Karlsruhe Institute of Technology

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Refrigeration and Cryogenics
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Our reference:
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Open position – Research associate (f/m/d) for investigation of cryogenic fluid properties
Start: 1 January 2023

The properties of cryogenic fluid mixtures are of fundamental importance for the development of closed-cycle cryogenic cooling systems for applications of high-temperature superconductivity (HTS) and for liquefaction or re-liquefaction of low-boiling fluids, such as hydrogen. Cryogenic mixed-refrigerant cycles (CMRC) operated with such mixtures offer the potential for application-specific solutions with a substantial increase of efficiency, and for closing an existing technology gap in the mid-scale cooling power range that affects both HTS power applications and decentralised and mobile applications of a future hydrogen economy.

For most cryogenic fluid mixtures, phase equilibria have only been predicted based on binary data of their components. Even for binary mixtures, caloric data is often not available. Therefore, the *Cryogenic Phase Equilibria Test Stand* CryoPHAEQTS has been developed (see Figure 1). It provides precise vapour-liquid equilibrium (VLE) and vapour-liquid-liquid-equilibrium (VLLE) data in a temperature range of 20 K to 300 K with operating pressures up to 15 MPa [1,2,3].

In order to measure both caloric and thermal state properties simultaneously, the test facility shall be upgraded with a specific heat measurement. The method is based on the combination of a cryogenic self-calibrating thermal mass flowmeter in combination with a Coriolis sensor at room-temperature. The principle of the former system was patented at KIT and developed further together with WEKA AG. This system explained in [4] eliminates all systematic errors, except errors in the specific heat capacity cp. The measurement in series with the Coriolis flow meter therefore allows the measurement of cp with the uncertainty of the Coriolis sensor, yielding combined uncertainties below 1 %.

Figure 1: The Cryogenic Phase Equilibria Test Stand CryoPHAEQTS.

Your work as research associate will include the following activities:

- Implementation and commissioning of the specific heat measurement into the existing test facility
- Simultaneous measurement of caloric and thermal data of cryogenic fluid mixtures
- Data evaluation including thermodynamic consistency tests
- Modelling of the data with appropriate equations of state
- Contributions to student education through courses and thesis supervision
- Presentation of your research at national and international conferences

Your profile

- Completed scientific university studies, in particular in the area of chemical and process engineering
- Background in thermodynamics, preferably in refrigeration and/or cryogenics
- Excellent communication skills in either English or German

This position is intended to be filled with candidates willing to pursue a PhD.

For further information please contact Prof. Dr.-Ing Steffen Grohmann (steffen.grohmann@kit.edu) or Jens Tamson (jens.tamson@kit.edu).

We prefer to balance the number of employees (f/m/d). Therefore, we kindly ask female applicants to apply for this position.

Recognised severely disabled persons will be preferred if they are equally qualified.

[1] J. Tamson, M. Stamm, S. Grohmann, Set-up of the cryogenic phase equilibria test stand cryophaeqts, IOP Conference Series: Materials Science and Engineering 502 (2019) 012087. doi: 10.1088/1757-899X/502/1/012087.
[2] J. Tamson, P. Blanck, S. Grohmann, Commissioning of the cryogenic phase equilibria test stand cryophaeqts, IOP Conference Series: Materials Science and Engineering 755 (1) (2020) 012150. doi:10.1088/1757-899X/755/1/012150.
[3] J. Tamson, M. Mair, S. Grohmann, Vapor-liquid equilibrium of the nitrogen-argon system at 100 k, IOP Conference Series: Materials Science and Engineering 1240 (1) (2022) 012159. doi: 10.1088/1757-899X/1240/1/012159.
[4] S. Grohmann, A new method for flow measurement in cryogenic systems, Cryogenics 60 (2014) 9 - 18. doi: 10.1016/j.cryogenics.2014.01.004