

Refrigeration and air conditioning systems
As compared to CO₂ systems, the new generation of HFC-based systems can deliver better overall environmental performance

Energy efficiency and the climate impact of refrigeration and air conditioning systems depends not only on the type of refrigerant but also on the quality and design of the system in which it is used.

The new generation of systems using HFCs are delivering improved efficiency, in addition to reduced refrigerant emissions, compared to HFC systems, designed in 2000. However it is often the case that it is the older systems that are typically used as the baseline reference for comparisons to non-HFC refrigerants.

Efficiency Comparison of CO₂ with fluorocarbon-Example

Using similar equipment, including microchannel heat exchangers optimised for each refrigerant would provide fairer comparisons. This has been simulated using sophisticated refrigeration models for air-conditioning. The study showed that fluorocarbon refrigerant had significantly better energy efficiency (COP) than CO₂. The energy efficiency of fluorocarbon was found to be about 41% higher than CO₂ at 28°C. At higher temperatures the efficiency gap was even greater.

Reference: Evaluation of Carbon Dioxide as R-22 Substitute for Residential Air-Conditioning, J. Steven Brown, Yongchan Kim, Piotr A. Domanski, 2002 submitted to ASHRAE

Note: This study used HCFC 22 as the fluorocarbon and HFC 410A has been shown to have very similar efficiencies to HCFC-22 for air-conditioning.

Given that the performance of refrigeration and air-conditioning systems is dependent both on the refrigerant and the system design, to use comparisons with five-year-old systems to generate accurate conclusions about performance of current HFC systems is inappropriate.

For example, CO₂ is intrinsically less efficient than HFCs for usual applications in refrigeration and air-conditioning. This is mainly due to its low critical temperature (a very important property for refrigerant performance) of only 31°C. In contrast the widely used HFCs have much higher critical temperatures.

The properties of HFCs provide the greater opportunity to further optimise systems for a range of applications. So far RAC systems

with HFCs were strongly influenced by first cost investment whereas competitive developments (for example with CO₂) have always been focused on best possible technical optimisation.

Many of the measures taken to optimise CO₂ for energy efficiency can also be applied to HFCs, so that HFCs can be superior to CO₂.

New generation HFC systems have improved designs, lower charge size and low refrigerant emissions, and can be based on a range of HFC refrigerants to deliver optimum performance across the broad range of applications and operating conditions used in refrigeration and air-conditioning.

In addition, direct comparisons have also shown HFCs do have the potential for better energy efficiency than hydrocarbons for some air conditioners, heat pumps, and commercial refrigeration applications.

Improved efficiency with fluorocarbons

In Japan, between 1995 and 2004, room air-conditioners have become twice as efficient, which translates into approximately 10 million tonnes of CO₂ emissions savings.

District cooling and heat pump systems

For district cooling and heat pump systems, HFCs provide the right balance of properties for these large systems, which result in major energy savings compared to other approaches.

Because energy consumption is clearly the most critical factor determining the climate impact of the refrigeration and air conditioning systems, the new generation of high performance HFC-based systems offering the best energy efficiency will further contribute to limit overall greenhouse gas emissions.

The refrigeration and air-conditioning industry uses a range of refrigerants including HFCs, CO₂, ammonia and hydrocarbons in order to deliver the benefits that society needs while driving down the environmental impact of the systems, which is dominated by energy use.

Refrigerant Containment

The containment measures of the F-Gas Regulation, and the WEEE Directive will ensure that industry can select the most appropriate refrigerant, and contain it within the system to deliver improved environmental performance cost-effectively.

Banning HFCs in any refrigeration and air-conditioning application will limit improvements in environmental performance, will reduce the competitiveness of EU industry and will impose considerable costs preventing investment in other more cost-effective approaches to reduce environmental impact.

Refrigerator or small commercial appliance using HFC refrigerant

With end-of-life recovery of refrigerant, required by WEEE Directive, energy use is 98% of global warming impact.

Note: Refrigerator with 70% end of life recovery.

New generation HFC chiller designed with low refrigerant emissions

With end of life recovery, which is straightforward and necessary before decommissioning, energy use is 95-98% of global warming impact, depending on location and chiller operating requirements.

Note: Chiller with 0.5% annual loss, 95% end of life recovery, 30 years lifetime estimate