TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Mechanical Science and Engineering Bitzer Chair of Refrigeration, Cryogenics and Compressor Technology

Internal Cooling of Reciprocating Compressor Parts

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Motivation

Thermodynamics and heat transfer phenomena significantly influence the energy and volumetric efficiency of reciprocating piston compressors. In addition, the durability of sealing elements is affected particularly for non-lubricated operation.

As a consequence, an effective, reliable and economical cooling technique is demanded. The Internal Cooling of Reciprocating Compressor Parts is believed to meet all these requirements.

Cooling Technology

In order to cool the thermally stressed piston and piston rod, these components are provided with a leak-tight internal volume which is charged with a two-phase coolant. Owing to the reciprocating motion, both phases are mixed and the coolant flows back and forth between both ends of the internal volume. This enables a fluid flow-based heat transfer from the cylinder area to the oil-lubricated crosshead.

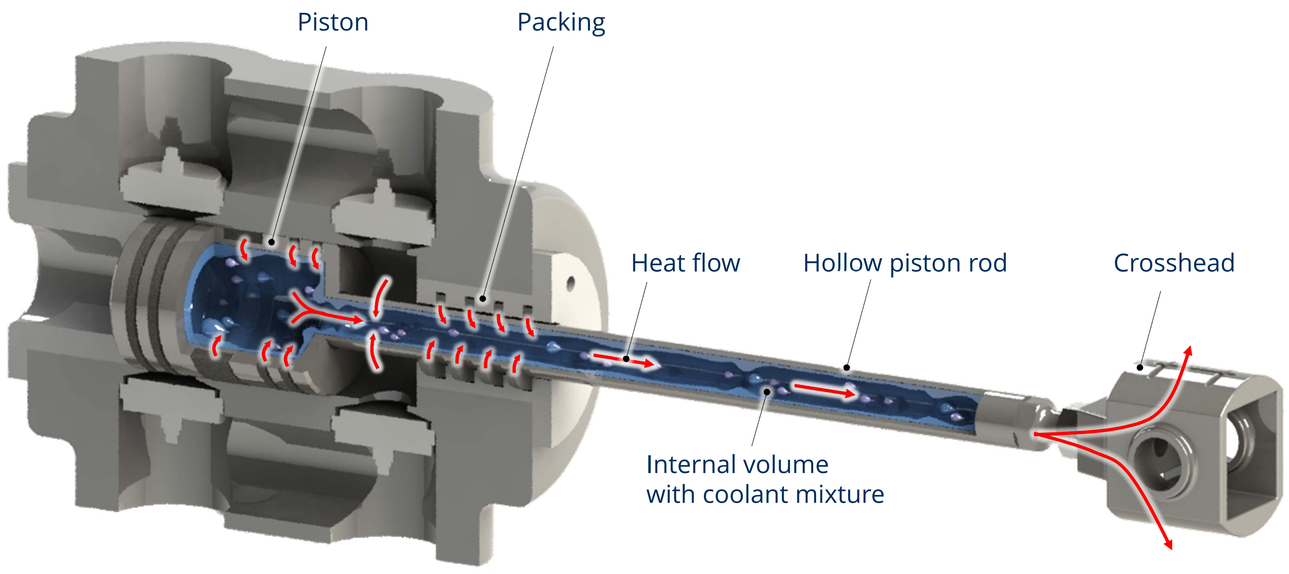
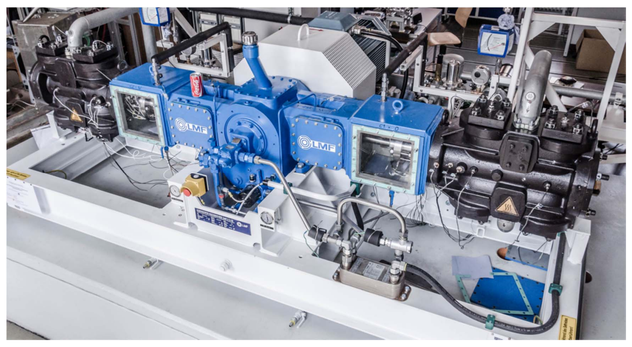


Fig. 1: Sectional view of the piston and piston rod cooling

Test Rigs

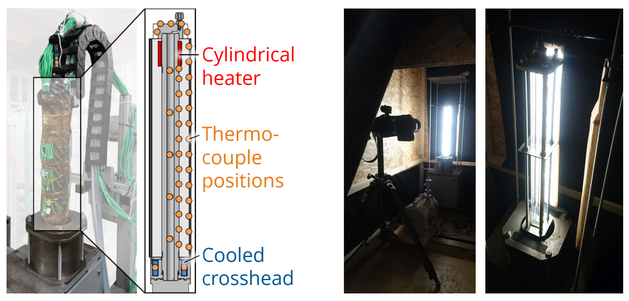
Test rig A: Balanced-opposed air compressor

- single-stage, double-acting piston compressor
- Nominal flow rate: $\dot{V}_{nom} = 150\ m^3\ h^{-1}$
- Power consumption: $P_{el} = 15\ \ldots\ 30\ kW$
- Speed range: $n = 500\ \ldots\ 1500\ rpm$
- Pressure range: $p_s = p_{amb}$ $p_{d,max} = 5.5\ bara$

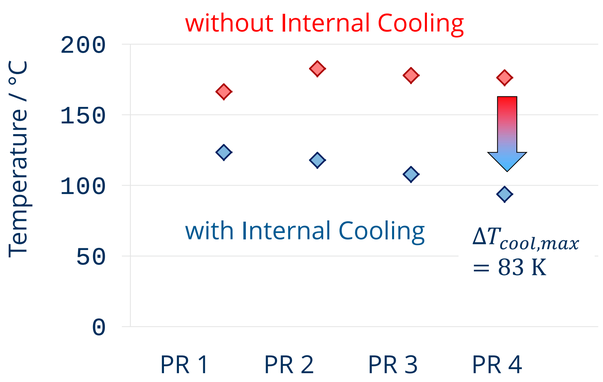


Test rig B: Vertical reciprocating test rig

- Thermal and optical setup
- Heat supply: $P_{Heater} = 0 \ldots 300\ W$
- Speed range: $n = 0 \ldots 600\ rpm$



Results



Gas temperatures measured at different packing rings (PR) from the horizontal test rig A with and without Internal Cooling show a significant cooling effect ($n = 1300\ rpm, p_d/p_s = 3.5$).

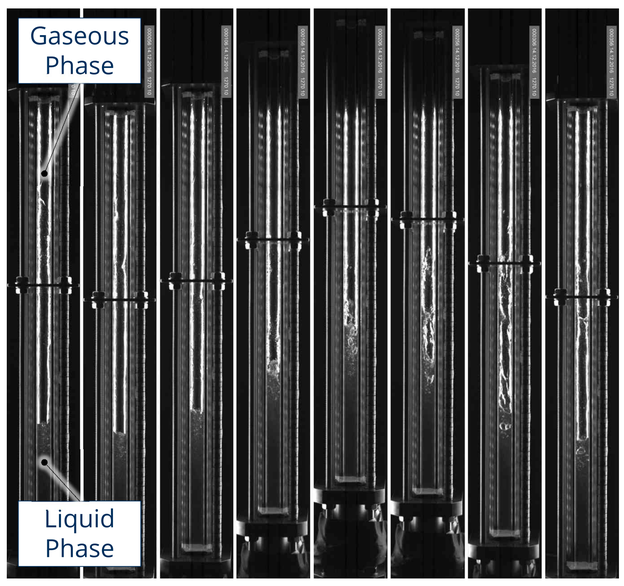


Fig. 2: High speed images of the two-phase flow inside the glass pipe from the vertical test rig B ($n = 300\ rpm$, liquid fraction = 30%)

Fig. 3: Different flow characteristics inside the reciprocating glass pipe for different oscillation frequencies

Conclusion

The Internal Cooling of Piston Compressor Parts has shown promising results in various experiments illustrating its great impact to improve the cooling of the piston rod and the piston.

Further research into internal flow phenomena and the optimization of the heat transfer will be addressed as key topics in the future.

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