HIGH PERFORMANCE CENTER

DYNAFLEX®

FLEXIBLE SOLUTIONS FOR THE ENERGY TRANSITION AND RAW MATERIALS SHIFT

DETERMINATION OF PROPERTIES FOR SIMULATIONS

EXPERIMENT AND THEORY

FROM THE MEASURING POINT TO THE EQUATION OF STATE

CONTACT

Prof. Dr.-Ing. Roland Span
Chair
Phone +49 234 32-23033
r.span@thermo.rub.de

Christian Scholz, M. Sc.
Phone +49 234 32-22832
c.scholz@thermo.rub.de

Robin Beckmüller, M. Sc.
Phone +49 234 32-26414
r.beckmueller@thermo.rub.de

Ruhr University Bochum
Chair of Thermodynamics
Faculty of Mechanical Engineering
Institute for Thermo- and Fluiddynamics
Universitätsstraße 150
44801 Bochum

www.thermo.ruhr-uni-bochum.de/en

RUHR UNIVERSITÄT BOCHUM RUB

With experimental activities and theoretical work, a property model shall be developed that ensures static and dynamic simulations of pipeline networks and (stationary and mobile) gas storages with uncertainties that are nowadays common for the management of natural gas.

The experimental equipment at the chair of thermodynamics at Ruhr University Bochum provides several apparatuses and systems (Single- and Two-Sinker Densimeter, Sperical Resonator …) for the measurement of thermophysical properties, such as density or speed of sound.

On the basis of the gained (p,ρ,T,x)- and (p,c,T,x)-data sets for binary gas mixtures with higher H_2-fractions, weaknesses of the previously used property standard can be identified and improved.

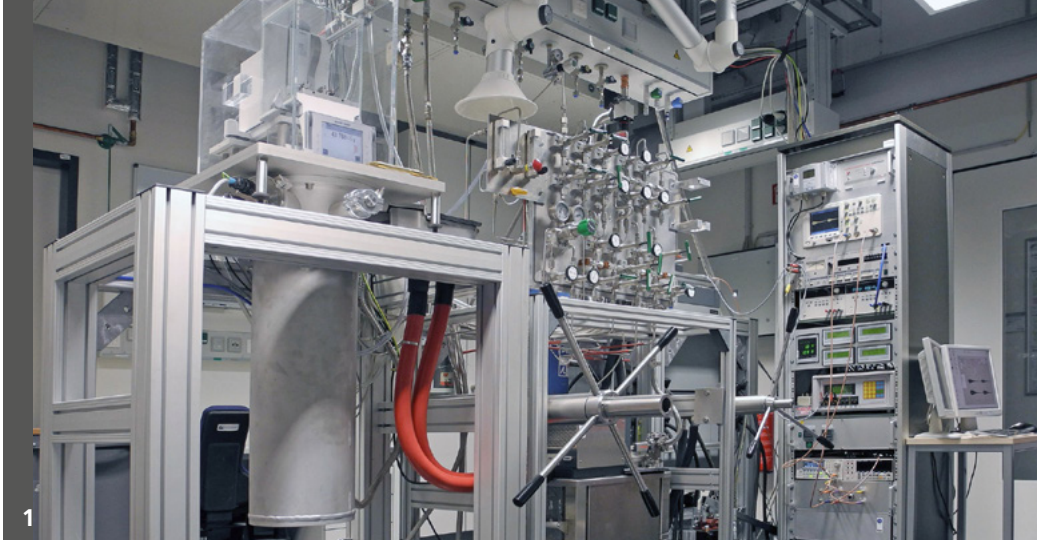
Keywords

- Gas Density measurements
- Speed of sound measurements
- Equations of state
- Property models

Branchen

- Chemical industry
- Natural gas producer
- Pipeline operators
- Operators of gas storages
- Public utility companies

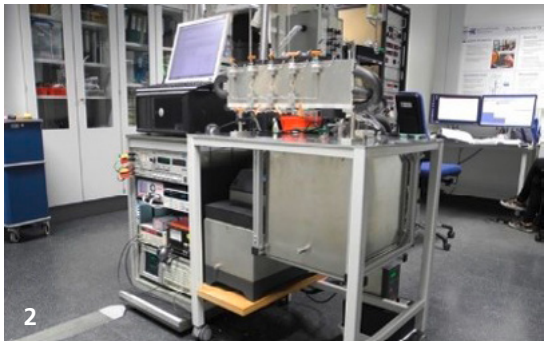
DYNAFLEX®

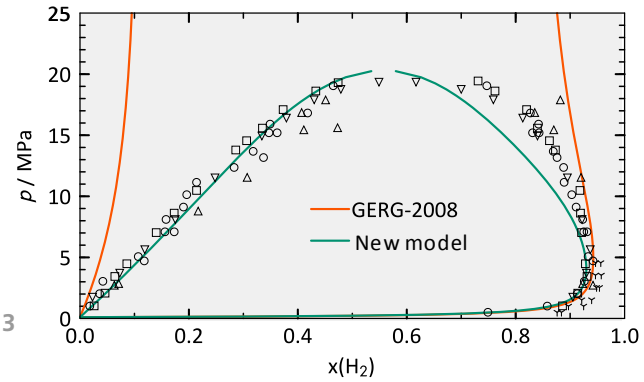


1 Single-Sinker Densimeter for density measurements in the temperature range from 253 to 453 K with pressures up to 20 MPa, consisting of the core apparatus with measuring cell, magnetic-suspension coupling and analytical balance (left), manifold and thermostate (centre) and 19''-rack with electronical devices (right), such as resistance measuring bridge or measuring computer.

2 Spherical Resonator for speed of sound measurements in gases in the temperature range from 300 to 350 K with pressures up to 8 MPa, consisting of a thermostated bath with immersed measuring cell (bottom right), manifold (top right) and electronical devices such as the measuring computer (left).

3 Comparison of available experimental data with the property model GERG-2008 and the current status of the new model using a pressure-composition diagram for a nitrogen-hydrogen mixture at 77 K.





Experimental work

Density measurements

- Measurement of various binary, hydrogen-rich gas mixtures, using a Single-Sinker Densimeter in the temperature range from 253 to 453 K with pressures up to 20 MPa
- Validation of the results by repeating measurements at selected state points with a Two-Sinker Densimeter

Speed-of-Sound measurements

- Measurement of various binary hydrogen-rich gas mixtures, using an optimised Spherical Resonator in the temperature range from 300 to 350 K and pressures up to 8 MPa

Theoretical work

Property modeling

- Validation of the property model GERG-2008 on the basis of the experimental work and of a comprehensive literature search (identification of the binary sub-systems relevant for improvement)
- Development of new equations of state for hydrogen-rich natural gas mixtures considering all available experimental data
- Integration of the new equations of state into the property model GERG-2008 which is accepted as an international standard
- Implementation of the improved property model in the existing software TREND and REFPROP

Your benefit

Determination of properties for all kinds of simulations

- The applicability of the algorithms for the established property model GERG-2008 is maintained by integrating the improved equations of state
- Consistent calculation of all thermodynamic properties for relevant hydrogen concentrations in a wide pressure and temperature range for static and dynamic simulations
- Implementation of the new property model in existing software enables compatibility with widely-used simulation tools such as ASPEN Plus or EBSILON Professional

Further information
www.dynaflex.de

Funded by:
Fraunhofer
Ministry of Culture and Science of the German State of North Rhine-Westphalia