MOBILE AIR CONDITIONING

SOCIETAL IMPORTANCE

Mobile air conditioning is an important part of an integrated system that provides cooling, heating, defrosting, demisting, air filtering and humidity control for both passenger comfort and vehicle safety. Its reliability and convenience are often taken for granted but it is the key to keeping passengers safe and comfortable in more than 600 million vehicles worldwide.

Critical Application Considerations

Mobile air conditioning presents a severe test for systems and refrigerants. The system will operate for many years under widely varying weather conditions, even though it is exposed to hostile environments and is subject to vibration and temperature variations under the hood. It is desirable to have relatively rapid cool-down. It is important that the load on the engine is minimized to avoid an excessive carbon footprint from operating power demand. Because of the vibrations and adverse conditions, leakage has been historically high, but it has been reduced by tightening the systems. To further reduce direct impacts on the climate, there has been consideration of new refrigerant options with a lower GWP.

The European Union, in Directive 2006/40/EC, mandated new auto air conditioning systems to use a refrigerant with a GWP of 150 or less in new car platforms beginning in 2011 and a full transition of new equipment to such alternatives by 2017. To accomplish this, three major options were developed for this application. These included CO_2, HFC-152a and a newly introduced unsaturated compound known as HFO-1234yf. HFO-1234yf has an atmospheric lifetime of only 11 days and a GWP of 4 versus 1430, the GWP of HFC-134a. It exhibits energy efficiency equal to that of HFC-134a. Use of this low GWP option will greatly reduce the carbon footprint for use in mobile air conditioning.

Environmental Considerations

New refrigerant options included HFC-152a, HFO-1234yf, and CO_2. Each presents additional environmental concerns and technological challenges. **The most important factors in choosing the optimum system are energy efficiency, safety, and Life Cycle Climate Performance (LCCP).**

A cooperative study under the auspices of US EPA, Mobile Air Conditioning Society (MACS), and Japan Automobile Manufacturers Association (JAMA), utilizing the holistic metric of LCCP found that HFO-1234yf was the best performing option in all four selected climate regions: Frankfurt, Tokyo, Athens and Phoenix.

The LCCP for CO_2 systems was found to be more competitive under lower ambient temperature conditions but did not provide energy efficient cooling in hotter climates where air conditioning demand is most stringent. Several automobile manufacturers are planning transitions to HFO-1234yf systems. Use of this system is viewed as near drop-in. Some may still be considering CO_2. Some manufacturers are considering hydrocarbons which provide energy efficient cooling but introduce costly safety challenges and complexity for their successful use.

Technology Trends

Mobile air conditioning has been one of the most visible and successful applications where environmental improvements have been demonstrated and implemented. Initially the commonly used refrigerant was CFC-12 which was completely eliminated in new vehicle use during the early- to mid-1990s. The replacement HFC-134a was a zero ODP option with a GWP about one sixth that of CFC-12 resulting in far reduced climate change impact. Studies indicated that a 50% reduction in refrigerant losses could be achieved with only a small additional investment in improved seals, hoses and practices which illustrated a potential to reduce leakage to the environment. Finally, manufacturers improved the systems to allow charge sizes to be smaller that further reduced HFC-134a climate impact.

Based on cooperative test results, plans and investments, the current view is that HFO-1234yf will serve as a major alternative refrigerant to HFC-134a. The industry will continue to examine how best to use HFO-1234yf while at the same time be open to other alternatives and technologies. **The metrics will continue to be LCCP, cost, safety and efficacy.**

SOURCES

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The Alliance is an industry coalition that was organized in 1980 to address the issue of stratospheric ozone depletion. It is presently composed of about 100 manufacturers and businesses which rely on HCFCs and HFCs.

Today, the Alliance is a leading industry voice that coordinates industry participation in the development of international and U.S. government policies regarding ozone protection and climate change.