STATEMENT

Latest Update: June 2007

Carbon Dioxide (CO_2) in Refrigeration and Air-Conditioning Systems (RAC)

Carbon dioxide (CO_2[①]) was one of the first refrigerants to replace early air cycle systems and was in use primarily for shipboard refrigeration in the beginning of the twentieth century. It was then superseded by chlorofluorocarbons. However, since CO_2 is environmentally benign, non-toxic (in the classical sense), non-flammable, chemically inactive and offers a very high volumetric cooling capacity together with excellent heat transfer properties, it is increasingly considered for use today in RAC systems. Because of its very low global warming potential and zero ODP[②], CO_2 systems do not need the very stringent containment criteria necessary for HFCs and other refrigerants. Since CO_2 is in the same safety class (L1) as HFCs the safety requirements may be less onerous than they would be for ammonia or hydrocarbons.

The thermodynamic characteristics of CO_2 are very different to the refrigerants usually applied in RAC systems. Its very low critical temperature of 31°C may require trans-critical operation, depending on the heat sink temperature on the discharge side. The energy efficiency tends to be lower as compared to a sub-critical conventional system and the system design for trans-critical operation will differ from a conventional vapour compression cycle. Nevertheless, in the right circumstances CO_2 systems can reach or exceed the energy efficiency of systems with established refrigerants.

Pressure levels and volumetric cooling capacity for CO_2 systems are much higher than those for conventional systems. This results in smaller compressor displacement and smaller tube dimensions, and many components, particularly the compressors, need to be specifically designed for use with CO_2.

Therefore, CO_2 technology cannot be seen as a general alternative solution to systems with HFCs, NH_3 or hydrocarbons and in no circumstances must CO_2 be introduced into a non-CO_2 system. Any development/application of CO_2 RAC systems requires a careful assessment of system efficiency, TEWI[③], life cycle cost, technical feasibility, reliability and safety aspects.

ASERCOM members are involved in projects with CO_2 as a refrigerant. Components and solutions for its application have started to become available. However, before proceeding with a CO_2 application, individual consultation with manufacturers is required due to the very specific issues involved.

① R744 according to ISO 817 / EN378-1

② ODP Ozone Depleting Potential

③ TEWI Total Equivalent Warming Impact