UPDATE ON THE HFC PHASE-DOWN IN MOBILE AIR CONDITIONING

GLOBAL AUTOMAKERS MOVING TO HFO-1234YF,
EXCEPT SOME GERMAN AUTOMAKERS WAITING FOR CO_2 SYSTEMS

BACKGROUND ON HFCS IN THE MOBILE AIR CONDITIONING (MAC) SECTOR

From the introduction of the first mobile air conditioner in 1939 until about 1955, air conditioning used a variety of refrigerants, including hydrochlorofluorocarbon (HCFC)-22, chlorofluorocarbon (CFC)-11, and CFC-12; but from about 1955 until 1990 all MACs worldwide used CFC-12 (Andersen et al., 2013; Zaelke et al, 2012).

In 1974, Mario Molina and F. Sherwood Rowland warned that CFCs could destroy the stratospheric ozone layer that protects Earth from harmful ultraviolet radiation (Molina & Rowland, 1974). One year later, Dr. Veerabhadran Ramanathan confirmed that CFCs are also powerful greenhouse gases, adding significantly to the scientific justification to control CFCs (Ramanathan, 1974). In the decade after, scientists confirmed the ozone science and quantified the adverse effects, which motivated the public and policymakers to take action. In 1987, 24 nations plus the European Community signed the Montreal Protocol. The Montreal Protocol now has universal membership with all UN countries participating as Parties.

HFC-134a is an ozone-safe refrigerant with a global warming potential (GWP) of 1430, which is considerably lower than the GWP of 10,900 for the CFC-12 refrigerant it replaced. It was identified around 1930 by the same General Motors research team that invented CFCs, but was not commercialized at the time because it was more expensive and because the impacts on stratospheric ozone depletion and climate change were not anticipated. In response to the Molina & Rowland and Ramanathan warnings, Harrison Radiator and Allied Chemicals evaluated HFC-134a in 1977 and tested a MAC system in a wind tunnel in 1978. After the Montreal Protocol was signed, the automobile industry moved quickly to select HFC-134a in 1990. The transition from CFC-12 to HFC-134a was completed quickly in developed countries by about 1994 and in developing countries in 2003 (Andersen et al., 2013b).

MAC CONTRIBUTION TO GLOBAL HFC EMISSIONS

Today, HFC-134a emissions from MACs account for about 30% to 50% of GWP-weighted HFC emissions, and such emissions are growing rapidly as increasing incomes in developing countries make automobile ownership possible (CEEW et al., 2013). MACs consume between 3% of motor fuel in mild climates with little air conditioning for either comfort or demisting and up to 20% in India and other countries with long, hot and humid air conditioning seasons and traffic congestion (CEEW et al., 2013; Chaney et al., 2007; Rugh et al., 2004).

Many governments have proposed amending the Montreal Protocol to phase-down the HFCs that replaced ODSs and replacing them with chemicals that have low global warming potentials (GWP) and are energy efficient. Phasing-down HFCs under the Montreal Protocol would reduce HFC production and consumption 85–90%, providing climate mitigation of 87–146 Gt CO_2-eq. by 2050 (Velders et al., 2009; Molina et al., 2009; Velders et al., 2012; Zaelke et al., 2012). Phasing down HFCs could avoid between 0.35ºC and 0.5ºC of warming and 13% of projected sea-level rise by 2100 (Xu et al., 2013; Hu et al., 2013). A significant portion of the climate benefits—30 to 50%— would result from transition to a low GWP MAC refrigerant.

AVAILABILITY OF LOWER-IMPACT REFRIGERANTS FOR INDIAN MACS

Currently, nearly all automobile air conditioners produced or marketed in India use HFC-134a, which has a GWP of 1430 (Andersen et al., 2013b, CEEW et al., 2013; Chaney et al., 2007). However, there are three viable refrigerant options to replace HFC-134a in automobiles: HFO-1234yf, HFC-152a, and CO_2 (CEEW et al., 2013; Andersen et al., 2013). Two companies with a significant presence in India—TATA Motors and Maruti Suzuki—have designed prototype HFO-1234yf systems for the vehicles they intend to export to Europe, but could also be marketed to domestic consumers (CEEW et al., 2013). At least one system supplier is offering Indian automakers designs that can be charged with HFC-134a today, but are "HFO-1234yf-ready" on very short notice for vehicles exported to the European Union (CEEW et al., 2013).

The first European, Japanese, and North American vehicles with HFO-1234yf refrigerant have entered the global market, including Cadillac, Chrysler, Dodge, Honda, Hyundai, Jeep, Kia, Lexus, Maserati, Mazda, Mitsubishi, Toyota, and Subaru (Andersen, 2014, 2013a, 2013b.) Daimler introduced HFO-1234yf in Europe and North America, but later announced that their engineers were unable to safely use this slightly flammable refrigerant and recalled and retrofitted these cars to HFC-134a. Audi, Daimler, Porsche and Volkswagen have announced an intention to commercialize MACs with CO_2 refrigerant but no timetable has been announced.

MAXIMIZING ENERGY EFFICIENCY GAINS WHEN TRANSITIONING TO NEW MAC REFRIGERANTS

Projects supported by both the United States (U.S.) EPA and the global automobile and air conditioning industries have demonstrated technical options to increase energy efficiency of typical HFC-134a MACs by 30% or more compared with standard HFC-134a systems. These energy efficiency design options can be applied to both HFO-1234yf and HFC-152a MACs (US EPA, 2014 and Rugh, 2005)). In India's hot and humid climate, operation of vehicle air conditioners can account for up to 20% of fuel consumption, compared to about 3.2% in Europe, 3.5% in Japan, and 5.5% in the U.S. Consequently, a 30 percentage improvement in air conditioners' fuel consumption produces a greater savings in India than in these other regions (US EPA, 2014).

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