TECHNISCHE UNIVERSITÄT DRESDEN

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

Thermophysical Properties of Refrigerants and Lubricant Refrigerant Mixtures

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Motivation

The optimization of compressors and refrigeration processes require detailed knowledge of all components but also of the fluids used. Especially the properties of the compressor lubricants significantly influence the lubrication, oil transport, pressure drop and oil separator effectivity. The various properties depend on temperature and pressure, but also on the solubility of the refrigerant in the lubricant. The measurement of this fluid behavior is vital to define drop-in solution for high GWP refrigerants.

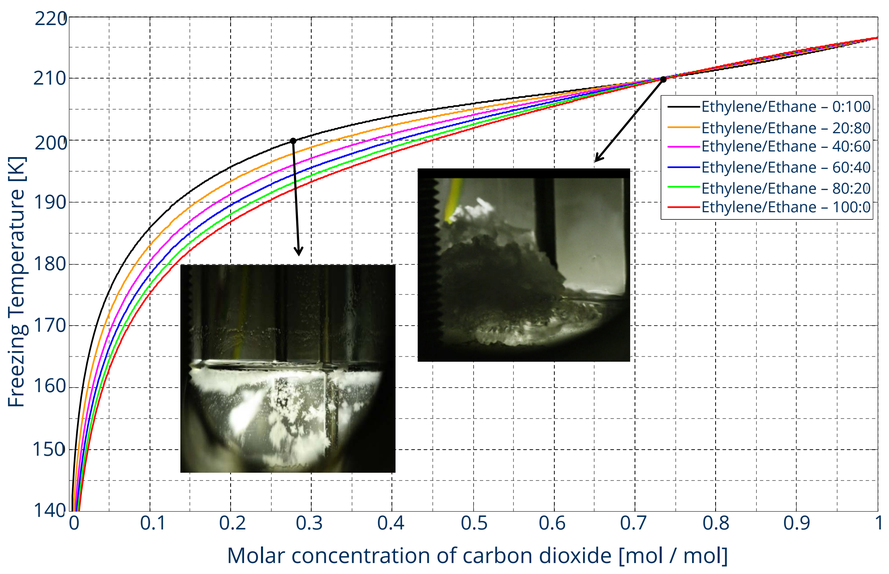

Fig. 1: Freezing temperatures of carbon dioxide mixtures

Freezing point

Carbon dioxide mixtures can serve as replacement of very high GWP refrigerants for low temperature applications. The limitation however is set by their freezing point.
Figure 1 shows the reduction of the freezing temperature of carbon dioxide-hydrocarbon mixtures for varying concentrations. The measurements serve as a basis to calculate the freezing points of other multi-component mixtures.

Vapour pressure and miscibility gap

The knowledge of the solubility of the refrigerant in the lubricant provides the basis for any calculation of the properties of lubricant-refrigerant mixtures. The measurements are carried out in the depicted measurement setup and give information on potential miscibility gaps (see Fig. 2 and 3).

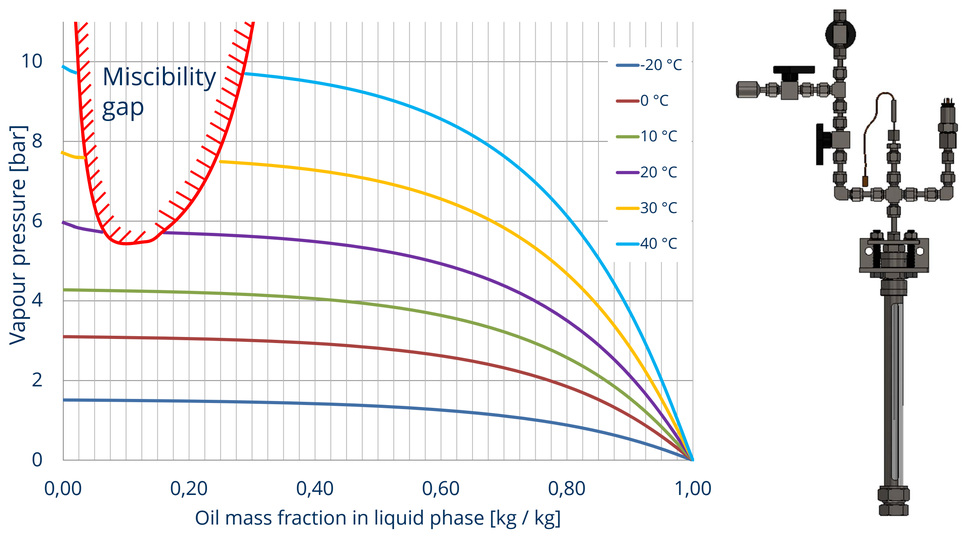

Fig. 2: left: Behaviour of the vapour pressure with varying concentrations of PAG oil and R1234yf,
right: measurement setup

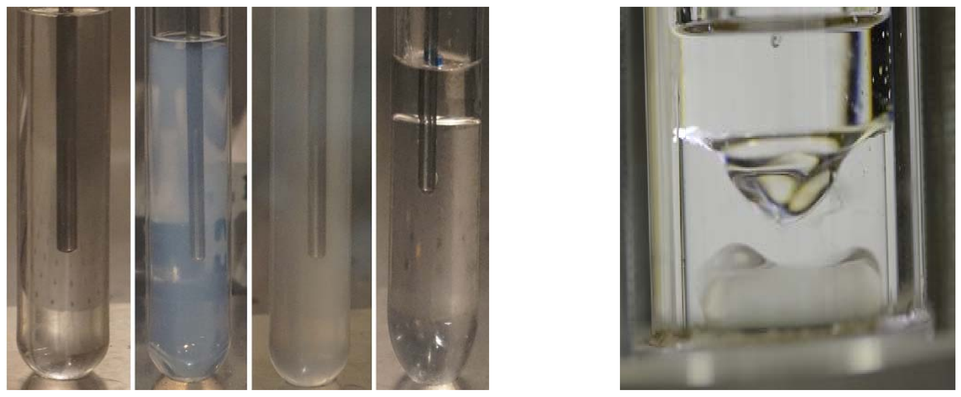

Fig. 3: left: Incremental appearance of a miscibility gap of R744 and a POE,
right: Miscibility gap of ammonia and a mineral oil

Measurement Density and Viscosity

Density and viscosity of the refrigerant-lubricant mixture are measured using a continuous system. The setup is based on the setup presented by Seeton and Hrnjak.

The mixture is circulated with a variable gear pump (3). Varying the temperature within the chamber, viscosity (6) and density (7) are measured.

1. Burst disc containment vessel
2. Bulk fluid RTD
3. Variable speed gear pump
4. Liquid filling valve
6. Oscillating piston liquid viscometers
7. Vibrating tube densitometer/mass-flow meter
8. Circulation valve
9. Circulation valve
10. Gas filling valve
11. Pressure diaphragm seal
12. Burst disc
13. Bulk fluid reservoir

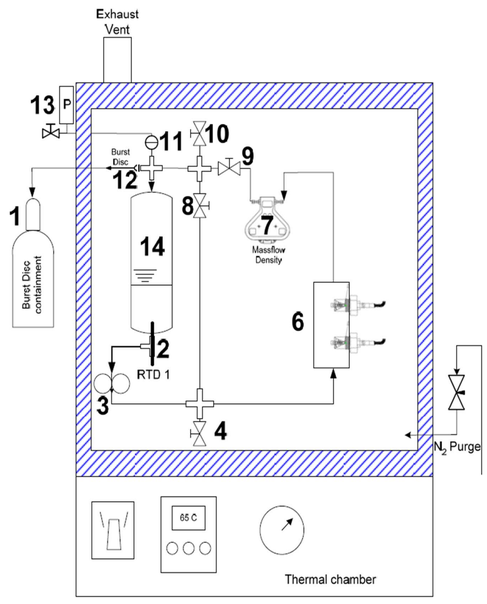

Fig. 4: Schematic Setup of the Thermophysical Property Test System[1]

Literatur:

1 *Seeton, Christopher J., and P. S. Hrnjak. "Measurements of Solubility, Liquid Density, and Liquid Viscosity for CO2-Lubricant Mixtures." 3rd IIR Conference on Thermophysical Properties and Transport Processes of Refrigerants. Boulder, CO. 2009.*