Rapid depressurization of CO_2-rich mixtures

Background

Carbon dioxide (CO_2) is a greenhouse gas contributing to global warming. A key mitigation strategy to limit the global warming is to deploy CO_2 capture and storage (CCS). In general, the storage sites will not be collocated with the capture points. Therefore, large pipeline transport networks will be needed. The CO_2 will often not be pure. Even small amounts of other components may significantly affect the thermophysical properties. A main design criterion for pipelines is that a fault in the pipeline does not lead to a long running fracture. Current engineering tools work for natural gas, but not for CO_2. Thus, more physical insight is needed.

The current project focuses on rapid depressurization of CO_2-rich mixtures in pipes. Upon depressurization, phase change will occur. Some experiments indicate that it may not be correct to assume that the process is in equilibrium. We will therefore investigate the effect of non-equilibrium in one or more of the quantities temperature, chemical potential, pressure and velocity. This will affect the mathematical formulation of the flow model.

SINTEF Energy Research has a numerical workbench for compressible multiphase flow of multicomponent CO_2-rich mixtures, which will be used in the project. As part of the European CCS Research Laboratory Infrastructure (ECCSEL), a depressurization facility is under construction at the NTNU-SINTEF thermal engineering laboratory. Depending on the schedule, it may become possible to carry out experiments there as part of this project. Furthermore, the project will be carried out as part of the new NCCS research centre for environment-friendly energy research (FME), where a PhD grant has been allocated for this subject.

Tasks

A collection of the following tasks will be performed:

- Getting acquainted with the problem at hand
- Mathematical analysis of the coupled thermo-fluid model
- Numerical discretization
- Implementation of submodels
- Study of the effect non-equilibrium assumptions and thermodynamic models
- Comparison with experimental data

Prerequisites

- Interest for thermo- and fluid dynamics
- Interest for numerical methods
- Interest for numerical mathematics and analysis of systems of hyperbolic partial differential equations
- Knowledge of (or ability to learn) Fortran 95/2003 and Linux

Contact Persons

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