Star International

Worldwide marine and offshore services

RS-51

Description

Type		HFC blend
HFC replacement		R404A and R507
Drop-in or long term		Both
Lubricant		POE
ODP		Zero
GWP	**100 year ITH**	697
	500 year ITH	236

RS-51 Physical properties

		RS-51 (2)	R404A (2)
Molecular Mass		89.73	97.60
Boiling point (1 atm) (1)	°C	-61.45	-46.23
	°F	-78.6	-51.2
Critical Temperature	°C	94.29	72.12
	°F	201.7	161.8
Critical Pressure	bara	54.66	37.35
	psia	792.8	541.7
Liquid Density (25°C) (1)	kg/m^3	1107	1044
Density of saturated vapour (25°C) (1)	kg/m^3	56.74	66.41
Latent Heat of Vaporisation at boiling point (3)	kJ/kg	259.9	200.9
Heat capacity constant volume Cv (25°C & 1bara)	kJ/kg.K	0.762	0.784
Heat capacity constant pressure Cp (25°C & 1bara)	kJ/kg.K	0.862	0.877
Cp/Cv (25 0C & 1 bara)		1.131	1.118
Vapour Pressure (25°C) (1)	bara	17.07	12.55
	psia	247.7	182.0
Vapour Viscosity (25°C & 1 bara)	cP	0.0129	0.0121
Liquid Viscosity (25°C (1)	cP	0.143	0.128
Liquid Thermal Conductivity (25°C)	W/m.K	0.0812	0.0627
Surface Tension (25°C) (1)	N/m	0.00642	0.00446
Specific heat of liquid (25°C) (1)	kJ/kg.K	1.54	1.54
Ozone Depletion Potential	ODP	0	0
Global warming potential AR5	GWP	697	3943
Flammability limit in air (1 atm)	vol%	none	none
Inhalation exposure (8 hour day & 40 hour week)	ppm	1000	1000

(1) Bubble point
(2) RS-51 refrigerant properties obtained from NIST's REFPROP v10 program.
(3) Difference between bubble point liquid enthalpy and dew point vapour enthalpy at 1 atm.

Type and description

RS-51 is a non-flammable, non-toxic, zero ODP blend which is a low GWP replacement for R404A and R507.

Applications

With a GWP less than a quarter that of R404A and R507, RS-51 is an excellent replacement for R404A and R507 which results in a lower carbon footprint. RS-51 also has a GWP which is just over half that of R448A or R449A.

Service work

Because it is a blend, it is essential that RS-51 be charged into systems in the liquid as opposed to the gaseous phase.

Since there is no need to change the existing lubricant, RS-51 is straightforward to use as the procedure below outlines.

Lubricants

RS-51 is fully compatible with polyol ester (POE) lubricants which are commonly used with R404A and R507.

Materials compatibility

RS-51 is compatible with all materials commonly used in systems that were designed and charged with R404A and R507.

In general, materials which are compatible with R404A can be used with RS-51. It is recommended to check equipment manufacturer's retrofit literature and obtain recommendations from equipment manufacturers with regard to materials' compatibility.

Environmental data

None of the components of RS-51 contains chlorine so that it has no ability to deplete the ozone layer. RS-51 does have a direct global warming potential (GWP) but at 697 (AR5) its GWP is the lowest of any non-flammable alternatives for R404A and R507 on the market.

Retrofit procedure

Replacing R404A or R507 with RS-51 essentially will follow the procedure specified by the equipment manufacturer for a refrigerant change. Since RS-51 is zeotropic it is very important that liquid, not vapour, refrigerant be added to the system.

1. Ensure the right equipment is available, eg recovery unit and cylinders, container for recovered lubricant, vacuum pump, weighing scales, replacement drier etc.

2. Before removing the R404A or R507A, operate the unit under standard operating conditions and record the pressures, temperatures and any other relevant measurable data to establish unit performance. Typically, the appropriate standard conditions for setting up the unit will have already been specified by the equipment supplier.

3. Recover and weigh the R404A or R507A from the unit. The weight should be within the range specified by equipment manufacturer.

4. Replace the filter/drier and evacuate the system.

5. As in the case of R404A and R507, RS-51 should be used with a polyol ester lubricant.

6. Before operating the unit, charge the unit with **liquid** RS-51. The weight added at this stage should be approximately 10% lower than the R404A or R507 charge specified by the equipment manufacturer.

7. Operate the unit under conditions similar to those used in Step 2, closely watching the liquid line sight glass, the compressor oil level sight glass and the suction superheat.
8. RS-51 has a lower liquid flow rate than R404A and R507, so that it may be necessary to close the expansion device relative to its setting for R404A or R507.
9. The evaporator superheat should be checked and changed as necessary by adjusting the TX valve.

10. If liquid is observed in the suction line sight glass or the suction superheat is lower than required, close the TX valve further. If the equipment manufacturer recommends charging R404A or R507 by evaporator superheat or liquid sub-cooling, use the same amount of superheat or sub-cooling for RS-51.
11. If a liquid line sight-glass is fitted, charge to a full glass gradually adding more liquid RS-51 until only liquid is passing through the expansion valve. **Do not overcharge the system.**

12. If more refrigerant is added, re-adjust the expansion device superheat setting as required.

13. Check system thoroughly for leaks.

14. Remove all R404A or R507A labels and clearly label system RS-51.

Warning: It is highly recommended that the thermostatic expansion valve be checked and adjusted to compensate for small differences in the pressure temperature relationship of the replacement refrigerant when compared to the original refrigerant. Failure to check and adjust the valve could allow liquid refrigerant to enter the compressor and damage bearings and other compressor components.

RS series of refrigerants pressure/temperature charts

RS Series Pressure/Temperature charts indicate both liquid bubble point and vapour dew point of the RS Series Refrigerant.

Bubble Point: this is the temperature which the liquid refrigerant will begin to vaporize at the given pressure. Below this temperature the liquid refrigerant will be sub-cooled.

Dew Point: this is the temperature at which refrigerant vapour will begin to condense at the given pressure. Above this temperature the refrigerant vapour will be superheated.
Evaporator Vapour

Evaporator Vapour Superheat:

To determine evaporator superheat, measure the suction line temperature at the outlet pipe of the evaporator and measure the suction pressure at the outlet pipe of the evaporator. Using the Pressure/Temperature chart, determine the vapour dew point for the measured suction pressure. Subtract the determined dew point from the actual temperature and this difference is the evaporator superheat.

Condenser Liquid Sub-Cooling:

To determine condenser sub-cooling, measure the temperature of the outlet pipe of the condenser and measure the condenser pressure at the outlet pipe of the condenser. Using the Pressure/Temperature chart, determine the liquid bubble point for the measured condenser pressure. Subtract the measured temperature from the determined bubble point and this difference is the condenser liquid sub-cooling.