AIR-COOLED CHILLERS

Specifying The Right Refrigerant

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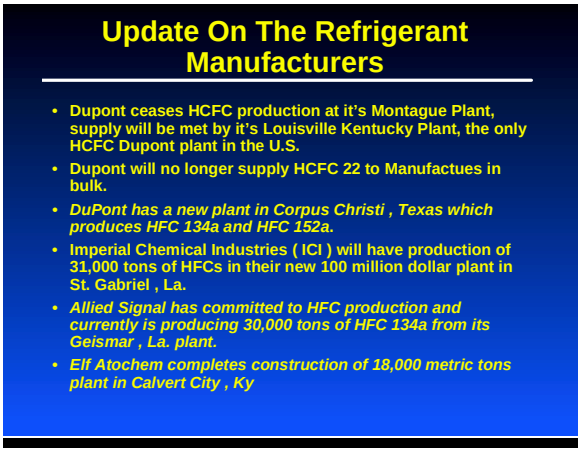
International negotiators meeting in Montreal in 1987 agreed to phase out all chlorinated refrigerants not only CFCs but also HCFCs. Since then, the Montreal Protocol has driven the air conditioning and refrigeration industry to find the best alternatives.

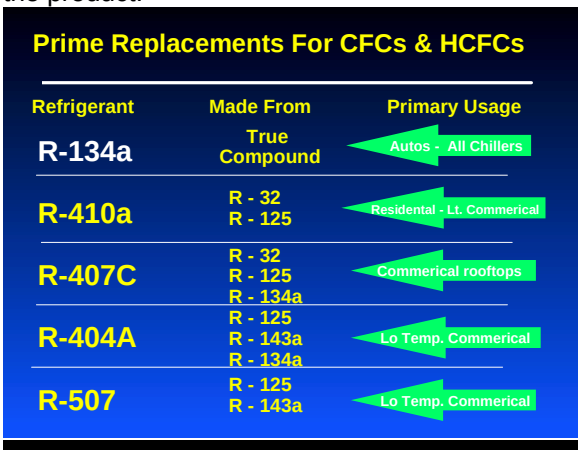
A number of manufacturers of air-cooled liquid chillers have made a transition away from HCFC-22, a chlorodifluoromethane (HCFC) that has been linked to depletion of the ozone layer. Others, however, are defending this refrigerant as acceptable until they are able to develop new equipment.

Although the Montreal Protocol gave manufacturers many years to wind down the use of HCFCs, chemical producers are accelerating the phase-out. DuPont has announced plans to stop supplying HCFC-22 in bulk to major manufacturers after 2005. This will drive up the price as the manufacturers are forced to buy the refrigerant in small containers. DuPont has shut down all HCFC-22 production sites except for the plant in Louisville, Kentucky. A number of chemical producers are increasing production of a chlorine-free alternative, R-134a. Allied Signal, ICI, Elf Atochem and DuPont have either built new R-134a plants or have increased production at existing plants.

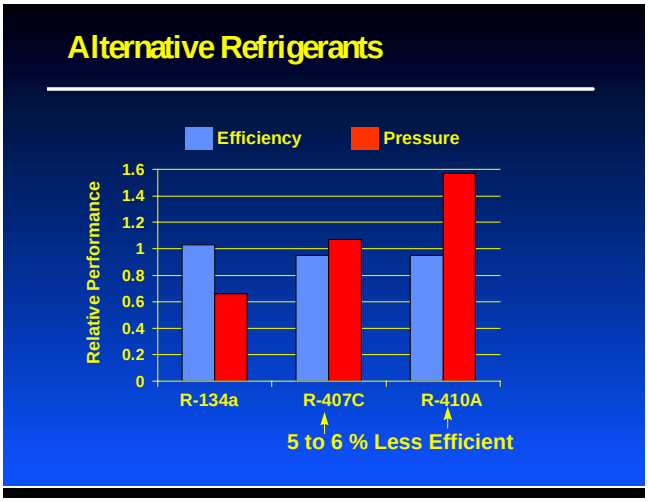


The direction is clear. Chlorine-free refrigerants are the future market. The choice replacement for HCFC-22 in chillers is R-134a. Carrier, Trane, York and McQuay have moved to R-134a in newly designed water-cooled centrifugal and screw chillers.

Some manufacturers have used alternatives, **R-407C** and **R-410A**, in cases where they have adapted existing equipment rather than completely redesigning the product.

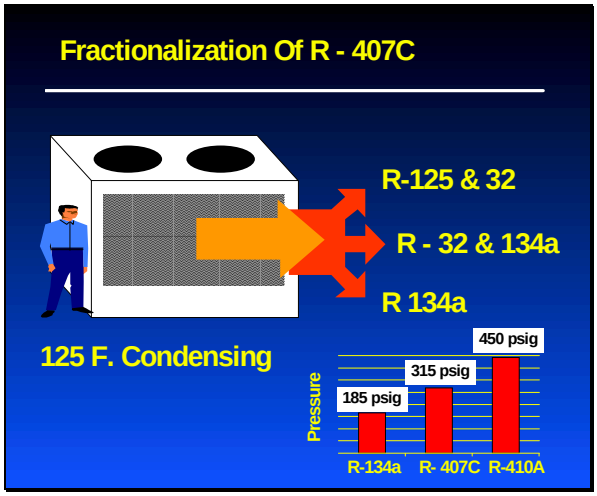


R-407C, a blend of R-134a, R-32 and R-125, has properties close to HCFC-22 and can be used as a close conversion, in which equipment has been adapted but not fully redesigned. However, if a manufacturer wants to move to a permanent replacement refrigerant for the long term, R-134a is the accepted better choice. One reason is that R-407C is 5 to 6% less efficient than R-134a. As R-134a is a true compound, the chiller system does not have to be designed to accommodate the special flow, pressure and temperature changes required by a blended refrigerant.



As a blended refrigerant, R-407C has a wide glide temperature. To fully evaporate at 125° F (51.7C°), the refrigerant will begin to evaporate at 116.4°F (bubble point) and fully evaporate at 124.9°F. This range of evaporation and condensing is a sub-optimized choice for application in air-cooled chillers, especially flooded evaporators, now being used by the leading manufacturers. On the other hand, R-134a, as a true compound, evaporates and condenses at a set temperature and pressure. This allows for a simpler and consistent performance.

R-407C has a wide temperature range for evaporation because the refrigerant is a blend of three chlorine-free refrigerants, R-134a, R-125 and R-32. The proportions are 52% R-134a, 25% R-125 and 23% R-32. Yes, over half of R-407C is R-134a. The blend was created as a conversion match for existing HCFC-22 designs.



Since the three refrigerants in R-407C have different evaporating and condensing rates, there is reason for concern over what happens when the refrigerant leaks. When R-407C leaks, the mixture ractionates." This fractionalization means a change occurs in the composition of the mixture left behind in the chiller. At an air-cooled condensing pressure of 315 psig, the contents can be spilled in a matter of minutes. Even a small leak can have an effect by leaving the chiller with a disproportionate mixture, which affects the equipment capacity and performance.

R-410A

R-410A, a blend of R-32 and R-125, is considered an azeotrope,* or a near compound. In the R-410A blend, the two refrigerants perform as if they were a single compound. However, R-410, with a 50/50% mixture of R-32 and R-125, operates at very high pressures. At a condensing temperature of 125°F and pressure of 449.2 psig, any leak would result in this refrigerant exiting the chiller in a matter of seconds. R-134a, at 125° condensing, has a pressure of 184.6 psig. As a result, the leak rate and the change in performance are not as great as with 407C and 410A. Why worry about leaks? In air-cooled chillers, this is a big consideration. The condenser coils, exposed to the open atmosphere, are subject to corrosion and damage. As most air-cooled chillers are installed on the top of buildings, gaining access is more difficult and repair takes longer.

**Azeotropes are near compounds consisting of unique mixtures of two or more compounds which have precisely or nearly the same composition in both liquid and vapor states. ASHRAE Standard 34 defines azeotropes as lends comprising multiple components of different volatilities (evaporating quickly) that, when used in refrigeration cycles, do not change volumetric composition (size) or saturation temperatures as they evaporate (boil) or condense at constant pressure."*

Another concern relating to chiller leaks is whether the replacement refrigerant will be readily available. R-134a is used in everything from automobiles to respirator inhalers. Since R-407C and R-410A are new, applications are limited to packaged chillers (R-407C) and residential air conditioners (R-410A) in the U.S. This is evident by the current price of these refrigerants.

The application of refrigerants in air-cooled chillers raises concerns not only over possible leaks and lengthy repair times, but also over performance.

Manufacturers of new air-cooled equipment have proven the effectiveness of R-134a. The performance of R-134a has been certified by such organizations as the Air Conditioning Refrigeration Institute (ARI) for both water-cooled and air-cooled chillers. In contrast, R-407C and R-410A have not been subject to the chiller certification audits of ARI and other organizations. Theoretical performance of the refrigerants favors R-134a as the choice, and ARI has verified the actual hardware. R-407A and R-410A have not been verified. At this time, consulting engineers should specify R-134a. However, manufacturers who are migrating to R-134a using R-407C and R-410A deserve an entry. To assist in that direction, attached is a specification that addresses the issues critical to this choice until all manufacturers have fully migrated to the best choice, R-134a.

Refrigerant Specification

Chiller is to be an R-134a design. Any alternative refrigerant designs must be chlorine-free and must comply with the following requirements.

- Factory performance tested to ARI550/590-98. Performance is to match sold conditions both at full load and part load conditions.
- Refrigerant full charge replacement due to fractionalization is to be guaranteed for eight years. Any leaks or loss of charge is the responsibility of the manufacturer without cost to the owner.
- Certification documentation for all pressure vessels testing and inspection is to be submitted prior to shipment signed by an officer of the manufacturing company