global warming potential only one-fourth that of R-502. The performance of Suva HP62 in refrigeration service combines many of the favorable features customers have previously encountered with R-502 and HCFC-22. For example, capacity is higher than with HCFC-22, while compressor discharge temperatures are lower than those found with R-502. In refrigerant-cooled hermetic compressors, motor cooling is better than will be found using HCFC-22.

Suva HP62 has become established as an improved low temperature refrigerant especially for ice cream and frozen food display cases, frozen food processing and storage, transport refrigeration, and industrial applications. Many field installations are in operation, and equipment designed or accepted for operation with Suva HP62 is available from many manufacturers.

Some of the advantages of Suva HP62 over HCFC-22 include:

For low temperature applications (below –17.8°C [0°F] evaporating temperature)

- Greater capacity for a given compressor
- Higher Btu/W·hr
- Lower compression ratio
- Higher refrigerant flow rate
- Lower discharge temperature
- Lower motor winding temperature
- Lower oil temperature
- Better system stability
- Greater cooling capacity per invested dollar
- More effective when subcooling used

For medium temperature applications (–17.8 to –1.1°C [0 to 30°F] evaporating temperature)

- Greater capacity for a given compressor
- Lower compression ratio
- Higher refrigerant flow rate
- Lower discharge temperature
- Lower motor winding temperature
- Lower oil temperature
- Better system stability

For high temperature applications (above –1.1°C [30°F] evaporating temperature)

- Higher refrigerant flow rate
- Lower compression ratio
- Lower discharge temperature
- Lower motor winding temperature
- Lower oil temperature

Refrigerating Properties

The basis for the rapid acceptance of Suva HP62 in commercial refrigeration applications lies in its thermodynamic and related properties. Some of the properties that make Suva HP62 favorable over R-502 or HCFC-22 are discussed below.

Thermodynamic Properties

Perhaps the greatest difference between Suva HP62 and HCFC-22 is in the heat produced during adiabatic compression. The more complex molecular structure in Suva HP62 leads to a greater share of the mechanical energy applied during compression being absorbed as internal energy and a smaller portion being available for an increase in the heat content of the gas. The lower gas discharge temperatures experienced with Suva HP62 are due in part to this lower heat of compression.

Inlet Gas Temperature

The temperature of the gas as it enters the compressor cylinder should be used for locating the specific volume and heat content in the thermodynamic tables. These properties are needed to calculate refrigeration capacity and horsepower.

The inlet gas temperature with Suva HP62 is always lower than with HCFC-22 for the same system. The heat capacity of Suva HP62 is higher than that of HCFC-22. As a result, the heat developed in a compressor is absorbed by Suva HP62 with a lower rise in temperature. This difference is found with all types of compressors, but is especially noticeable in hermetic units where the motor is cooled by the suction gas.

Discharge Temperature

One of the most important properties of Suva HP62 for commercial refrigeration is its low compressor gas discharge temperatures. In either theoretical or practical comparisons, the compressor discharge temperatures seen for Suva HP62 are significantly lower than for HCFC-22. The differences are greatest at lower evaporator temperatures.

The lower discharge temperatures experienced with Suva HP62 translate directly into reduced compressor wear, better lubricant stability, and less maintenance problems. Decreases of even a few degrees is important. Decomposition of the lubricant circulating with the refrigerant is reduced. Deposits of varnish or sludge from decomposition of the lubricant are also reduced. The danger of discharge valve failure is less. The pressure drop through valves and lines is reduced, since the volume of gas is directly related to the temperature. All of these factors contribute to longer operating life for the compressor.

Capacity

Table 1 shows calculated comparisons of refrigerant performance for Suva HP62 versus HCFC-22. Calculated cycles such as used for the table do not take into account two factors that favorably affect the behavior of Suva HP62.

- Compression ratio—The compression ratio of Suva HP62 is well below that of HCFC-22, and lower compression ratio means higher volumetric efficiency.
- Heating of suction gas in the compressor—Effects of clearance volume and other sources of compressor inefficiency are less for Suva HP62. The higher weight rate of flow and the higher heat capacity of Suva HP62 combine to reduce the temperature rise of the suction gas as it picks up heat from the compressor body, and in the case of hermetic compressor, from the compressor motor. This is true despite the fact that Suva HP62 does a better job of cooling these parts than HCFC-22.

Both of these factors increase the actual capacity of Suva HP62 beyond the calculated values. Because the various factors affecting compressor efficiency are based on an individual machine design, the extent of compressor performance improvements will vary with compressor size and design.

Because of its lower discharge temperature, the use of Suva HP62 eliminates the need for liquid injection required in single-stage HCFC-22 compressors operating at low evaporator temperatures. Liquid injection uses some cooling capacity to cool the compressor. Therefore, Suva HP62 provides an additional capacity improvement in addition to those discussed above.

Additional benefit can be obtained from the use of a suction-liquid heat exchanger. The suction-liquid heat exchanger enables most of the cooling capacity available from superheating of the suction gas to be retained. Because of the relatively higher mass flow rates and heat capacity characteristic of Suva HP62, use of a suction-liquid heat exchanger is an important factor in realizing all of the potential capacity advantage offered by the new refrigerant.

Table 1
Comparison of Refrigerant Properties

Conditions: 43.3°C (110°F) condensing temperature
5.6°C (10°F) subcooling
18.3°C (65°F) suction temperature
0.7 compressor isentropic efficiency
No clearance volume effect
Based on one ton load

	Evaporating Temperature					
	–40°C (–40°F)		–17.8°C (0°F)		4.4°C (40°F)	
	R-22	Suva HP62	R-22	Suva HP62	R-22	Suva HP62
Net Refrig. Effect, Btu/lb	61.02	37.01	65.23	42.95	68.91	48.37
Comp. Displacement, ft^3/min	13.8	15.61	4.94	5.29	2.05	2.07
Compression Ratio	15.84	14.66	6.24	5.97	2.90	2.84
Refrig. Circulated, per Ton, lb/min	3.28	5.40	3.07	4.66	2.90	4.14
Heat of Compression, Btu/lb	56.26	44.09	33.8	26.86	17.49	13.95
Horsepower per Ton	4.35	5.62	2.44	2.95	1.20	1.36
Compressor Discharge Temp., °C (°F)	204.4 (399.9)	138.4 (281.2)	139.8 (283.6)	100.5 (212.9)	88.5 (191.3)	69 (156.2)

Motor Temperature

In hermetic compressors, the temperature of the motor windings is an important factor in determining the operating life of refrigeration equipment. Measured comparisons of motor temperatures with Suva HP62 and HCFC-22 show significantly lower temperatures with Suva HP62. The beneficial effects of using Suva HP62 are most dramatic at low evaporator temperatures, but are still apparent even at medium temperature conditions. As with all refrigerant properties, the effects will be dependent on the equipment design.

Efficiency

As has been seen historically with R-502, Suva HP62 offers better efficiency than HCFC-22 at evaporator temperatures below about –17.8°C (0°F). At higher evaporating temperatures, the efficiency of HCFC-22 improves, but it is only comparable to slightly better than Suva HP62 well up into the medium temperature range.

Physical Properties

Selected physical properties of Suva HP62 and HCFC-22 are shown in **Table 2** for comparison.

Table 2
Physical Properties of Suva HP62 and HCFC-22

	Suva HP62	HCFC-22
Chemical Formula	Blend*	$CHClF_2$
Molecular Weight	97.6	86.47
Boiling Point at 1 atm, °C	–46.5	–40.75
°F	–51.6	–41.36
Critical Temperature, °C	72.1	96.0
°F	161.7	204.8
Critical Pressure, kPa	3732	4978
psia	541.2	721.9
Critical Density, kg/m^3	484.5	525.0
lb/ft^3	30.23	32.76
Liquid Density at 25°C, kg/m^3	1048	1193
77°F, lb/ft^3	65.45	74.53
Specific Heat of Liquid, 25°C (77°F)		
kJ/kg·K	1.53	1.25
Btu/lb·°F	0.367	0.300
Specific Heat of Vapor, 25°C (77°F) and 1 atm		
kJ/kg·K	0.870	0.660
Btu/lb·°F	0.207	0.157
Heat of Vaporization at Boiling Point		
kJ/kg	202.1	233.3
Btu/lb	87.0	100.45
Thermal Conductivity at 25°C (77°F)		
Liquid, W/m·K	6.83×10^{-2}	8.79×10^{-2}
Btu/hr·ft·°F	3.94×10^{-2}	5.07×10^{-2}
Vapor (1 atm), W/m·K	1.346×10^{-2}	1.054×10^{-2}
(1 atm), Btu/hr·ft·°F	7.78×10^{-3}	6.09×10^{-3}
Viscosity at 25°C (77°F)		
Liquid, Pa·s	1.28×10^{-4}	1.98×10^{-4}
Vapor (1 atm), Pa·s	1.22×10^{-5}	1.27×10^{-5}

*HFC-125/HFC-143a/HFC-134a (44/52/4 wt%)

Additional properties of and information concerning Suva HP62 can be obtained from the following DuPont bulletins:

P-HP	"Suva HP Refrigerants PUSH Bulletin"
ART-18	"Transport Properties of Suva HP Refrigerants"
ART-22	"Retrofit Guidelines for Suva HP62"

For the New Equipment Owner or Designer

All of the above properties may make Suva HP62 a good refrigerant, but what is the justification for using it for new refrigeration equipment designs today?

Simplicity

Equipment, especially that operating at low temperatures, will be less complicated in design than that required for HCFC-22. Single-stage compressors without liquid injection or other desuperheating equipment is all that is required for Suva HP62. Additional performance can be obtained using internally compounded compressors, depending on individual tastes. Less equipment and compressor controls are needed with Suva HP62 than with HCFC-22, resulting in some additional savings.

Longevity

In addition, you will be building equipment using refrigerants that have no proposed manufacturer phase-out date connected to them. Certainly HCFC-22 has value in the existing marketplace, and for some years to come, but using HFC refrigerants today eliminates that equipment from future retrofit consideration.

Performance

The operating performance of Suva HP62 makes it a far more attractive refrigerant than HCFC-22, particularly at low temperature configurations. Suva HP62 can be used in both medium and low temperature refrigeration equipment, simplifying your maintenance to a single refrigerant. The additional capacity, EER, and lower operating temperatures will add up to a superior system design, with lower expected maintenance and operating cost, for years to come.

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