Prof. Dr.-Ing. Johannes Reichelt
Chairman of the Valerius-Füner
Foundation at Karlsruhe University
of Applied Sciences, which
supports studies in the fields of
refrigeration, air conditioning and
environmental engineering

© Johannes Reichelt

CO₂ as a Refrigerant – A Start Has Been Made

In his guest commentary column in ATZworldwide 10/2016, Holger Großmann wrote: “There are no technical obstacles to prevent R744 from being used in automotive air conditioning systems. In my view, R1234yf can only be a temporary solution, while R744 has a promising future, particularly in electric cars.” The future has now arrived with the introduction by Daimler last autumn of air conditioning systems that use CO₂ (R744) as their refrigerant in the Mercedes-Benz S-Class.

Professor Gustav Lorentzen from the University of Trondheim in Norway proposed adopting CO₂ as the refrigerant in car air conditioning systems as early as 1989. Since then, hundreds of millions of euros have been invested in research and development. Suppliers, vehicle manufacturers and research institutions have carried out in-depth investigations into air conditioning systems based on CO₂. Why then has it taken almost 30 years for Lorentzen’s proposal to be put into practice?

The main reasons are political and economic, but the cost of the components and the more complex structure of the new CO₂ air conditioning systems are also influencing factors. The refrigerant itself is much cheaper than R1234yf. It is more difficult to control the thermodynamic process than in conventional air conditioning systems, but this difficulty can be overcome.

In the mid 1990s, German car manufacturers switched from using the R12 refrigerant (high ozone depletion and global

warming potential) in their air conditioning systems to R134a (high global warming potential) over the space of just a few months. As one supplier to the automotive industry said at the end of the 1990s: “Although we have carried out thorough tests of our R134a compressor with the new refrigerant, we are still pleased that there have been no failures in production models.” The current changeover to CO₂ presents more risks. Existing car air conditioning systems use open type compressors with shaft seals and are driven by V-belts or toothed belts. Because of the higher pressure (120 compared to 125 bar) in the refrigerant circuit of a CO₂ air conditioning system, hermetic compressors are needed with a frequency converter to allow them to operate at different speeds. These are currently much more expensive than conventional belt-driven compressors. As more electric cars start to appear on our roads, electrically powered hermetic compressors will become the standard solution.

Daimler’s introduction of CO₂ air conditioning systems in the S-Class and shortly as an option in the E-Class will be followed by Audi with the A8 and other Volkswagen Group cars. In a few years, CO₂ components will be mass-produced, although a heat pump circuit will be required in electric cars, and then the headline will no longer read “A start has been made” but instead “The breakthrough has been achieved”.