HARP® 407A

Thermodynamic Properties

Absolute Pressure (bar)	Bubble Temperature (°C)	Dew Temperature (°C)	Liquid Density (kg/m³)	Vapour Density (kg/m³)	Liquid Enthalpy (kJ/kg)	Vapour Density (kJ/kg)	Liquid Entropy (kJ/kg.K)	Vapour Entropy (kJ/kg.K)
0.5	-58.6	-51.9	1445.60	2.51	122.7	367.7	0.684	1.810
0.6	-55.2	-48.7	1435.30	2.98	126.9	369.7	0.703	1.802
0.7	-52.3	-45.8	1426.40	3.45	130.6	371.3	0.720	1.796
0.8	-49.8	-43.3	1418.30	3.91	133.9	372.8	0.735	1.790
0.9	-47.4	-41.0	1411.00	4.37	136.9	374.2	0.748	1.786
1.0	-45.3	-38.9	1404.20	4.82	139.6	375.4	0.760	1.782
1.013	**-45.01**	**-38.6**	**1403.37**	**4.88**	**140.6**	**376.2**	**0.862**	**1.882**
1.5	-36.6	-30.3	1376.40	7.07	150.9	380.3	0.808	1.766
2.0	-29.9	-23.8	1354.60	9.29	159.6	383.9	0.845	1.756
2.5	-24.5	-18.4	1336.30	11.50	166.8	386.8	0.874	1.749
3.0	-19.8	-13.8	1320.30	13.70	173.0	389.2	0.898	1.743
3.5	-15.7	-9.8	1306.00	15.90	178.5	391.3	0.920	1.738
4.0	-12.0	-6.2	1293.00	18.10	183.5	393.1	0.939	1.733
4.5	-8.6	-2.9	1281.00	20.30	188.1	394.7	0.956	1.730
5.0	-5.6	0.1	1269.70	22.51	192.3	396.2	0.972	1.726
5.5	-2.7	2.9	1259.10	24.73	196.3	397.5	0.986	1.723
6.0	0.0	5.5	1249.10	26.96	200.0	398.7	1.000	1.721
6.5	2.5	7.9	1239.50	29.21	203.5	399.8	1.012	1.718
7.0	4.8	10.2	1230.30	31.46	206.8	400.8	1.024	1.716
7.5	7.1	12.4	1221.50	33.73	210.0	401.7	1.036	1.714
8.0	9.2	14.5	1212.90	36.01	213.0	402.6	1.046	1.712
8.5	11.2	16.5	1204.70	38.31	215.9	403.4	1.056	1.710
9.0	13.2	18.4	1196.70	40.62	218.7	404.1	1.066	1.708
9.5	15.0	20.2	1188.90	42.96	221.4	404.8	1.075	1.706
10.0	16.8	21.9	1181.30	45.31	224.1	405.4	1.084	1.705
11.0	20.2	25.2	1166.50	50.06	229.1	406.6	1.101	1.701
12.0	23.4	28.3	1152.40	54.91	233.8	407.6	1.117	1.698
13.0	26.4	31.2	1138.70	59.84	238.3	408.5	1.132	1.696
14.0	29.2	33.9	1125.50	64.86	242.6	409.2	1.146	1.693
15.0	31.9	36.5	1112.50	69.99	246.8	409.8	1.159	1.690
16.0	34.4	38.9	1099.90	75.22	250.7	410.4	1.172	1.687
17.0	36.8	41.3	1087.40	80.57	254.6	410.8	1.184	1.685
18.0	39.2	43.5	1075.10	86.05	258.3	411.2	1.196	1.682
19.0	41.4	45.6	1063.00	91.65	262.0	411.5	1.207	1.679
20.0	43.5	47.7	1051.00	97.40	265.5	411.7	1.218	1.677
21.0	45.6	49.7	1039.10	103.30	268.9	411.8	1.228	1.674
22.0	47.6	51.6	1027.20	109.36	272.3	411.9	1.239	1.671
23.0	49.5	53.4	1015.40	115.59	275.6	411.9	1.249	1.669
24.0	51.4	55.2	1003.60	122.02	278.9	411.8	1.258	1.666
25.0	53.2	56.9	991.70	128.64	282.1	411.7	1.268	1.663
26.0	55.0	58.6	979.76	135.49	285.2	411.5	1.277	1.660
27.0	56.7	60.2	967.73	142.57	288.3	411.2	1.286	1.657
28.0	58.4	61.8	955.58	149.92	291.4	410.8	1.295	1.654
29.0	60.0	63.3	943.26	157.56	294.4	410.4	1.304	1.651
30.0	61.6	64.8	930.73	165.52	297.5	409.9	1.313	1.647
31.0	63.1	66.2	917.94	173.83	300.5	409.3	1.322	1.644
32.0	64.6	67.6	904.85	182.54	303.5	408.6	1.330	1.640
33.0	66.1	69.0	891.38	191.70	306.5	407.8	1.339	1.636
34.0	67.5	70.3	877.46	201.37	309.6	406.9	1.347	1.632
35.0	68.9	71.6	862.98	211.64	312.6	405.9	1.356	1.628

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HARP INTERNATIONAL

HARP® 407A

HARP® 407A is a zero ozone depletion (ODP) hydrofluorocarbon (HFC) refrigerant blend. HARP® 407A is a ternary blend of R32, R125 and R134a (20%/40%/40%). It is widely used in new equipment that would have previously used CFC R502, HFC R404A and HCFC R22.

APPLICATION

Originally designed to replace R502, HARP® 407A therefore matches the properties and performance of both R502 and R404A and is suitable for use in medium and low temperature refrigeration systems typically found in supermarkets, food processing, cold storage and industrial sectors where the much reduced direct Global Warming Potential (GWP) offers significant environmental advantages over R404A. With modifications it can be retrofitted into existing R404A.

Its thermo-physical properties are also broadly similar to R22 and therefore offers a zero ODP and moderate GWP alternative in refrigeration systems and chillers that would have previously used R22. With modifications it can be retrofitted into existing R22 systems.

It is not recommended for use in systems with flooded evaporators.

PROPERTIES AND PERFORMANCE

HARP® 407A is designed to meet the needs of many types of new and existing refrigeration systems. HARP® 407A is a zeotropic HFC refrigerant blend, which is rated A1 by ASHRAE (lowest levels of toxicity and flammability), having zero Ozone Depletion Potential and a Global Warming Potential of 2107.

As a replacement for R404A, HARP® 407A is the ideal candidate having a similar refrigerating capacity across the range of low and medium evaporating temperature conditions and offers a distinct advantage with regard to the Coefficient of Performance (COP). The improved energy efficiency and reduced direct GWP help contribute to reduced running costs and a reduction in carbon the footprint in many application areas.

As a replacement for R22, HARP® 407A is a close match to R22's capacities and mass flow rates, with the mass flow rate required for each kilowatt of refrigeration within 10% of that required for R22. This makes it well suited as a retrofit for R22 in supermarket and food storage applications. Additionally, HARP® 407A is one of the more energy efficient R22 retrofit options available for refrigeration applications. Discharge temperatures of HARP® 407A are significantly lower than those seen with R22 though system pressures for HARP® 407A are slightly higher than R22, particularly in high ambient environments.

HARP® 407A is also the perfect solution for new refrigeration systems that would have previously used R22 offering zero ODP and a moderate direct GWP.

LUBRICATION

POE lubricants must be used with HARP® 407A since it is not miscible with mineral or alkyl benzene lubricants. As with many HFC blends, retrofitting HARP® 407A will require a change to a polyolester lubricant (POE) to ensure reliable oil return and circulation throughout the system. When retrofitting, a lubricant flushing procedure is necessary to reduce the original oil content below 5% of the new POE charge. For refrigeration systems using an oil separator, multiple oil flushes may not be required. New R407A equipment will be charged with the OEM recommended lubricant, ready to use with HARP® 407A.

CHARGING

Due to the zeotropic nature of HARP® 407A, it should be charged into the system as a liquid to prevent fractionation (changes in refrigerant composition due to vapour charging). In situations where vapour is normally charged into a system, a valve should be installed in the charging line to flash the liquid to vapour while charging.

RETROFITTING

HARP® 407A can be used to retrofit existing R22 and R404A systems in positive displacement, direct expansion refrigeration and air conditioning equipment.

HARP® 407A retrofit procedures are straightforward and similar to those of other HCFC and HFC system retrofits. Pipework and expansion valves can be equivalent to those of R22 and are within the range of R404A systems operation. HARP® 407A should not be used in centrifugal chillers or equipment that uses a flooded evaporator due to its high temperature glide.

MATERIAL COMPATIBILITY

Whenever retrofitting air conditioning or refrigeration systems, compatibility of system materials must always be taken into consideration. Items such as elastomers, hoses, and filter-driers respond differently to different refrigerants and oils. For these reasons, before performing any refrigerant retrofit, Harp International recommends contacting the OEM for specific recommendations.

HARP® 407A COMPARISON WITH R22 and R404A

Property	HARP® 407A	R22	R404A
Critical temperature	82.3°C	96.1°C	72.1°C
Critical pressure	45.2 bar	49.9 bar	37.3 bar
Molecular weight	90.1	86.5	97.6
Liquid density (saturation @ 20°C)	1167 kg/m^3	1210 kg/m^3	1067 kg/m^3
Dew point at 1 atm.	-38.6°C	-40.8°C	-45.5°C
Temperature glide at 1atm.	6.4 K	0 K	0.7 K
Capacity [1]	11.2 kW	11.1 kW	11.0 kW
Mass flow per kW[1]	109%	100%	144%
Compressor discharge temperature[1]	81.1°C	99.4°C	65.7°C

1Based on calculated medium temperature refrigeration cycle.
Evaporator mid-point -15.0°C
5K useful superheat,
40.0°C condensing mid-point,
5K liquid sub-cooling,
65% compressor isentropic efficiency with fixed displacement of 20m3/hour.
No demand cooling applied.

R404A to HARP® 407A RETROFIT PROCEDURE

Whilst HARP® 407A is a good match for R404A, check OEM recommendations to ensure the existing system design is suitable, including system capacities, relief valve sizing and equipment seal material compatibility.

Like R404A, HARP® 407A is a HFC refrigerant and a POE lubricant will be required. Whilst it is likely that the same lubricant may be suitable for use with both, R404A and HARP® 407A, check with the compressor manufacturer.

SYSTEM PREPARATION

- Record the system performance to obtain a baseline prior to retrofit, e.g. suction and discharge pressures, discharge temperature, temperatures in and out of the condenser and evaporator and the energy consumption if possible.
- Check the system service history for any on-going issues and to highlight any regular maintenance activities that may need to be undertaken.
- Remove the R404A from the system and record the system charge weight.
- Check and repair any existing leaks on the system.
- Check condition of compressor lubricant.
- Replace all seals on joints that have been opened and on the liquid receiver.
- Replace receiver float seal.
- Repair or replace old solenoid valves and ball valves to minimise leaks.
- Replace system filter drier.
- Evacuate the system to at least 1 mbar and perform a system strength pressure test with oxygen free Nitrogen in accordance with EN 378.
- If system fails the strength test repair any faults or replace any defective components and re-test.
- Perform a triple evacuation procedure, each time ensuring a vacuum of 1 mbar is pulled and held. Repair any leaks.
- Reset pressure controls for HARP® 407A. Pressure/temperature data is on Page 4 of this product information sheet.
- Charge the system with HARP® 407A. Typically the charge will be around 95% that of the original R404A charge weight.
- Note: If charging into the suction line on a running system the liquid from the cylinder must be vapourised before entering the system.

SYSTEM START UP

- Start the system and check for any leaks.
- Set the expansion valve settings. For calculating the sub-cooling use the HARP® 407A bubble point as the saturation temperature. For calculating the superheat use the HARP® 407A dew point as the saturation temperature.
- Monitor refrigerant and oil levels and adjust amounts as required.
- Record performance data and compare to that obtained for baseline performance.
- Label the system in accordance with the F-Gas Regulation and indicate all required information in the system log book.

R22 to HARP® 407A RETROFIT PROCEDURE

Before converting an R22 system to HARP® 407A, check OEM recommendations to ensure the existing system design is suitable, system capacities, relief valve sizing and equipment seal material compatibility.

HARP® 407A is a HFC refrigerant and a POE lubricant will be required. Older R22 systems may contain a mineral or alkyl benzene based lubricant that is not compatible with HFCs like HARP® 407A. Check with the compressor manufacturer for any recommendations they may have.

SYSTEM PREPARATION

- Record the system performance to obtain a baseline prior to retrofit, e.g. suction and discharge pressures, discharge temperature, temperatures in and out of the condenser and evaporator and the energy consumption if possible.
- Check and repair any existing leaks on the system.
- If not a POE then remove the oil from the compressor sump, oil separators, oil float and suction line accumulators. Record amount removed.
- Replace all seals on joints that have been opened and on the liquid receiver.
- Replace drier.
- Add the recommended viscosity grade POE.
- Evacuate system and check for leaks.
- Re-charge with old refrigerant.
- Re-start system and check for leaks. Check oil levels.
- Run system for at least 24 hours.
- Check mineral oil concentration in the POE using a refractometer. Ensure residual mineral oil content is not more than 5%. Repeat oil change if necessary.
- Remove R22 from system.
- Install a HFC compatible filter drier.
- Replace receiver float seal.
- Repair or replace old solenoid valves and ball valves to minimise leaks.
- Evacuate the system to at least 1 mbar and perform a system strength pressure test with oxygen free Nitrogen in accordance with EN 378.
- If system fails the strength test repair any faults or replace any defective components and re-test.
- Perform a triple evacuation procedure, each time ensuring a vacuum of 1 mbar is pulled and held. Repair any leaks.
- Reset pressure controls for HARP® 407A. Pressure/temperature data is on Page 4 of this product information sheet.
- Liquid charge the system with HARP® 407A. Typically the charge will be around 95% that of the original R22 charge weight.
- Note: If charging into the suction line on a running system the liquid from the cylinder must be vapourised before entering the system.

SYSTEM START UP

- Start the system and check for any leaks.
- Set the expansion valve settings. For calculating the sub-cooling use the HARP® 407A bubble point as the saturation temperature. For calculating the superheat, use the HARP® 407A dew point as the saturation temperature.
- Monitor refrigerant and oil levels and adjust amounts as required.
- Record performance data and compare to that obtained for baseline performance.
- Label the system in accordance with the F-Gas Regulation and indicate all required information in the system log book.