Technical Paper:

Natural refrigerants at high temperatures:

a challenge for pumping technology

Not only since the F-gas regulation was enacted by the EU, natural refrigerants have become an increasingly important focus of system manufacturers. The use of CO_2, ammonia and hydrocarbons as energy carriers, however, poses new challenges to design engineers and thus also to pump manufacturers. At the same time, the requirements regarding energy efficiency are increasing. One way of saving energy are for example higher standby temperatures of refrigeration systems. This combination of high temperatures, which are also used in processes such as defrosting, and new natural refrigerants leads to pressure load peaks in pumps and systems. Design and sizing have to be adapted to these conditions.

Refrigerant pumps reliably supply the required amount of medium to the evaporators of a refrigerating plant and overcome the inherent pressure loss. Reliability and safety, expressed as MTBF and absolute leak-tightness of the pump, are a matter of course. Canned motor pumps which provide safety [absolute leak-tightness] and a high MTBF [by avoiding shaft seals and couplings] due to their design are preferably used. With canned motor pumps, additional safety is ensured by a second pressure casing, referred to as secondary containment which prevents gas leakage. For this proven pump technology, friction bearings lubricated by the refrigerant are used. They support the rotating part (rotor) of the pump so that the pump operates in a contact-free and therewith wear-free manner.
The viscosity of liquid gases such as NH_3 or CO_2 is already low at common operating temperatures. Low viscosities at higher temperatures have a negative impact on the load-bearing capacity of friction bearings. Bearings made of the wrong material or bearings with a small surface show mixed friction during operation which causes wear. This leads to premature failure of the pump. Especially the trend towards higher operating and standby temperatures and the use of the pump for defrosting may cause problems. Due to the temperature dependence, the viscosity drops considerably at higher temperatures. The load-bearing capacity of the friction bearing decreases and has to be checked and the design has to be adapted. This prevents premature failure.

High standby and operating temperatures of systems are increasingly common in day-to-day operation. In addition to the viscosity, the steam pressure of the liquefied gases used as refrigerants also depends on the temperature. This is why the design of the system must conform to the steam pressure at higher temperatures. All components used must be selected accordingly. This also applies to the pump. When using for example CO_2 and a standby temperature of approx. 10 degrees Celsius and taking common safety coefficients into account, the resulting design pressure of the pump (PN = nominal pressure) is 52 bar. The design of pumps and the materials used must withstand this nominal pressure. Pressure containing parts are for example made of cast steel.

The CAMh pump by HERMTIC-Pumpen GmbH in Gundelfingen, Germany, is designed for these requirements. The generously dimensioned friction bearings made of state-of-the-art sintered materials ensure a contact-free and thus virtually wear-free operation of the pump. The design and material selection safely covers the nominal pressure PN of 52 bar. According to the applicable standards, such as ISO 15783 for canned motor pumps, a pressure test using 78 bar is performed for each pump. In addition, the secondary safety containment is tested for leak-tightness using nitrogen (N_2). This ensures that potential faults in workmanship or material are detected and a maximum leak-tightness and safety are guaranteed.

Profile of HERMETIC-Pumpen GmbH
HERMETIC-Pumpen GmbH, based in the German town of Gundelfingen (near Freiburg), is a world leader in the area of sealless pumps. The company employs around 440 people in Germany. HERMETIC pumps are used in the chemical industry, as well as in the oil and gas industries. They are also used in the industrial refrigeration industry and at solar thermal power plants. Over 250,000 HERMETIC pumps have hitherto been deployed worldwide for the most demanding conveying applications.

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