Klea® 473A

Technical Data Sheet

Introduction

With the refrigeration industry looking for low GWP alternatives to products such as R-23 and R-508B, Orbia Fluor & Energy Materials has designed a near drop in solution where temperatures of -50°C to -75°C are desired. This revolutionary refrigerant, Klea 473A represents the latest in our technology pipeline designed for use in cascade refrigeration systems, such as climate chambers, low temperature cold chain and industrial applications.

Benefits

Klea 473A affords the following benefits to the user:

- **Futureproof:** Klea 473A is a low GWP alternative to incumbents such as R-23, and R-508B, offering up to 85% reduction in GWP.

	R-23	R-508B	Klea® 473A
GWP (AR-4)	14,800	13,400	1,831

- **A1 ASHRAE Rating:** Klea 473A has been designated A1 by ASHRAE and is the same classification as R-23 / R-508B, which is non-flammable and low toxicity.
- **Performance:** Drop in performance is similar to R-23 and R-508B with some special nuances regarding valve operation, expansion valve sizing, charging and system operation. For best system effect, maintain suction pressure above 0.5 barg. Please contact your local Orbia Fluor & Energy Materials representative for optimisation support.
- **Easy to Install:** Klea 473A has been designed to be a near drop in low GWP alternative for cascade refrigeration systems using R-23 / R-508B. Please see "Charging Klea 473A Systems from High Pressure Cylinders" document, available from your local Orbia Fluor & Energy Materials representative.
- **System Operation:** In operation, system glide is the same as incumbents, making Klea 473A a very close drop in for current heat exchanger designs. Comparing to other candidates (R-469A and R-472A), Klea 473A is able to utilize current compressors, and operates at reasonable discharge temperatures and cooling capacity.

	R-472A	R-469A	R-508B	R-23	Klea® 473A
Temperature Glide	16.9 K	8.5 K	1.5 K	2.0 K	1.6 K
Suction Pressure	0.6 bara	0.6 bara	2.5 bara	1.9 bara	2.2 bara
Volumetric Capacity vs. R-23	24%	28%	112%	100%	116%
Discharge Temperature	>150 °C	>150 °C	38 °C	76 °C	103 °C

Conditions: -30°C condensing, -70°C evaporating (exit dewpoint for blends), 5°C evaporator superheat, 25°C suction line and compressor superheat, compressor isentropic efficiency 65%, 0.2 bar pressure drop in condenser and evaporator.

Applications

Klea 473A is an ASHRAE A1 classified refrigerant (non-flammable, low-toxic) that has been designed to be a low GWP alternative for R-23 / R-508B in low temperature cascade refrigeration applications, where temperatures of -50°C to -75°C are required. Potential applications for Klea 473A are climate chambers, low temperature cold chain and industrial applications.

Charging Strategies

Whilst Klea 473A has been designed as a near drop in alternative to R-23 type cascade systems, it is important to note that each individual system can vary according to the dedicated application and set up. The following is intended as a guide as to what a user can expect:

Klea® 473A has higher volumetric capacity than R-23

- For use in an existing system, Klea 473A could benefit from reduced compressor displacement/speed to avoid overloading the top stage of cascade.
- Klea 473A will have reduced pressure drop losses compared to R-23 at equivalent cooling capacity.

Compressor discharge temperature is higher for Klea® 473A

- Klea 473A anticipated to be 10 – 20K higher than R-23.

Condensing pressure of Klea® 473A is higher than R-23

- Expansion valve adjustment is advisable as pressure drop is higher and the required mass flow is lower.

Charge size

- Whilst individual systems do vary, we believe that starting at 90% of the R-23 mass is suitable. Precise charge will depend on how the liquid is distributed in the unit at steady state running.

Evaporator pressure

- To prevent dry ice formation we recommend a minimum evaporator pressure of 1.5 bara (0.5 barg). This may also be accomplished by pulsing an electronic expansion valve.

Klea 473A is supplied in 13 L cylinder with a 10 kg charge in each cylinder. The cylinders have no dip pipes and are fitted with a CGA 320 or CGA 660 valve (contact your Orbia Fluor & Energy Materials representative to confirm valve type before ordering). **To charge a refrigerant unit, we suggest the cylinder is held at least 35ºC to ensure the refrigerant is in a homogenous gas phase**. Temperature regulated heating blankets / bands are available in the welding supply industry. Once the cylinder has been emptied, contact your local Klea 473A Distributor representative to arrange return.

Materials Compatibility

Testing of Klea 473A has been conducted as per ASHRAE Guideline 38 (Standard 97). When testing standard refrigeration grade materials (metals / polymers) no materials of concern were observed. Contact Orbia Fluor & Energy Materials if you intend on using a non-standard refrigerant material. Orbia Fluor & Energy Materials has tested both POE and polyether lubricants and found them both acceptable for use. We recommend using lubricants with HFO grade additives.

Physical Properties

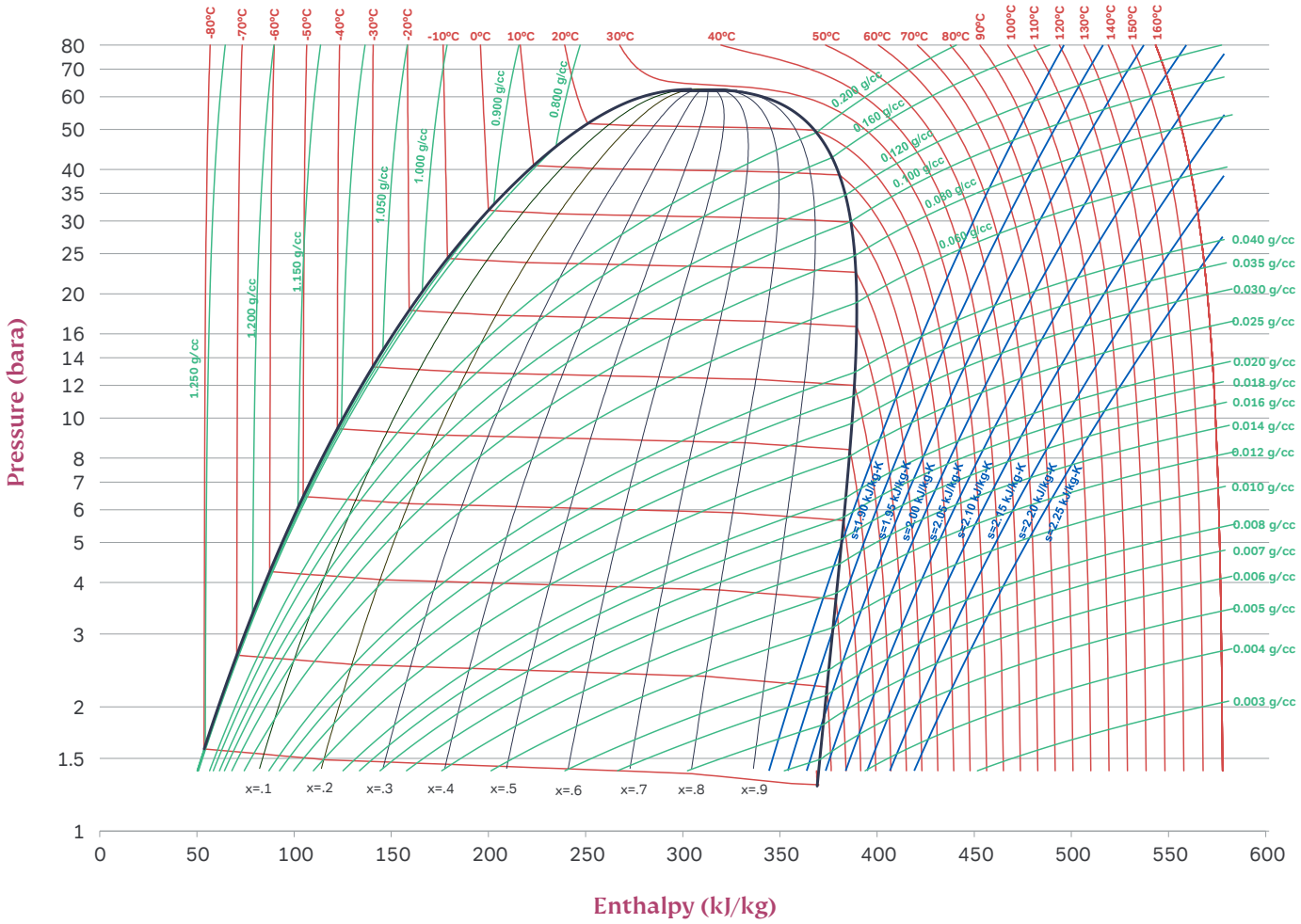
A summary of key physical property data is below – contact your local Orbia Fluor & Energy Materials representative if further information is required.

Property	Units	R-23	Klea® 473A
Global Warming Potential (AR 4)	---	14,800	1,831
Molecular mass	g/mol	70.01	52.59
Critical temperature	°C	26.1	29.7
Critical pressure	kPa	4830	6287
Liquid density (0°C)	kg/m^3	1035	907
Bubble pressure (-60°C)	kPa	312	423
Bubble pressure (-20°C)	kPa	1395	1811
Isentropic index (Cp/Cv) (at 0°C/300kPa)	---	1.24	1.27
Latent heat at -60°C	kJ/kg	220	293
Typical temperature glide (at -75°C evaporating)	K	0	4

Table 1. | Klea® 473A Saturation Properties - Temperature Table

Temperature	Pressure		Density		Enthalpy			Entropy	
	Bubble Pt.	Dew pt.	Liquid	Vapor	Liquid	Vapor	h_{fg}	Liquid	Vapor
(°C)	(bara)	(bara)	(kg/m³)	(kg/m³)	(kJ/kg)	(kJ/kg)	(kJ/kg)	(kJ/kg/K)	(kJ/kg/K)
-75.0	2.06	1.61	1230	5.35	62.3	373.0	310.71	0.426	2.023
-72.5	2.34	1.85	1222	6.08	66.5	374.3	307.79	0.447	2.008
-70.0	2.65	2.11	1213	6.90	70.7	375.5	304.83	0.468	1.994
-67.5	2.99	2.40	1204	7.79	74.9	376.7	301.83	0.488	1.981
-65.0	3.37	2.72	1196	8.77	79.1	377.9	298.78	0.508	1.968
-62.5	3.78	3.08	1187	9.84	83.4	379.1	295.69	0.529	1.955
-60.0	4.23	3.47	1178	11.01	87.6	380.2	292.55	0.548	1.943
-57.5	4.71	3.89	1169	12.29	91.9	381.3	289.35	0.568	1.931
-55.0	5.24	4.35	1160	13.68	96.2	382.3	286.09	0.588	1.919
-52.5	5.81	4.85	1150	15.19	100.5	383.3	282.78	0.607	1.908
-50.0	6.42	5.40	1141	16.82	104.9	384.3	279.40	0.627	1.897
-47.5	7.08	5.99	1131	18.59	109.2	385.2	275.95	0.646	1.886
-45.0	7.79	6.63	1122	20.50	113.6	386.0	272.42	0.665	1.875
-42.5	8.56	7.31	1112	22.57	118.0	386.8	268.82	0.684	1.865
-40.0	9.37	8.05	1102	24.79	122.5	387.6	265.14	0.703	1.855
-37.5	10.25	8.84	1092	27.19	126.9	388.3	261.38	0.721	1.845
-35.0	11.18	9.69	1081	29.78	131.4	388.9	257.51	0.740	1.835
-32.5	12.17	10.60	1071	32.56	136.0	389.5	253.55	0.759	1.825
-30.0	13.22	11.57	1060	35.55	140.6	390.0	249.49	0.777	1.816
-27.5	14.34	12.60	1049	38.77	145.2	390.5	245.31	0.796	1.806
-25.0	15.53	13.70	1038	42.23	149.8	390.9	241.01	0.814	1.797
-22.5	16.78	14.87	1026	45.96	154.6	391.1	236.59	0.832	1.787
-20.0	18.11	16.12	1015	49.96	159.3	391.3	232.02	0.851	1.778
-17.5	19.51	17.43	1003	54.27	164.1	391.5	227.31	0.869	1.768
-15.0	20.99	18.83	990	58.92	169.0	391.5	222.43	0.888	1.759
-12.5	22.55	20.31	978	63.93	174.0	391.4	217.38	0.906	1.749
-10.0	24.19	21.87	965	69.33	179.0	391.2	212.15	0.925	1.739
-7.5	25.91	23.52	951	75.17	184.1	390.8	206.70	0.943	1.729
-5.0	27.72	25.26	937	81.50	189.3	390.3	201.02	0.962	1.719
-2.5	29.62	27.10	922	88.37	194.6	389.7	195.10	0.981	1.709
0.0	31.62	29.04	907	95.85	200.0	388.9	188.87	1.000	1.698
2.5	33.70	31.08	891	104.03	205.5	387.9	182.34	1.019	1.687
5.0	35.89	33.23	875	113.00	211.2	386.6	175.43	1.039	1.675
7.5	38.17	35.49	857	122.90	217.1	385.2	168.09	1.059	1.663
10.0	40.56	37.88	838	133.91	223.1	383.4	160.25	1.079	1.650
12.5	43.06	40.38	818	146.25	229.4	381.2	151.80	1.100	1.636
15.0	45.66	43.03	796	160.26	236.0	378.6	142.60	1.122	1.621
17.5	48.38	45.82	772	176.42	243.0	375.4	132.43	1.145	1.604
20.0	51.22	48.76	745	195.50	250.5	371.5	120.94	1.170	1.585
22.5	54.17	51.89	713	218.86	258.9	366.4	107.56	1.197	1.563
25.0	57.24	55.22	672	249.32	268.6	359.6	90.99	1.228	1.535
27.5	60.40	58.84	614	295.13	281.4	348.9	67.49	1.269	1.495

Pressure-Enthalpy Diagram for Klea® 473A



Reference State: IIR
h = 200 kJ/kg, s = 1.0 kJ/kg-K
@ sat. liq at 0 °C

For more information,
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