TECUMSEH PRODUCTS COMPANY

GUIDELINES FOR UTILIZATION OF

R134a

GUIDELINES FOR UTILIZATION OF R134a

After many years of investigation and testing, HFC134a has emerged as the industry's choice as an alternative refrigerant for CFC12. R134a has an ozone depletion potential (ODP) factor of zero (0.0) and a direct global warming potential (GWP) factor of 0.26. It is not flammable and has acceptable toxicity levels. Unfortunately, R134a is not a "drop-in" replacement for R12. There are significant differences between R12 and R134a, which must be considered when handling, processing, applying or retrofitting with R134a. The following is offered to help understand these differences.

I REFRIGERANT PROPERTIES

A. Pressure/temperature plot of R134a vs. R12 is shown in *figure 1*. The crossover point is approximately at 64°F. Above this temperature, the saturation pressure of R134a is higher than that of R12; below, it is lower.

B. A capacity curve is shown in *figure 2* for relative capacity of R134a vs. R12 for evaporating temperatures from 0°F to 50°F. This curve is based on 120°F condensing temperature. The crossover point will move depending on the condensing temperature. The higher the condensing temperature, the higher the crossover point.

Figure 1. **Pressure vs. Temperature**

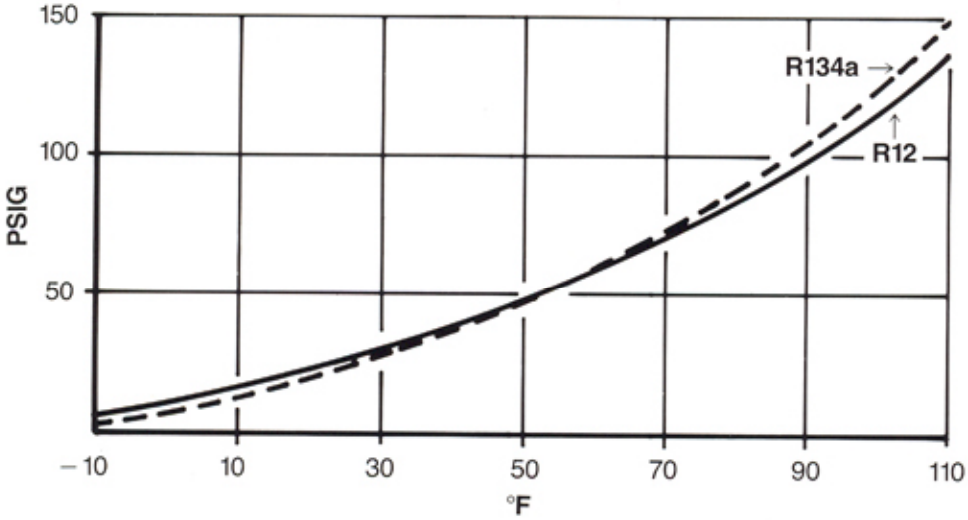
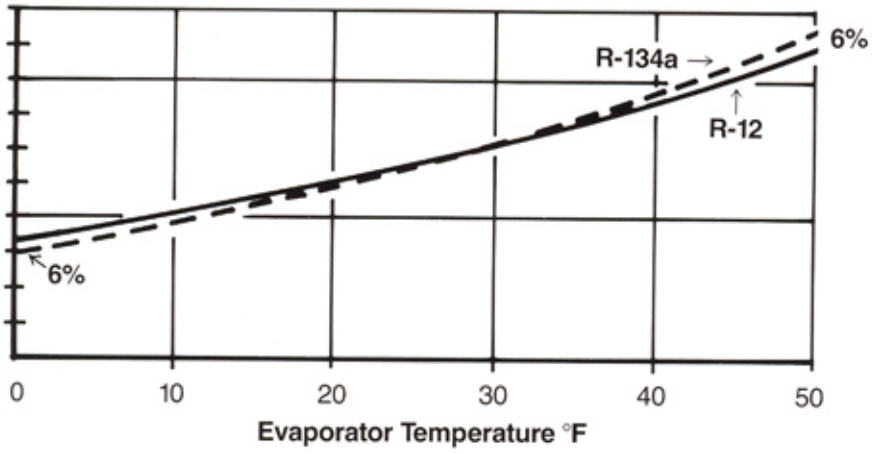


Figure 2. **Relative Capacity vs. Evaporator Temperature**



C. *Figure 3* shows the comparison of some properties of R12, R134a and R22. The data is taken at the standard refrigerant conditions of 5°F evaporating or 86°F condensing.

D. For the same amount of subcooling, R134a produces the greater refrigerating effect.

E. **Water Solubility:** Liquid R134a, like R22, can absorb **much** more water than R12 therefore it would be less likely for a low temperature system to exhibit capillary tube blockage due to ice buildup. However, this does not reduce the need for a dry system. See Section II. B.

F. Extensive investigation and testing have been conducted to determine that R134a is compatible with all materials used in Tecumseh Products' hermetic compressors and condensing units.

Figure 3

DATA	R12	R134a	R22
Chemical Formula	CCL_2F_2	CH_2FCF_3	$CHCLF_2$
Evaporating Pressure (PSIG)	11.8	9.1	28.2
Condensing Pressure (PSIG)	93.3	97	158.2
Sat. Vapor Density @ 5°F (Lbs./cu. ft.)	.6859	.5128	.8042
Sat. Liquid Density @ 86°F (Lbs./cu. ft.)	80.7	74.3	73.3
Latent Heat of Vaporization @ 5°F (BTU/Lb.)	68.2	89.3	93.2

II LUBRICANTS - POLYOL ESTERS (POE's) ----------

A. **Miscibility**

1. Miscibility is the ability of the lubricant and the refrigerant to mix. This miscibility is a very important factor in the returning of the lubricant to the compressor in a refrigeration system over its range of operating temperatures.
2. R134a and mineral oils are **not miscible.**
3. Polyol ester oils and R134a **are miscible.** The miscibility of polyol ester (POE) oils and R134a is similar to that of current refrigerant oils and R22.

   Some types of POE's are fully miscible with R134a (as are synthetic alkylate and R22), while some POE's are partially miscible with R134a (as are mineral oils and R22).

B. **Moisture**

1. Polyol ester oils, while not as hygroscopic (ability to absorb moisture) as earlier considered PAG's (poly alkylene glycols), are **100 times** more hygroscopic than mineral oils. This moisture is difficult to remove even with heat and vacuum.
2. **Utmost care must be taken to prevent moisture from getting into the refrigeration system.** Do not leave the compressor or system open to the atmosphere for longer than 15 minutes maximum. The preferred method of assembly would be to remove system component plugs and caps just prior to brazing. The maximum system moisture content after completing system processing should be 80 PPM. After running the system with the appropriate drier installed, the system moisture level should be 10 PPM or less.
3. **Always** use an appropriate drier in the system when using R134a. (See section on DRIERS.)

C. **Compatibility**

1. Extensive investigation and testing have been conducted by Tecumseh Products Company to determine that the polyol ester lubricants **approved by Tecumseh** are compatible with all materials used in Tecumseh hermetic compressors. Contact your Tecumseh sales representative for the latest list of approved oils. (Policy Bulletin No. 105.)
2. All polyol ester oils approved by Tecumseh Products are compatible with each other.
3. While polyol ester oils are compatible with mineral oils, they should **not** be indiscriminately mixed with mineral oils in R134a refrigerant systems. This practice could result in the inability of the oil to return to the compressor and/or reduce heat transfer performance in the evaporator. However, small amounts, up to 1% of mineral oil are acceptable in field retrofit situations.

III SYSTEM DESIGN

A. **Compressor selection:** Tecumseh is continuing to design R134a compressors with the compatibility of oil, refrigerant and materials in mind. These compressors will have the letter **"Y"** as the refrigerant designator, e.g. **AE3440Y**. These compressors are designed to closely match the capacity of their corresponding R12 compressors at their individual rating point. In many cases, the same displacement is used, especially in HBP compressors, while in some cases it is necessary to use the next larger displacement. 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**, R134a has a greater refrigerating effect than R12, thus reducing the required mass flow for a given capacity. Consequently, a non-heat exchange capillary tube may require a change, either more restrictive **or** less restrictive, depending on the actual application. A heat exchange capillary tube may not require any change. As with any capillary tube selection, system testing is necessary.

C. **Expansion valve selection:** The expansion valve manufacturers have designed product specifically for use with R134a. Consult them for their recommendations.

D. **Driers:** Tecumseh requires that an appropriate drier be used on every R134a system. See section on DRIERS.

E. **Return gas/discharge temperatures:** The theoretical discharge temperature for R134a is **slightly** lower than that of R12 at similar conditions. Therefore existing compressor guidelines regarding return gas and discharge temperatures for R12 should apply to R134a compressors as well. In general, keeping the return gas cool without flooding 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**, based on limited application data, 5% to 30% less R134a will be needed compared to R12.

IV DRIERS

A. The polyol ester oils, which are used with R134a, are prone to hydrolyze with moisture, resulting in the formation of acids. Therefore, Tecumseh requires that an appropriate drier be used in every R134a application.

B. The types of driers, which should be used, are the molecular sieve type, which are presently compatible with R22. The XH-6 **(bonded core)**, XH-7 and XH-9 types are recommended. The XH-6 (loose fill) type is not recommended due to its high attrition rates.

C. Solid core driers if made with bauxite would have the tendency to absorb both polyol ester oil and moisture. The ester could hydrolyze and form acidic materials. If the drier were to be overloaded due to excessive moisture in the system, it could release the acidic materials back into the system. Clearly this would **not** be healthy for the compressor. **For this reason, Tecumseh does not recommend the use of solid core driers made with bauxite for systems containing polyol ester oils.**

D. For specific drier selection, contact your drier supplier.

V SYSTEM PROCESSING

A. **Compatibility**

1. R12 has more tolerance to system processing materials, such as drawing compounds, rust inhibitors and cleaning compounds, than R134a. Such materials as these are not soluble in R134a. If they were to be washed from the system surfaces by the polyol ester oils, they could be free to accumulate at the capillary tube or expansion valve and plug it. Care must be taken to remove such processing materials from all the system components.

2. The earlier investigated PAG oils were totally incompatible with chlorinated materials. The current polyol ester oils, however, do not behave the same way. Similar to R12 systems, residual chlorinated materials **must** be considered as system contamination and eliminated from all internal surfaces of the refrigeration system.

B. **Evacuation**

1. The evacuation levels for R134a systems should be the same as for R12 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-condensibles. Tecumseh recommends a maximum of 2% non-condensibles and 80 PPM moisture. The completed system should have a moisture level of 10 PPM or less after running with an appropriate drier installed.
2. Polyol ester oils vaporize much less than mineral oils for the same level of heat and vacuum. Therefore, if oil vaporization was not a problem with the R12 system processing, it should not be a problem with the R134a system processing.
3. Consult your vacuum pump manufacturer to learn if your existing equipment may need to be converted for use on R134a/polyol ester systems.

C. **Leak Testing**

1. Use equipment that is designed for R134a detection or approved for R134a use by its manufacturer. Many leak detector manufacturers have R134a detectors on the market, and more are in development. Consult these manufacturers for their recommendations.
2. **CAUTION**. DuPont warns not to attempt to use R134a as a mixture with air to pressure test for leaks. Contact DuPont for more information.

D. **Refrigerant Charging**

1. In general, refrigerant charging equipment such as charging boards, valves, and hoses, which are compatible with R22 (considered more aggressive with gaskets and plastics than R12), should be compatible with R134a. This equipment would need to be recalibrated for use with R134a. **Once designated for R134a use, it should be used specifically for R134a only**. Converted R12 equipment should be clean of all residual R12. Pulling a deep vacuum (25 to 50 microns) and repeated flushing with R134a should be sufficient. Consult your equipment and component manufacturer for specific recommendations for converting R12 equipment for use with R134a.
2. R134a can be charged in either the liquid or vapor state. 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 while the compressor is running. **CAUTION: Always break the vacuum with refrigerant vapor <u>before</u> applying power to the compressor.**

VI RETROFITTING ----------

The ideal situation regarding the use of R134a would be that it be limited to new equipment only. In this way, the system components would all be selected and tested by a system designer with the necessary concerns regarding R134a and polyol ester oils in mind. However, in the real world of today with millions of existing R12 systems in the field, and the supply of R12 rapidly declining as the CFC phaseout date approaches, this would not be possible.

Therefore we offer some **<u>general</u>** guidelines to those who must retrofit existing R12 units in the field with R134a. Specific procedures can only be determined after an in-depth evaluation of the existing equipment. Contact the equipment OEM for specific details.

A. Replacing an R12 compressor with an R134a ("Y") compressor: Use generally accepted system change out procedures, taking special effort not to leave the system or the R134a compressor open to the atmosphere for more than a few minutes (15 minutes maximum).

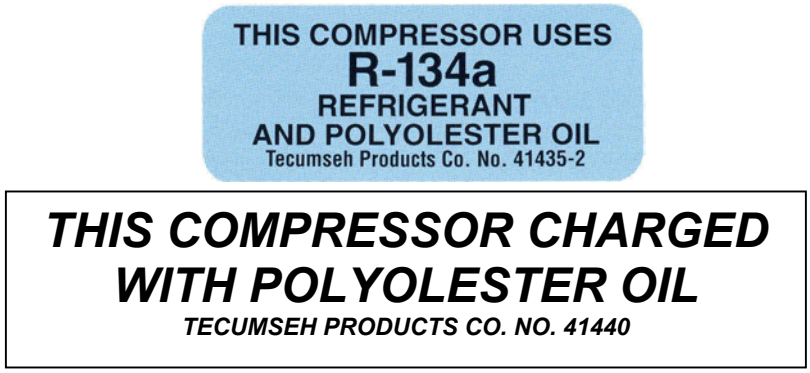
1. Recover the R12 refrigerant and any residual mineral oil left in the system using proper recovery equipment.
2. Refit the system with the proper capillary tube or expansion valve.
3. Install a drier suitable for R134a use and of suitable size for the system being retrofitted.
4. Install the proper Tecumseh R134a ("Y") compressor containing polyol ester oil. This compressor displays a blue label stating that it uses R134a refrigerant and polyol ester oil. (See Figure 4.) Be sure to use the correct electrical components; they could differ from those used with the R12 compressor.
5. Evacuate the system thoroughly. (Ref. VB.1.)
6. Break the system vacuum with R134a vapor.
7. Charge the system using industry acceptable charging methods with the proper amount of R134a. Generally, the system will use less than that used with R12.
8. Check the system for proper operation.

B. **Replacing the R12 in an existing system with R134a:**

1. Recover the R12 using proper recovery equipment and procedure.
2. Remove the compressor from the system and drain the original oil from the compressor.
3. Recharge the compressor with the proper amount of a Tecumseh approved polyol ester oil. Consult your authorized Tecumseh Wholesaler or Tecumseh literature for the correct oil charge. (Compare the correct oil charge with the amount drained from compressor to determine if a substantial quantity of oil has been left in the system.)
4. Reinstall the compressor and evacuate the system.
5. Charge the system with R12 using industry acceptable charging methods.
6. Run the system long enough to allow the remaining original oil to mix with the polyol ester oil.
7. Repeat this process (steps B.1 through B.6) of draining and recharging with new polyol ester oil until the amount of original oil remaining in the polyol ester oil is approximately 1% or less. (Typically three change outs will be sufficient.)
8. Recover the R12 from the system using proper recovery equipment and procedures.
9. Remove the compressor from the system and drain the used oil. Recharge with the proper amount of new, dry Tecumseh approved polyol ester oil.
10. Refit the system with the proper capillary tube or expansion valve.
11. Install a drier suitable for R134a use and of suitable size for the system being retrofitted.
12. Evacuate the system thoroughly. (Ref. V.B.1.)
13. Break the vacuum with R134a vapor.
14. Charge the system using industry acceptable charging methods with the proper amount of R134a. Generally the system will use less than that used with R12.
15. Check the system for proper operation.

    After retrofitting an R12 system with R134a, always identify the system as being charged with R134a and containing a polyol ester oil. Indicate on the unit the amount of R134a used.

Figure 4



The transition from the familiar R12 refrigerant to the new unfamiliar R134a refrigerant will present many challenges to our industry. Tecumseh Products Company is working diligently to meet these challenges. For information regarding the new Tecumseh R134a "Y" compressors, contact your Tecumseh sales representative.

Tecumseh Products Company
Tecumseh, Michigan 49286