STATEMENT

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ASERCOM
ASSOCIATION OF EUROPEAN REFRIGERATION COMPONENT MANUFACTURERS

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 It was then superseded by chlorofluorocarbons.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 considered to become one of the major refrigerants for use in RAC systems.

It is already widely applied in commercial refrigeration applications with subcritical, transcritical and booster configurations and frequently used in combination with heat reclaim and air conditioning. Also a number of prototypes are in operation across Europe in heat pump, air conditioning and refrigerated transport applications. Furthermore, CO_2 is increasingly applied in industrial refrigeration systems with cooling capacities of up to more than 1 MW.

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, however the application of good practices remain necessary for a good functioning of the system. Since CO_2 is in the same safety class (A1) as non-flammable 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 subcritical conventional system and the system design for transcritical operation will differ from a conventional vapor compression cycle. Nevertheless, with solutions like parallel compression, ejectors, heat recovery CO_2 systems can reach or exceed the energy efficiency of systems with established refrigerants and are now applied more and more also in warmer climatic regions.

Uncertainties on the future scenario of HFC and HFO refrigerants and an extraordinary escalation of HFC's market prices also initiated the development and wider availability of CO_2 dedicated components, thus supporting the increased popularity of CO_2 systems.

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.

Furthermore, new dedicated components, increased complexity of the systems, more demanding requirements with higher operating pressures and the consideration of specific CO_2 properties requires new skills and know-how also for planners, installers and maintenance technicians as well as constant training of all the operators involved.

ASERCOM members are widely involved in projects with CO_2 as a refrigerant. A wider range of components and solutions for its application have been available for some years now and will steadily be extended in future. 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