

# GUIDELINES FOR THE UTILIZATION OF R600a and R290



*Tecumseh*



The use of hydrocarbon (HC) refrigerants R600a (isobutane) and R290 (propane) for replacements for HCFC's and HFC's continues around the globe. R600a and R290 have ozone depletion potential (ODP) factors of zero (0.0) and a fraction of the global warming potential of those refrigerants they are intended to replace. Both have acceptable toxicity levels; however, both are flammable.

**Tecumseh**

Neither of these refrigerants are “drop-in” replacements for HCFC's or HFC's. There are significant differences between R600a and R290, and the non-HC refrigerants that must be considered in handling, processing and application. These guidelines are offered to help understand these differences.

Tecumseh cannot control the final use and application of the compressors it sells, nor can Tecumseh guarantee that compliance with agency standards will eliminate all risk of fire. However, we do urge all OEM's to use care in the selection and use of such compressors and to obtain appropriate certifications from recognized testing agencies concerning compliance with all standards.

## I. REFRIGERANT PROPERTIES

A. Pressure temperature table of R600a vs R143a and R290 vs. R404A shown in *Table 1*.

Temperature °F (°C)	Pressure PSIA (kPa Abs.)			
	R600a	R134a	R290	R404A*
-40 (-40.0)	4.1 (28.3)	7.4 (51.2)	16.1 (111.0)	19.3 (132.7)
-30 (-34.4)	5.4 (37.4)	9.9 (68.0)	20.3 (140.3)	24.6 (169.6)
-20 (-28.9)	7.0 (48.6)	12.9 (88.9)	25.4 (175.1)	31.0 (214.0)
-10 (-23.3)	9.0 (62.3)	16.6 (114.7)	31.4 (216.3)	38.7 (266.8)
0 (-17.8)	11.5 (79.0)	21.2 (146.0)	38.4 (264.5)	47.7 (329.1)
10 (-12.2)	14.3 (98.9)	26.6 (183.6)	46.5 (320.4)	58.3 (401.8)
20 (-6.7)	17.8 (122.5)	33.1 (228.4)	55.8 (384.8)	70.5 (486.2)
30 (-1.1)	21.8 (150.3)	40.8 (281.2)	66.5 (458.4)	84.6 (583.2)
40 (4.4)	26.5 (182.7)	49.7 (343.0)	78.6 (542.0)	100.7 (694.1)
50 (10.0)	31.9 (220.1)	60.1 (414.6)	92.3 (636.4)	118.9 (820.0)
60 (15.6)	38.2 (263.1)	72.1 (497.1)	107.7 (742.5)	139.6 (962.4)
70 (21.1)	45.3 (312.1)	85.8 (591.6)	124.9 (861.0)	162.8 (1122)
80 (26.7)	53.3 (367.6)	101.4 (699.0)	144.0 (992.8)	188.8 (1301)
90 (32.2)	62.4 (430.3)	119.0 (820.6)	165.2 (1139)	217.7 (1501)
100 (37.8)	72.6 (500.5)	138.9 (957.3)	188.6 (1300)	249.9 (1722)
110 (43.3)	83.9 (578.8)	161.1 (1111)	214.3 (1477)	285.5 (1968)
120 (48.9)	96.6 (665.8)	185.9 (1281)	242.5 (1672)	324.9 (2240)
130 (54.4)	110.5 (762.1)	213.4 (1471)	273.3 (1884)	368.4 (2540)
140 (60.0)	125.9 (868.3)	243.9 (1682)	306.9 (2116)	416.4 (2871)
150 (65.6)	142.8 (984.9)	277.6 (1914)	343.5 (2369)	469.6 (3237)

Source of Data Refprop 6.01

\* Dew Point Pressures

Table 1: Pressure Temperature of R600a vs R143a and R290 vs R404A

- B. A given displacement compressor with R600a will produce 50 to 60% of the capacity that it would with R134a. R290 will produce 85 to 90% compared to R404A.
- C. *Table 2* shows the comparison of some properties of R600a, R134a, R290, and R404A. The data is taken at the standard refrigerant conditions of 5°F (-15°C) evaporating and 86°F (+30°C) condensing.

Data	R600a	R134a	R290	R404A
Evaporating pressure PSIA (kPa Abs.)	12.8 (88.5)	23.8 (164.0)	42.3 (291.6)	52.8 (364.1)
Condensing pressure PSIA (kPa Abs.)	58.6 (404.5)	111.7 (771.0)	156.4 (1079)	205.8 (1419)
Sat. Vap. Density @5°F (-15°C) Lbs/ft <sup>3</sup> (kg/m <sup>3</sup> )	0.1556 (2.489)	0.5173 (8.278)	0.4061 (6.498)	0.9658 (18.57)
Sat. Liq. Density @86°F (30°C) Lbs/ft <sup>3</sup> (kg/m <sup>3</sup> )	33.98 (543.7)	74.13 (1186)	30.24 (483.9)	63.71 (1020)
Latent Heat @5°F (-15°C) BTU/ Lb (kJ/kg)	159.1 (355.7)	90.12 (201.5)	169.7 (379.4)	76.45 (177.7)

Table 2: Comparison of some properties of R600a, R134a, R290 and R404A

- D. R600a and R290 are compatible with all materials used in Tecumseh Products' hermetic compressors and condensing units that are designated for use with these refrigerants.

## II. LUBRICANTS

- A. R600a and R290 are miscible with and soluble in conventional mineral and synthetic oils used with HCFC's.

## III. SYSTEM DESIGN

- A. Compressor selection: Tecumseh offers selected compressors for use with R600a and R290. These compressors have the letter "M" as the designator for R600a and the letter "U" as the designator for R290, e.g., AZ\_1335M\_ and AE\_9415U\_. It will be necessary to test each compressor selection in the applications to determine its suitability, since system operating conditions vary greatly from one application to another.
- B. Capillary tube selection: In general, capillary tubes selected for R134a applications should be adequate as a preliminary selection for R600a. Likewise, capillary tubes selected for R404A applications should be adequate as a preliminary selection for R290. As with any capillary tube selection, system testing is necessary to determine the proper final selection.
- C. Expansion valve selection: The expansion valve manufacturers have designed product specifically for use with R600a and R290. Consult them for their recommendations.
- D. Driers: R600a and R290 will use the same driers as HCFC's.
- E. Return gas/ discharge temperatures: The theoretical discharge temperature for R600a is lower than that of R134a at similar conditions. R290 theoretical discharge temperature is about the same as R404A. Therefore, existing compressor guidelines regarding return gas and discharge temperatures

for R134a and R404A should apply to R600a and R290 compressors as well. In general, keeping the return gas cool without flooding liquid refrigerant back to the compressor is beneficial in limiting compressor discharge and motor temperatures to acceptable levels.

- F. **Refrigerant quantity:** The refrigerant quantity will depend on the system components. **In general**, 40 to 50% less R600a or R290 will be needed compared to R134a or R404A.

## IV. SYSTEM PROCESSING

### A. Evacuation

1. The evacuation levels for R600a or R290 systems should be the same as for HCFC systems (minimum of 200 microns at the system and pulled from both the low and high pressure sides of the system). If care is not taken to prevent moisture from entering the system components prior to assembly, evacuation could be expected to take longer to achieve acceptable limits of system moisture and non-condensables.

### B. Leak Testing

1. Use equipment that is designed for R600a or R290 detection by its manufacturer. Consult these manufacturers for their recommendations on their equipment.

### C. Refrigerant Charging

1. In general, materials found in refrigerant charging equipment such as charging boards, valves, and hoses, which are compatible with HCFC's should be compatible with R600a or R290. Consult your equipment and component manufacturer for their specific recommendations. Proper care must be exercised in the selection and use of charging equipment due to the flammable nature of R600a and R290.
2. R600a and R290 can be charged in either the liquid or vapor state, since they are pure fluids. If refrigerant charging is done in the liquid state, it should be done into the liquid line. Vapor charging can be done into the suction line. (The preferred method of charging any refrigerant is to charge liquid into the liquid line.) **CAUTION: Always break the vacuum with refrigerant vapor or liquid before applying power to the compressor.**

## V. RETROFITTING

- A. Since special safety considerations must be applied in the design of equipment using hydrocarbon refrigerants, such as R600a and R290, Tecumseh does not approve of, endorse, nor recommend retrofitting existing systems with R600a and R290.



**Tecumseh**

Ann Arbor, MI 48108

[www.tecumseh.com](http://www.tecumseh.com)