Cryogenic PHAse EQuilibria Test Stand (CryoPHAEQTS)

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Cryocoolers and cryoplants can provide efficient cooling for high-temperature superconductor (HTS) applications in the range of small and large cooling capacities, respectively. At some kW cooling power and temperatures below 77 K, which is typical for HTS power applications, both technologies have their limitations, however. The technology gap may be closed with cryogenic mixed refrigerant cycles (CMRCs). Such development requires fluid property data of cryogenic fluid mixtures, which are unavailable today. Therefore, the Cryogenic Phase Equilibria Test Stand is being built at KIT. CryoPHAEQTS will provide physical property data of binary, ternary or quaternary mixtures of cryogenic fluids. The test stand is operated between 15–300 K and at pressures up to 15 MPa. Operation with hydrogen and deuterium is considered through compliance with relevant explosion protection regulations. The cooling is provided by a pulse-tube cryocooler and the cell temperature is adjusted by electrical compensation heating. Vapour-liquid (VLE) and vapour-liquid-liquid equilibrium (VLLE) measurements are conducted by dynamic gas-phase circulation; solid-liquid equilibrium (SLE) measurements by a calorimetric method. The measurement cell has optical access, allowing dynamic light scattering (DLS) and surface light scattering (SLS) experiments . These techniques are used to determine the bulk transport properties of the investigated systems, such as thermal diffusivity, mutual diffusivity, kinematic viscosity and surface tension. With this experimental set-up, both fluid state and transport properties of cryogenic fluid mixtures can be measured simultaneously in equilibrium, yielding consistent and reliable thermodynamic data.