



The Refrigerant Replacing R-22:  
**R-410A**



Functionality

Factory Testing

Ease of Installation

Ease of Maintenance

Energy Efficiency

AAON • 2425 South Yukon Avenue • Tulsa, Oklahoma 74107 • (918) 583-2266 • Fax (918) 583-6094 • [www.aaon.com](http://www.aaon.com)

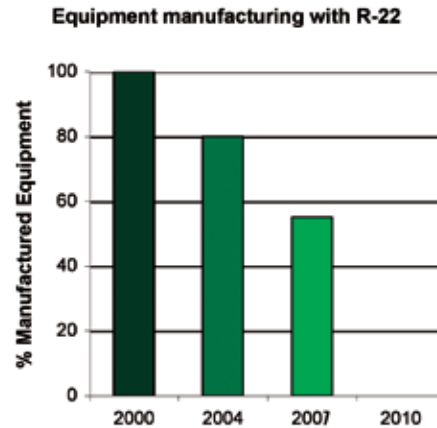
## Why is R-22 being replaced?

### Classic Refrigerants Deplete Ozone

In the 1980s, the depletion of stratospheric ozone, a compound which absorbs harmful UV-B radiation was discovered, the root cause of the problem was determined to be atmospheric halogen gases. Atmospheric ozone ( $O_3$ ) is created when oxygen molecules ( $O_2$ ) collide with free oxygen atoms (O), however, upon exposure to solar radiation, halogen gases create compounds that are highly reactive with ozone molecules, breaking them apart, and leaving oxygen ( $O_2$ ). One of the halogen atoms principally responsible for depleting ozone in this manner is chlorine (Cl), commonly used in so called chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants.

### Regulations

In response to the stratospheric ozone losses, a treaty known as The Montreal Protocol on Substances That Deplete the Ozone Layer was developed. The treaty calls for the discontinuation of the substances with the greatest potential for ozone depletion such as CFC-12 (R-12) which was phased out in 1996, and gradual phasing out of HCFCs such as HCFC-22 (R-22). As a result, the United States developed ozone protection legislation in the form of the EPA's US Clean Air Act which will not allow the use of HCFC's in newly manufactured air conditioning equipment after Jan. 1, 2010. Subsequent production of HCFC's will be for the servicing of existing equipment. Production levels for HCFC-22 (R-22) refrigerant were capped in 1989, and the phase out time line calls for R-22 production levels to be reduced to: 35% of the 1989 cap in 2010, 10% of the 1989 cap in 2015, 0.5% of the 1989 cap in 2020, and complete phase out in 2030.



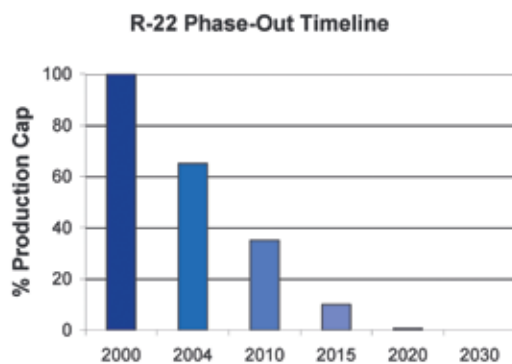
### Refrigerant Alternatives

The necessity for non-chlorinated refrigerants pursuant to the new regulations resulted in the investigation of HCFC-22 replacements in the 1990s. Several refrigerant alternatives emerged from these studies, with none being a perfect replacement in the sense that it mimics the performance of HCFC-22 in all applications. Those refrigerants that have shown the greatest potential as HCFC-22 replacements are known as hydrofluorocarbons (HFCs), compounds that contain no chlorine atoms, and so have very little or no ozone depletion potential. Of these alternatives, the most commonly considered to be candidates to replace HCFC-22 are HFC refrigerants R-410A, R-134a, and R-407C. R-410A and R-407C are blends, while R-134a is composed of a single constituent. R-410A is composed of a 50/50 mixture of R-32 and R-125, while R-407C is composed of 23% R-32, 25% R-125, and 52% R-134a by weight. When considering alternative refrigerants, the advantages and disadvantages of each (including R-22) must be carefully considered.

## What are the potential replacements?

### R-22

R-22 has been the industry standard for air conditioning applications. However, as of 2010, the availability of R-22 will diminish significantly, and over the 15 year (or more) lifespan of an air conditioning unit, R-22 will be available only from what is recoverable, which will diminish year over year, likely increasing prices.



### R-134a

The advantage to selecting R-134a is that as a single component refrigerant, it is not subject to any of the difficulties that arise with mixtures. However, when compared with R-22, R-134a has a 40% lower refrigeration capacity. In practical applications, using this refrigerant requires larger heat exchanger sizes and bigger compressors to provide the same capacity and efficiency attained with R-22. This requires more sheet metal, a larger equipment footprint, a greater requirement of building space to accommodate equipment, and higher manufacturing costs. This refrigerant cannot be used in existing R-22 systems as a 'drop-in' replacement, but requires new, dedicated equipment.

### R-407C

The advantage in selecting R-407C is its ability to be used as a 'drop-in' replacement for R-22 systems, allowing existing R-22 systems to be charged with R-407C. When retrofitting equipment that is in use,

the R-22 refrigerant and mineral oil must be carefully and thoroughly removed before charging, as R-407C is not miscible with the mineral oils typically used in R-22 systems, requiring instead a synthetic lubricant. When used in systems designed for R-22, R-407C performs with about a 5% reduction in efficiency. A primary disadvantage of R-407C is that as a zeotrope it experiences fractionation; the mixture does not maintain a constant composition across phase changes. Saturation temperatures may vary up to 9°F (a phenomenon known as temperature glide) in the refrigeration cycle because at a given pressure, the blend boils/condenses at different temperatures. This can be a particularly serious issue if the system develops leaks, and performance diminishes. When re-charging the system, refrigerant cannot simply be added because the leak rates of the individual components are not equal due to the fractionation effect. The system must be completely evacuated. The previous charge must be recovered and disposed of or recycled. A complete re-charge of unused refrigerant is required to ensure the proper mixture and desired performance.

### R-410A

The refrigerant blend R-410A is a nearly azeotropic refrigerant blend, and does not experience fractionation upon change of phase, and very little temperature glide (<0.3°F). This means that the concern over refrigerant composition with blends such as R-407C is eliminated, and a system may be serviced as with refrigerants of single molecular composition. System efficiencies are comparable to or greater than R-22 for the same capacity due to the increased heat capacity and higher operating pressure, allowing for reduced flow rates, and smaller heat exchangers and compressors. Smaller equipment requires less sheet metal, smaller equipment footprints, and can reduce manufacturing costs thereby eliminating the larger building space and equipment requirements found in systems designed around R-134a.

## Why is R-410A the best choice?

### A Word About Warming Impact

Another environmental issue that is addressed in the evaluation of various refrigerants is their impact on global warming. In the ASHRAE Handbook 2006 – Refrigeration, each refrigerant is assigned a Global Warming Potential (GWP) as they are considered greenhouse gases. The GWP is a measure of the direct effect of the refrigerant on global warming by its release into atmosphere, and as such, does not describe the contribution of greenhouse gases such as carbon dioxide produced by the production of energy required to operate equipment that cycles the refrigerant. To account for the total warming effect (the direct and indirect effects), the Total Equivalent Warming Impact (TEWI) index is used. The direct warming effect associated with a piece of equipment comes from leakage of the refrigerant into the atmosphere, and typically contributes less to the TEWI than does the indirect effect, making the indirect effect the more critical aspect when considering warming potential. Because the indirect effect is related to energy consumption, the most efficient refrigerant will contribute the least to the TEWI. When R-410A, R-407C, R-134a, and R-22 are compared this way, R-410A contributes the least to the TEWI because it is the most efficient and demands the least use of carbon producing fossil fuels in the creation of energy.

been used extensively in residential applications for over ten years, has proven itself to be safe and dependable, and is being adopted as the standard to replace R-22 in commercial air conditioning markets. In anticipation of customer's needs, AAON began offering commercial products with R-410A in 2001, and subsequently incorporated it into nearly all products. Recently introduced product lines such as HB rooftop units and CB/CC condensing units have been designed to operate with R-410A only. All AAON systems that incorporate R-410A are engineered specifically to work with the refrigerant, independently tested, and certified to guarantee safety and performance. Opponents to adopting R-410A who cite first cost as a reason to continue purchasing equipment featuring R-22 should consider carefully the service costs over the product's lifetime, as R-22 becomes increasingly scarce. While it is currently possible to continue purchasing new products featuring R-22 it is not necessarily the best option. AAON fully supports R-410A as the refrigerant to succeed R-22 in air conditioning and comfort cooling applications. In 2010, it will be the only refrigerant available in new AAON equipment. To specify R-410A in your next purchase, or for more information about products featuring R-410A, contact your local AAON Sales Representative.

### R-410A - The Best Choice

On the basis of all these advantages (high efficiency, small footprint, low TEWI), R-410A is the best choice to incorporate into new equipment. It has



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*For more information on AAON products, contact your local AAON sales representative.*

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