

FORANE[®] 427A

MORE ABOUT

HCFC-22 has been used for decades in air-conditioning and refrigeration applications due to its excellent thermodynamic properties. But, like all HCFCs, R-22 is subject to the regulations of the Montreal Protocol and its subsequent amendments. In Europe in particular R-22 is due to be phased out by 2010. In these countries therefore, the industry will rapidly need a zero-ODP solution to replace R-22 in existing equipment.

Arkema has developed an easy solution to serve its customers' needs: Forane[®] 427A. Forane[®] 427A is a 100% HFC blend which consequently has no impact on the ozone layer (ODP = 0). Forane[®] 427A also has one of the lowest GWP among the retrofit solutions available on the market.

A non-toxic and non-flammable refrigerant, Forane[®] 427A requires just one change-out of the system's oil, followed by replacement by a POE lubricant. Outstanding performance, similar to that of R-22, can be achieved without a long and costly rinse of the circuit, thanks to the high tolerance of Forane[®] 427A to residual original oil (mineral or alkylbenzene). No modification of the installation is required.

Moreover Forane[®] 427A is a simplified retrofit solution for existing R-22 installations in a large range of applications: Forane[®] 427A can be used to retrofit low temperature refrigeration equipment as well as air-conditioning installations.

Forane[®] 427A has already been chosen by many end-users as *the* solution for their retrofits. Many industrial installations in commercial refrigeration (supermarkets, etc...), in industrial refrigeration (food industry, pharmaceutical industry, etc...) and in many water chillers have been successfully converted to Forane[®] 427A in the last three years.

Highly satisfactory operating conditions are achieved rapidly with Forane[®] 427A. The required temperature levels are reached easily and remain stable, the discharge temperatures can be up to 10°C lower with Forane[®] 427A, which improves equipment

lifetimes, and energy consumption can be reduced too

Move a step forward with one of the lowest GWP on the market! Today, you can combine performance simplicity and meet regulatory requirements with Forane[®] 427A.

CHARACTERISTICS

Properties	Units	R-427A	R-22
Components	-	HFC-32, 125, 143a, 134a	HCFC-22
Composition	% weight	15/25/10/50	-
Molecular weight	g/mol	90.4	86.5
Bubble point (at 1.013 bar)	°C	-42.7	-40.7
Temperature glide at 1.013 bar	K	7.1	-
Critical temperature	°C	86.8	96
Critical pressure	bar	44.0	49.8
Bubble pressure at 25°C	bar	11.2	10.4
Bubble pressure at 50°C	bar	20.8	19.7
Saturated liquid density at 25°C	kg/dm ³	1.151	1.194
Density of saturated vapor at 1.013 bar	kg/m ³	4.78	4.70
Liquid thermal Conductivity at 25°C	W/(m.K)	0.081	0.083
Vapor Thermal conductivity at 25°C and 1.013 bar	W/(m.K)	0.014	0.012
Surface tension at 25°C	mN/m	6.9	8.1
Liquid viscosity at 25°C	mPa.s	0.15	0.17
Vapor viscosity at 25°C and 1.013 bar	mPa.s	0.013	0.013
Liquid specific heat	kJ/(kg.K)	1.58	1.26
Vapor specific heat at 25°C and 1.013 bar	kJ/(kg.k)	0.842	0.662
ODP	-	0	0.055
GWP	-	2000	1700

FORANE[®] 427A FREQUENTLY ASKED QUESTIONS

1. What does Forane[®] 427A stand for?

Forane[®] 427A is results from Arkema's research and innovation programs to adapt to the changing regulatory environment. It is Arkema's proprietary refrigerant solution especially developed to replace R-22 in your existing installations, and it complements Arkema's comprehensive Forane[®] product range to better serve its customers needs. R-427A is the designation given to this blend. by ASHRAE Standard 34

2. What is the composition of Forane[®] 427A?

Forane[®] 427A is a 100% HFC blend made of the following components R32 / 125 / 143a / 134a (15 / 25 / 10 / 50 %wt). It contains no hydrocarbons.

3. Does Forane[®] 427A comply with current environmental regulations?

Yes, it does: as a pure HFC refrigerant it has a zero ODP (Ozone Depletion Potential) and also has one of the lowest GWP (Global Warming Potential) among other retrofit solutions since its GWP is 2000.

4. For which application can Forane[®] 427A be used?

Forane[®] 427A can be used to replace R-22 in existing equipment for a wide range of temperatures. Forane[®] 427A can be used to retrofit low temperature refrigeration units as well as air-conditioning installations, which is one of the main advantages of this product over its competition.

5. Is Forane[®] 427A a safe product?

Yes, it is. Forane[®] 427A has been assigned A1 safety classification by ASHRAE Standard 34. This means that Forane[®] 427A is non-toxic and non-flammable.

6. When replacing R-22 by Forane[®] 427A, system's original oil need changing?

Forane[®] 427A is a 100% HFC blend and consequently requires the use of PolyOIEster (POE) lubricants to ensure proper oil return. As a consequence, when replacing R-22 with Forane[®] 427A, it is advisable to replace the original oil in the system (mineral or alkylbenzene) with a POE lubricant. Forane[®] 427A has been proven to work with 100% mineral oil systems which employ oil separators, but Arkema recommends an oil flush (see#13) for long-term system sustainability and enhanced performance. Many of the so-called no oil-change HFC R-22 replacement refrigerants on the market contain small traces of hydrocarbons which allow for some miscibility with mineral oil, but when compared to R-22 miscibility with mineral oil, they are very similar to Forane[®] 427A

FORANE[®] 427A FAQ's

7. What is the compatibility of Forane[®] 427A with residual mineral or alkylbenzene oil?

One advantage of Forane[®] 427A is its ability to tolerate a high residual amount of original oil in the POE lubricant (up to 10-15%), making the retrofit simpler: in most cases, Forane[®] 427A only requires one oil draining operation and its replacement with a POE lubricant. Optimal performance close to R-22 can be achieved without long and costly rinsing of the circuit.

8. Is Forane[®] 427A compatible with all plastics and elastomers?

Forane[®] 427A is a 100% HFC blend made of R-32, R-125, R-143a and R-134a. It does not contain any flammable hydrocarbons. It is consequently compatible with the elastomers and plastic materials usually compatible with R-407C and R-404A. Before any retrofit, the condition of any elastomer seals, gaskets and valve packing should be checked carefully. If these parts are damaged they must be replaced to prevent leakage.

9. What amount of Forane[®] 427A should be used when replacing R-22?

Arkema recommends to first fill the installation with a Forane[®] 427A load equal to 95% wt of the nominal R-22 load and then top up to 100% only if necessary. Like all blends, Forane[®] 427A must be installed in its liquid phase.

10. Is there any application for which Forane[®] 427A should not be used?

Forane[®] 427A, as all other zeotropic blends (i.e R400 series refrigerants), should not be used in systems with flooded evaporators.

11. What is the advantage of using Forane[®] 427A instead of R-404A for the retrofit of existing R-22 equipment?

When retrofitting existing R-22 equipment with Forane[®] 427A, no modification of the installation is necessary which is not the case with R-404A requiring in most cases replacement of the expansion valve, redesign of the liquid line, and sometimes modification of the heat exchangers or compressors. Forane[®] 427A is consequently a much simpler retrofit solution, and moreover it has a much lower GWP than R-404A.

12. What is the advantage of using Forane[®] 427A instead of R-407C for the retrofit of existing R-22 equipment?

When retrofitting existing R-22 equipment with Forane[®] 427A, an oil change is recommended (from mineral or alkylbenzene to polyolester) but thanks to Forane[®] 427A's high tolerance to residual original oil, in most cases only one oil draining operation is necessary. There is no need for long and costly rinsing of the circuit. This is not the case with R-407C, which can only tolerate traces of original oil in the POE lubricant. Forane[®] 427A is consequently a much simpler retrofit solution which, additionally can, in most cases offer better performances than R-407C.

R-22 TO FORANE® 427A RETROFIT PROCEDURE

Retrofit procedures that may be given by some original equipment manufacturers (OEMs) should be followed as a priority. The following guidelines are given as an indication only.

Before the retrofit of the system:

- Make sure that the system is operating properly, repair if necessary.
- Check for any leaks, repair if necessary.
- Check that the elastomeric seals, gaskets and valve packing are in good condition, replace if necessary.
- Record where possible the operating conditions of the system with R-22, this will provide a baseline for comparison when the system is brought back into operation with Forane® 427A.

Retrofit procedure:

- Fully recover the entire original R-22 load from the system using appropriate recovery cylinders. Arkema does not recommend mixing Forane® 427A with R-22.
- Remove the original oil from the system. When replacing R-22 with Forane® 427A it is advisable to replace the original oil (mineral or alkylbenzene) with a polyolester oil (POE). However thanks to Forane® 427A's ability to tolerate a high residual amount of original oil in the POE lubricant, in most cases only one oil draining operation is required.
- Fully recover the drained oil for destruction.
- Analyse the drained oil if possible (humidity, acidity, particles): this will indicate whether the installation is in a good state of repair.
- Refill the system with a POE lubricant: use the same volume of POE oil as for the original oil.
- Replace the filter drier.
- Drain the installation.
- Refill the system with Forane® 427A. Forane® 427A must be installed in the liquid phase. It is advisable to first fill the installation with a Forane® 427A load equal to 95% wt of the nominal R-22 load and then top up to 100% only if necessary. As Forane® 427A is a zeotropic blend some bubbles may appear at the compressor sight glass, but this does not mean there is under-charge.
- Restart the installation. Record the new operating conditions and compare them to those obtained with R-22. Please note: the Pressure-Temperature relationship for Forane® 427A is different from the P-T relationship for R-22 (please refer to the enclosed saturation table).
- It may be necessary to adjust the expansion valve to achieve an optimized superheat.
- Clearly label the system to indicate that it is now running on Forane® 427A and a POE lubricant.

SATURATION TABLE

FORANE® 427A : Properties of saturated liquid and saturated vapor											
Abs. Pressure P bar	Liquid					Vapor					Latent heat of vaporization Lv kJ/kg
	Bubble T T' °C	Volume v' dm ³ /Kg	Density p' kg/m ³	Enthalpy h' kJ/kg	Entropy s' kJ/(kg.K)	Dew T T'' °C	Volume v'' m ³ /Kg	Density p'' kg/m ³	Enthalpy h'' kJ/kg	Entropy s'' kJ/(kg.K)	
0.025	-100.2	0.637	1571.0	81.3	0.466	-91.7	6.667	0.150	346.5	1.961	265.2
0.125	-79.6	0.661	1513.1	103.5	0.587	-71.6	1.475	0.678	359.3	1.881	255.8
0.225	-70.6	0.672	1487.1	113.4	0.637	-62.8	0.852	1.174	365.0	1.855	251.6
0.325	-64.5	0.681	1469.0	120.3	0.670	-56.8	0.605	1.654	368.9	1.840	248.6
0.425	-59.8	0.687	1454.8	125.7	0.696	-52.2	0.471	2.124	371.9	1.829	246.3
0.525	-55.9	0.693	1442.9	130.1	0.716	-48.4	0.387	2.586	374.4	1.821	244.3
0.625	-52.5	0.698	1432.7	134.0	0.734	-45.2	0.329	3.043	376.6	1.815	242.6
0.725	-49.6	0.702	1423.6	137.4	0.749	-42.3	0.286	3.495	378.4	1.810	241.0
0.825	-47.0	0.707	1415.4	140.5	0.763	-39.7	0.254	3.943	380.1	1.805	239.6
0.925	-44.6	0.710	1407.9	143.3	0.775	-37.4	0.228	4.388	381.6	1.801	238.3
1.025	-42.4	0.714	1401.0	145.9	0.787	-35.3	0.207	4.831	383.0	1.798	237.1
1.125	-40.4	0.717	1394.5	148.3	0.797	-33.3	0.190	5.271	384.2	1.795	236.0
1.225	-38.5	0.720	1388.5	150.5	0.806	-31.5	0.175	5.708	385.4	1.793	234.9
1.325	-36.8	0.723	1382.8	152.6	0.815	-29.8	0.163	6.144	386.5	1.790	233.9
1.425	-35.1	0.726	1377.4	154.7	0.824	-28.2	0.152	6.579	387.6	1.788	232.9
1.525	-33.5	0.729	1372.2	156.6	0.832	-26.6	0.143	7.011	388.5	1.786	232.0
1.625	-32.1	0.731	1367.3	158.4	0.839	-25.2	0.134	7.443	389.5	1.784	231.1
1.725	-30.6	0.734	1362.6	160.1	0.847	-23.8	0.127	7.874	390.4	1.782	230.2
1.77	-30.0	0.735	1360.6	160.9	0.850	-23.2	0.124	8.067	390.7	1.782	229.8
2.17	-25.0	0.744	1343.7	167.1	0.875	-18.3	0.102	9.778	393.8	1.776	226.7
2.57	-20.7	0.753	1328.8	172.6	0.897	-14.1	0.087	11.48	396.4	1.772	223.8
2.97	-16.8	0.760	1315.5	177.5	0.916	-10.3	0.076	13.17	398.7	1.768	221.2
3.37	-13.4	0.767	1303.2	182.0	0.933	-7.0	0.067	14.87	400.8	1.765	218.7
3.77	-10.2	0.774	1291.9	186.2	0.949	-3.9	0.060	16.56	402.6	1.762	216.4
4.17	-7.3	0.780	1281.3	190.0	0.963	-1.1	0.055	18.25	404.2	1.760	214.2
4.57	-4.6	0.787	1271.3	193.7	0.977	1.5	0.050	19.94	405.8	1.758	212.1
4.97	-2.1	0.792	1261.9	197.1	0.989	4.0	0.046	21.64	407.2	1.756	210.1
5.37	0.3	0.798	1252.9	200.4	1.001	6.3	0.043	23.34	408.4	1.754	208.1
5.77	2.5	0.804	1244.3	203.5	1.012	8.5	0.040	25.05	409.6	1.752	206.2
6.17	4.6	0.809	1236.0	206.4	1.023	10.5	0.037	26.76	410.8	1.751	204.3
6.2	4.8	0.809	1235.4	206.7	1.024	10.7	0.037	26.88	410.8	1.751	204.2
6.6	6.8	0.815	1227.5	209.5	1.034	12.6	0.035	28.60	411.9	1.749	202.4
7.0	8.7	0.820	1219.8	212.3	1.044	14.5	0.033	30.33	412.8	1.748	200.6
7.4	10.6	0.825	1212.4	214.9	1.053	16.3	0.031	32.06	413.8	1.747	198.9
7.8	12.3	0.830	1205.2	217.5	1.062	18.0	0.030	33.80	414.6	1.745	197.1
8.2	14.0	0.835	1198.2	220.0	1.070	19.6	0.028	35.55	415.4	1.744	195.5
8.6	15.7	0.839	1191.4	222.4	1.079	21.2	0.027	37.31	416.2	1.743	193.8
9.0	17.3	0.844	1184.7	224.7	1.087	22.8	0.026	39.08	416.9	1.742	192.2
9.4	18.8	0.849	1178.2	227.0	1.094	24.2	0.024	40.86	417.6	1.741	190.6
9.8	20.3	0.853	1171.8	229.3	1.102	25.7	0.023	42.64	418.3	1.740	189.0
10.0	21.0	0.856	1168.6	230.4	1.106	26.4	0.023	43.54	418.6	1.739	188.2
11.0	24.5	0.867	1153.4	235.7	1.123	29.7	0.021	48.08	420.0	1.737	184.3
13.0	30.7	0.889	1124.5	245.7	1.156	35.8	0.017	57.37	422.4	1.732	176.7
15.0	36.3	0.911	1097.5	254.9	1.185	41.1	0.015	67.01	424.2	1.728	169.3
17.0	41.4	0.933	1071.6	263.6	1.212	46.0	0.013	77.05	425.6	1.723	162.0
19.0	46.1	0.956	1046.5	271.9	1.237	50.4	0.011	87.54	426.5	1.719	154.7
21.0	50.4	0.979	1021.9	279.8	1.261	54.5	0.010	98.56	427.1	1.714	147.3
23.0	54.4	1.002	997.5	287.6	1.284	58.3	0.009	110.2	427.4	1.709	139.8
25.0	58.1	1.028	973.0	295.1	1.307	61.8	0.008	122.5	427.3	1.703	132.2
27.0	61.7	1.055	948.2	302.6	1.328	65.2	0.007	135.6	426.9	1.698	124.3
29.0	65.1	1.084	922.7	310.0	1.350	68.3	0.007	149.7	426.2	1.691	116.2
31.0	68.3	1.116	896.1	317.5	1.371	71.3	0.006	164.9	425.1	1.685	107.6
33.0	71.4	1.152	867.9	325.1	1.392	74.1	0.006	181.6	423.6	1.677	98.5
35.0	74.3	1.194	837.2	333.0	1.414	76.8	0.005	200.3	421.6	1.668	88.7
35.5	75.0	1.206	829.0	335.0	1.419	77.4	0.005	205.3	421.0	1.666	86.1

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