C2Po2B-08: Cryostat for arbitrary ortho-parahydrogen reference mixtures

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**Introduction**

Some applications in liquid hydrogen (LH₂) research require the availability of hydrogen with a freely adjustable, known ortho para ratio. Example applications are

- the calibration and qualification of ortho-parahydrogen measurement systems,
- the provision of defined arbitrary inlet compositions for sample reactors used for activity measurements of ortho para catalysts, and
- property measurements (e.g., investigating the neutron scattering cross-section of LH₂-based cryogenic neutron moderators).

In this work, a cryostat for the production of stable, arbitrarily adjustable ortho-parahydrogen mixtures is presented. It is part of a new facility at TU Dresden focused on the comprehensive investigation of catalytic ortho-parahydrogen conversion which was built within the MyCat project (funded by the German Ministry of Education and Research, grant no. 03SF0639). The system uses a large isothermal catalyst bed to ensure an almost complete conversion of a continuous hydrogen flow to the equilibrium composition for temperatures between 18 and 200 K and pressures between about 2 bar(a) and 100 bar(a).

**Catalyst Test Facility (CTF)**

The presented Ortho-Para Precision Converter (OPPC) is part of the new Catalyst Test Facility (CTF) displayed below. Adjustable para concentrations at the inlet of the sample reactor inside the Catalyst Test Cryostat enable the creation of higher-quality kinetic data.

**Ortho-Para Measurement System (OPM)**

- Continuous online measurement of parahydrogen content based on speed of sound
- Several refinements done over past years, especially for stable measurement conditions
- Very high accuracy of <0.1 % p-H₂ achievable (currently being re-assessed), depending on quality of calibration and stability of measurement conditions
- 2-point calibration (n-H₂ and e-H₂(30)) & 3-point calibration (n-H₂, e-H₂(75), p-H₂) tested

**Ortho-Para Precision Converter (OPPC)**

- Coldhead
- Coaxial heat exchanger
- Filter: Avoidance of catalyst dust contamination
- Coldhead heat exchanger with o/p converter Cu tube braided onto Cu body filled with 110 g of hydrous ferric oxide (iron oxide)
- Si diode at outlet: Calibrated Lake Shore Dr-670, isolated at last piece of tube filled with catalyst for determination of final conversion temperature
- Optional module for temperature sensor calibration: With radiation shield, space for up to 8 sensors, T min = 14 K
- Heater cartridges: For control of conversion temperature

**Proof of „complete“ ortho-para conversion**

- T = 28 K, cpara,in = 25 %
- T = 77 K, cpara,in = 25 %

**Good match between theor. & measured para content**

**Conclusion**

The Ortho-Para Precision Converter has been commissioned recently. First functional tests proved that it functions as intended and can produce nearly fully equilibrated ortho-parahydrogen mixtures. A comparison of the theoretical parahydrogen outlet concentration with the measured concentration indicates that both the cryostat and the ortho-para measurement system allow a highly accurate operation.