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SERVICE GUIDELINES HCFC R22 TO HFC REFRIGERANT BLENDS

Refrigerant R22 is widely used for residential and commercial air conditioning, as well as commercial refrigeration applications. Tecumseh has supplied reciprocating and rotary compressors, along with condensing units with reciprocating and rotary compressors, for the above mentioned applications.

Driven by the 1992 amendment to the Montreal Protocol that calls for the phase-out of HCFCs, refrigerant manufacturers developed HFC alternatives. Original Equipment Manufacturers selected R404A/R507, R407C and R410A to replace R22. They found that system changes were necessary for this conversion and made appropriate design changes to meet application requirements and regulatory demands.

In order to support the service and maintenance of equipment, refrigerant manufacturers introduced HFC blends as a replacement for R22. HFC blends can vary in performance when compared to R22. Regardless, system adjustments must be made to insure that performance differences (between R22 and HFC blends) are minimized. Suggested system adjustments are highlighted in this document.

Tecumseh Products Company does not endorse any particular retrofit refrigerant. Given that an independent decision has been reached to use HFC blends, the following guidelines are provided to assist in better applying Tecumseh compressors. The application should be reviewed carefully prior to making decisions regarding retrofit or replacement refrigerants as oftentimes there can be capacity and efficiency losses.

Consult Tecumseh's Refrigerant Matrix for additional HFC blends. The matrix may be viewed on line under the *Technical Resource Center* section of Tecumseh's North American Compressor Group web site at (http://www.tecumseh.com/en/United-States). Considerations should be given to oil compatibility, refrigerant temperature glide, heat exchanger compatibility, operating pressure differences, system performance and pressure drop. The greater the difference in performance between R22 and the alternate refrigerant, the more complex the system adjustments may be, increasing the likelihood that compressor reliability will be adversely affected.

REFRIGERANT PROPERTIES

A) Pressure/temperature of R417A, R422 blends (R422A, R422B, R422C, and R422D), R407A, R427A, R438A, and R453A are shown in Figure 1, next page.

B) Depending on the application, many of the HFC blends may have less capacity in comparison to R22. Consult the refrigerant manufacturer for additional information.

Figure 1, Pressure/Temperature Chart

Temperature		Pressure (PSIG)										
°F	°C	R22	R422A	R422B	R422C	R422D	R417A	R407A	R427A	R438A	R453A	
-40	-40.0	0.6	3.1	0.9	2.2	2.4	4.2	-0.9	-2.5	-2.6	-3.2	
-30	-34.0	4.9	8.3	5.4	7.1	7.1	1.5	3.2	1.3	1.2	0.4	
-20	-28.0	10.2	14.6	10.7	13.2	12.9	5.9	8.4	6.0	5.9	4.9	
-10	-23.0	16.5	22.1	17.1	20.4	19.8	11.2	14.8	11.7	11.6	10.3	
0	-18.0	24.0	30.9	24.7	29.0	27.9	17.6	22.5	18.7	18.5	16.9	
10	-12.2	32.8	41.4	33.6	39.1	37.5	25.1	31.6	26.9	26.6	24.8	
20	-9.0	43.1	53.5	43.9	50.8	48.5	33.9	42.3	36.6	36.2	34.1	
30	-1.0	56.8	67.5	55.9	64.4	61.3	44.2	54.8	48.0	47.5	45.0	
40	4.4	68.6	83.5	69.6	80.1	75.9	56.1	69.3	61.2	60.5	57.7	
50	10.0	84.1	107.3	85.3	97.9	92.6	69.8	86.0	76.4	75.5	72.3	Dew Pt.
60	15.6	101.6	128.4	103.0	125.4	111.4	95.7	105.2	93.8	92.7	89.1	Bubble Pt.
70	21.1	121.4	152.1	123.0	148.7	132.6	114.0	126.9	113.7	112.3	108.3	
80	26.7	143.6	178.6	145.4	174.7	156.3	134.5	151.5	136.1	134.4	130.1	
90	32.2	168.4	208.1	170.4	203.7	182.8	157.3	179.3	161.5	159.3	154.6	
100	37.8	195.9	240.9	198.2	253.9	212.2	182.6	210.4	189.9	187.3	182.2	
110	43.3	226.4	277.1	229.0	271.5	244.7	210.6	245.2	221.7	218.5	213.0	
120	48.9	260.0	317.1	263.1	310.8	280.7	241.3	284	257.1	253.3	247.5	
130	54.4	296.9	361.2	300.6	354.1	320.2	275.0	327.1	296.5	292.0	285.9	
140	60.0	337.4	409.7	341.8	401.8	363.7	311.7	375	340.3	335.0	328.5	
150	65.6	381.7	463.2	387.1	454.2	411.4	-	428.3	388.8	382.6	375.9	

Temperature		Pressure (kPa)										
°F	°C	R22	R422A	R422B	R422C	R422D	R417A	R407A	R427A	R438A	R453A	
-40	-40.0	3.9	21.4	6.2	15.2	16.5	28.7	-6.2	-17.4	-17.6	-22.3	
-30	-34.0	33.9	57.2	37.2	48.9	48.9	10.6	22.0	9.0	8.6	2.6	
-20	-28.0	70.3	100.6	73.7	90.9	88.9	40.9	57.9	41.4	40.8	33.5	
-10	-23.0	113.9	152.3	117.8	140.6	136.4	77.3	102.0	80.9	80.0	71.1	
0	-18.0	165.6	212.9	170.2	199.8	192.2	120.9	155.0	128.5	127.2	116.6	
10	-12.2	226.3	285.2	231.5	269.4	258.4	172.6	217.7	185.3	183.4	170.8	
20	-9.0	296.9	368.6	302.5	350.0	334.2	233.3	291.4	252.2	249.6	234.9	
30	-1.0	391.1	465.1	385.2	443.7	422.4	304.3	377.6	330.5	327.0	310.0	
40	4.4	472.4	575.3	479.5	551.9	523.0	386.2	477.5	421.5	416.9	397.5	
50	10.0	579.2	739.3	587.7	674.5	638.0	480.7	592.5	526.4	520.3	498.4	Dew Pt.
60	15.6	700.0	884.7	709.7	864.0	767.5	659.2	724.8	646.4	638.7	614.2	Bubble Pt.
70	21.1	836.4	1048.0	847.5	1024.5	913.6	785.2	874.3	783.2	773.4	746.3	
80	26.7	989.4	1230.6	1001.8	1203.7	1076.9	926.4	1043.8	938.0	925.9	896.0	
90	32.2	1160.3	1433.8	1174.1	1403.5	1259.5	1083.8	1235.4	1112.5	1097.6	1065.1	
100	37.8	1349.8	1659.8	1365.6	1749.4	1462.1	1258.1	1449.7	1308.5	1290.2	1255.2	
110	43.3	1559.9	1909.2	1577.8	1870.6	1686.0	1450.8	1689.4	1527.5	1505.5	1467.8	
120	48.9	1791.4	2184.8	1812.8	2141.4	1934.0	1662.5	1956.8	1771.6	1745.3	1705.3	
130	54.4	2045.6	2488.7	2071.1	2439.7	2206.2	1894.5	2253.7	2043.2	2011.9	1969.6	
140	60.0	2324.7	2822.8	2355.0	2768.4	2505.9	2147.8	2583.8	2344.5	2307.9	2263.4	
150	65.6	2629.9	3191.4	2667.1	3129.4	2834.5	-	2951.0	2678.9	2636.3	2589.6	

LUBRICANTS

A) Types, Miscibility and Charge

POE Polyol Ester Oil
MO Mineral Oil
SA Synthetic Alkylate **(also referred to as Alkylbenzene, AB)**

1. Consult Tecumseh Products Company's Policy Bulletin no. PB105 to verify original oil type.
2. Many of the HFC blends contain a small percentage of hydrocarbons to promote oil return. The hydrocarbon component of the refrigerant provides only partial miscibility with MO or SA oils. Whenever practical, the compressor oil should be changed to POE.
3. Do NOT use MO or SA oil with HFC blends in systems using a receiver tank. MO or SA will suspend on top of the refrigerant and collect in the receiver. In such systems, the MO or SA oil must be replaced with POE oil.

B) Moisture

1. POE oil is more hygroscopic than MO or SA oils and will absorb moisture quickly. POE oil along with moisture and heat of the operation will cause acid and alcohol to form in the system resulting in reduced system efficiency and capacity, reduced compressor bearing lubrication, component corrosion, blockages, and coppering of parts.
2. Care should be taken not to leave the system open to the atmosphere for more than 10 minutes. Pull a system vacuum to a minimum of 500 microns. This applies to any retrofitting process using any type of oil.

C) Compatibility

1. POE acts as a solvent and can dislodge deposit debris in older systems operating with MO. The liquid line filter drier must be changed to keep the system free of debris. Multiple refrigerant and liquid line filter drier changes may be needed.
2. While POE is compatible with MO or SA oils, it should not be indiscriminately mixed. This practice could reduce the ability of the oil to return to the compressor and/or reduce heat transfer performance in the evaporator.

SYSTEM COMPONENTS AND DESIGN

A) Compressor Selection

1. Once the system operating problem has been diagnosed consideration should be given to the cost of service retrofit compared to the cost of new equipment. Issues with equipment age, lost system capacity, system performance, product warranty, service replacement component cost and availability, agency approval, human and environmental safety impact (TEWI), and, time/labor should weigh into the decision.
2. If the retrofit is extensive, often the best option is to replace the compressor or condensing unit. In this case, a compressor already designed for R404A/R507 or R134a/R513A, or R407C should be selected depending on the application. The same applies when a compressor problem is diagnosed that requires compressor replacement.
3. When the decision is made NOT to change the compressor, the following points need to be considered:
    a. Compressor RLA values may increase with the use of a higher pressure refrigerant compared to R22.
    b. The system has to be labeled as retrofitted with the specific refrigerant blend used.
    c. Differences in capacity may require system adjustments for refrigeration balancing.

B) System Capacity Compared with R22

1. Reference chart 1 on right for estimated system capacity gains or losses.

Chart 1

Capacity Relative to R-22			
Refrigerant	Evaporator Temperature		
	HIGH / AC	MEDIUM	LOW
R-422A	102%	98%	89%
R-422B	89%	85%	75%
R-422C	100%	97%	87%
R-422D	93%	89%	79%
R-417A	86%	81%	72%
R-407A	106%	103%	95%
R-427A	98%	94%	86%
R-438A	94%	90%	81%
R-453A	96%	92%	84%

C) Capillary Tube Selection

1. Conversion to R422B or R422D generally does not require capillary tube changes. Capillary tubes selected for R22 applications should be adequate for a preliminary selection.
2. Conversion to R417A, R422A, or R422C may require that the capillary tube be replaced or shortened. Check system subcooling, superheat over the evaporator coil and superheat at the compressor before and after the change out.
3. Consult the Original Equipment Manufacturer or Refrigerant Manufacturer for recommended capillary tube requirements for other R22 replacement refrigerants.

D) Expansion Valves

1. R422A and R422C will have higher superheat. Replace the expansion valve orifice (where possible) or the entire valve.
2. R417A, R422B and R422D will have lower superheat. Adjust the valve approximately 20% as more capacity is needed from the expansion device.
3. R407A, R438A, R427A, and R453A may *not* require a valve adjustment, however with any R22 replacement refrigerant superheat will still need to be checked for the proper setting.

E) Filter Drier

1. Recommended filter driers are comprised of a 70% (minimum by weight) molecular sieve absorbent and 30% (maximum by weight) activated alumina absorbent, regardless of whether drier construction is solid core or bead type. Filter driers should be selected at 1 to 2 PSI (0.07 to 0.14 BAR) pressure drop according to ARI 710-86 and DIN 8949. It is essential to use a sight glass with moisture indicator that is capable of indicating relative humidity (water) levels of 3% or less.
2. Solid core driers made with bauxite are not recommended. Driers of this design tend to absorb POE oil and moisture. Ester could hydrolyze and form acidic materials.
3. Once the drier meets absorption capacity it will release the acidic material back into the refrigeration system.
4. When retrofitting from HCFC to HFC the filter drier should be changed. Filter drier types XH-7 and XH-9 or molecular sieve non-bonded core types are recommended.

F) Return Gas and Discharge Temperatures

1. The maximum discharge temperature for any type (reciprocating, rotary and scroll) of Tecumseh hermetic compressor must NOT exceed 260°F (127°C).
2. Return gas and discharge temperatures are largely influenced by the metering device and refrigerant charge. Ambient temperatures and system operating conditions are also a factor.
3. Consult Tecumseh's Technical Service Team (800.211.3427) for assistance.

G) Refrigerant Charge

1. ASHRAE Series 400 refrigerants are zeotrope blends. Charging must be done in the liquid phase to obtain proper composition. In order to avoid feeding excessive liquid directly into the compressor, charge into the liquid line or place a restrictor into the charging equipment to limit the feed rate.
2. Due to the performance differences and varying amounts of temperature glide the charge amounts of alternate refrigerants will rarely match original charge specifications. Use good charging techniques and adjust for proper superheat and subcooling.
3. The Liquid Density of each refrigerant is different. Charge an equal volume if charging by cylinder or to OEM name plate if charging with a scale.
4. Approximately 3% less charge will be required for R422 blends and 5% less for R407A, R438A, R453A, and R427A compared to the original system charge. Charge to 90% of the name plate charge. If additional refrigerant is needed after confirming system subcooling and superheat, add refrigerant in small increments being careful NOT to exceed 90% of the receiver pump down capacity or 115% of the name plate charge in systems without a receiver tank.
5. To avoid overcharging do NOT charge HFC blends to a clear sight glass.
6. Do NOT mix refrigerants.

H) Pressure Switches and EPR Valves

1. For satisfactory operation, Low and High Pressure switches and EPR Valve settings need to be checked and possibly reset due to the higher pressures of the HFC blends.
2. Caution should be taken to assure that over pressure protection is maintained on systems where over pressure as a result of condenser fan failure is limited by the compressor motor protector (no High pressure control).

SYSTEM RETROFIT

(Consult Tecumseh's Service Hand Book)

The following guidelines are offered when substituting R22 with an HFC replacement refrigerant.

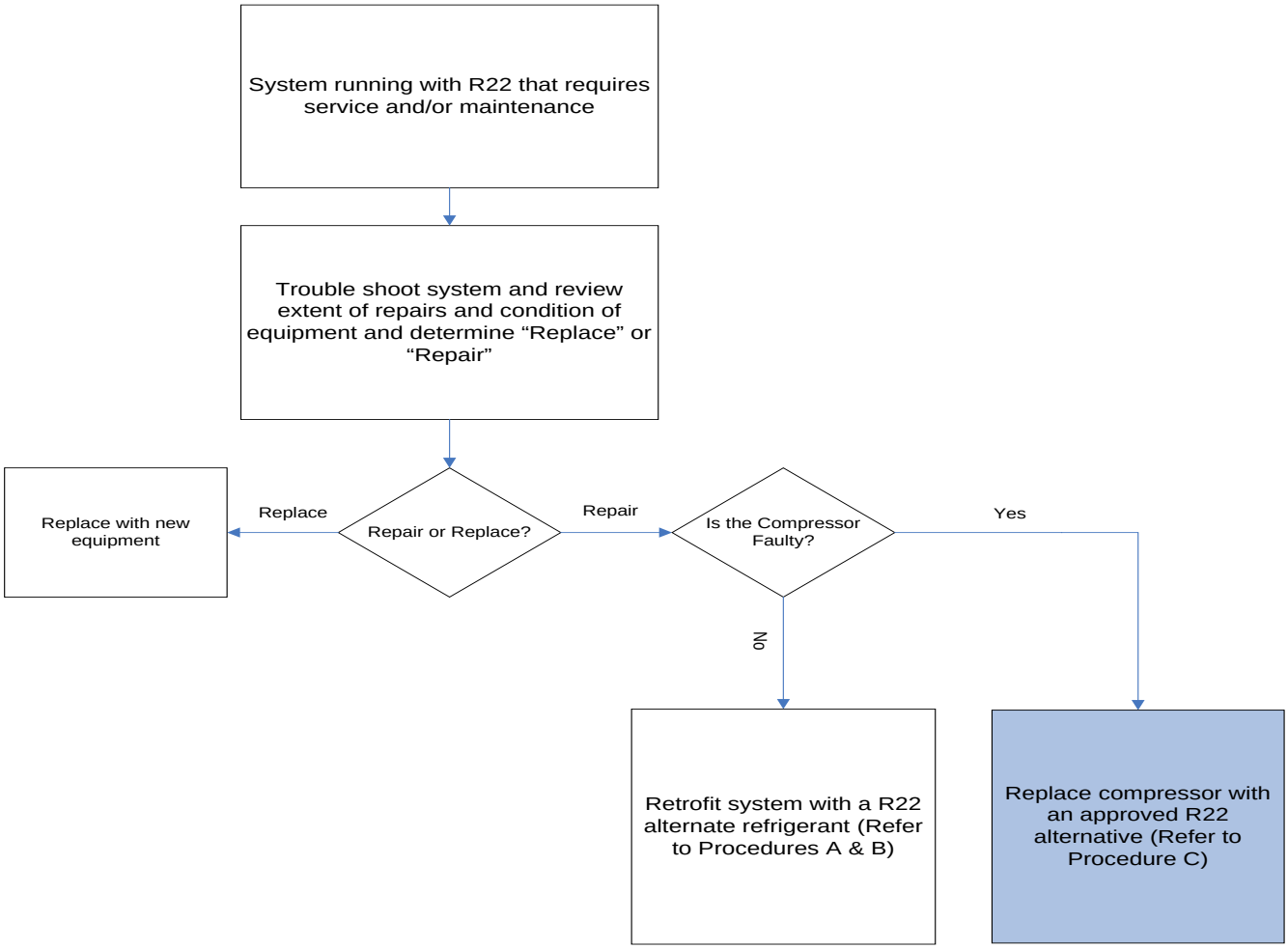
Service technicians should use generally accepted system retrofit procedures. Tecumseh's Service Hand Book may be referenced for assistance. The Service Hand Book can be found under the *Library* section of Tecumseh's North American website (http://www.tecumseh.com/en/United-States)

After service has been completed, operate the system to determine compressor run time and cycle rate. Confirm system pressures and temperatures, allowing the compressor to operate within its approved parameters. Correct as needed.

Consult Tecumseh Policy Bulletins and Engineering Recommendations for approved operating parameters. These documents can be found under the *Library* section of Tecumseh's North American website http://www.tecumseh.com/en/United-States.

GUIDELINES FOR R22 COMPRESSORS and CONDENSING UNITS
(Replacement and Service Retrofit Procedures)

Available Options: Repair or Replace (Replace with an Approved R22 Alternative or Retrofit with an HFC Blend)?



A) Procedure for Refrigerant Change-Out Only (No Oil Change-Out)

1. Disconnect power.
2. Recover R22 refrigerant from the system using proper recovery equipment. Weigh and record the amount.
3. Replace liquid line filter drier with a drier that is compatible with the replacement refrigerant.
4. Replace metering device as needed.
5. Leak test using nitrogen (refer to Tecumseh's Service Handbook for proper leak test procedure). When pressure testing confirms that the system is free of leaks, evacuate the system thoroughly. Air, moisture and non-condensables must be removed to ensure long term compressor reliability. Evacuate to a minimum of 500 microns. Always use a vacuum gauge to measure vacuum levels.
6. Recharge with refrigerant in the liquid state to 90% of the original R22 name plate charge or weighed amount. Depending on the application and system design, refrigerant charge may vary.

A) Procedure for Refrigerant Change-Out Only (No Oil Change-Out) Cont'd

7. Operate system and follow procedures outlined by the equipment or component manufacturer for measuring superheat. Adjust refrigerant metering device and operating control(s) settings as needed.
8. Label the compressor with the new refrigerant and oil type. Consult refrigerant supplier for color coding.

B) Procedure for Retrofitting System With a Different Refrigerant and Oil Type

(Applies to Reciprocating Compressors Only)

1. Disconnect power
2. Recover R22 refrigerant from the system using proper recovery equipment. Weigh and record the amount.
3. Remove the compressor from the system and drain the oil. Drain as much oil as possible from the compressor through the suction tube. Typically, ten (10) minutes is sufficient. When retrofitting systems with a change from MO or SA to POE, a residual of 1% to 5% of the original oil charge is acceptable. A second oil change is recommended to reduce system residual oil to an acceptable level.
4. Recharge the compressor with the correct amount of POE oil as recommended by Tecumseh.

   Refer to Tecumseh's Policy Bulletin No. PB105 for the correct oil type and Tecumseh's compressor technical data sheet for the required amount of oil.
5. Run the compressor using recovered R22 refrigerant to purge the system of any residual oil. A sufficient amount of recovered R22 should be used to bring the system to operating condition.
6. Repeat Steps 1 to 4 (above)
7. Replace liquid line filter drier with a drier that is compatible with the replacement refrigerant
8. Replace metering device as needed.
9. Leak test using nitrogen (refer to Tecumseh Service Handbook for proper leak test procedure). When pressure testing confirms that the system is free of leaks, evacuate the system thoroughly. Air, moisture and non-condensables must be removed to ensure long term reliability. Evacuate to a minimum of 500 microns. Always use a vacuum gauge to measure vacuum levels.
10. Recharge with refrigerant in the liquid state to 90% of the original R22 name plate charge or weighed amount. Depending on the application and system design, refrigerant charge may vary.
11. Operate system and following procedures outlined by the equipment or component manufacturer for measuring superheat. Adjust refrigerant metering device and operating control(s) settings as needed.
12. Label the compressor with the new refrigerant and oil. Consult the refrigerant supplier for color coding.

NOTE: Alternate blends may inhibit oil return on systems using SA/MO oil. This is important on rotary compressors where by design, the oil can not be drained.

C) Replace Compressor or Condensing Unit Using an Approved Refrigerant Such As R404A/R507 or R407C (depending on the application)

1. **R404A/R507: Refer to RD-0007-E**
2. **R407C: Refer to RD-0005-E**

REFERENCE

Refer to USA EPA web site http://www.epa.gov

Tecumseh's web site http://www.tecumseh.com/en/United-States