

Mobile RAC systems based on carbon dioxide

At the Thermodynamic Institute in Germany, researchers are investigating into the use of carbon dioxide (CO₂) in mobile air-conditioning and transport refrigeration systems. The team is studying a pressure-controlled reciprocating compressor, a pressure-controlled swash-plate compressor and a path-controlled swash-plate compressor. Prototype compressors were tested on a test rig under conditions expected in air-conditioning, refrigeration and heat pump applications. Initial results indicate fairly good efficiencies with a potential for improvement. Another team at Purdue University, the United States, is scrutinizing semi-hermetic CO₂ compressors. Applications for such compressors include “environmental control units, which are packaged air-to-air air-conditioners that are used in cooling of mission-critical electronics and personnel.”

In Japan, researchers are examining hermetic swing compressors using CO₂. They report that as the density of CO₂ is high and its refrigeration capacity per unit volume is large, the displacement of CO₂ compressors becomes small and, as a result, the influence of leakage on capacity becomes larger and the volumetric efficiency tends to be lower. In addition, its operating pressure is high and the differential pressure is large. As such, the focus is on a swing compressor that can maintain high efficiency and reliability even under larger differential pressure.

The team achieved high efficiency and reliability with CO₂ compressors by optimizing the design of a swing compressor for minimization of leakage and reviewing the thickness of parts that receive a large pressure difference. These compressors are mounted on CO₂ heat pump water heaters, which are already commercialized and contribute to energy savings through a high energy efficiency of COP 3 or higher.

Danfoss, Denmark, is considering low-capacity hermetic-type compressors to harness the fluid properties of CO₂. A number of compressors have been assembled and tested in various running conditions. Tests exceeded more than 1,300 h with individual compressors at various operating conditions up to 160 bars as high pressure. No critical wear was detected on any compressor performance, as well as the noise and vibration levels.

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