Hele-Shaw setup for investigation of two-phase flow in fractures

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Abstract. Understanding the mechanisms and the physics involved in two-phase flow in fracturs is important for optimisation of production from carbonates and gas-shale reservoirs. The amount of available research and models on this field are quite limited and has mostly been performed with single flow setups.

To obtain new experimental results on two-phase flow in fractures, in particular fluid trapping and the interplay of capillary, viscous, and gravity forces in fractures, SINTEF has developed a new transparent flow cell. Experimental results will be used for development and verification of theoretical models of two-phase flow in fractures. The cell has a dimension of 60 X 100 cm and is to our knowledge the largest existing horizontal Hele-Shaw cell for studies of two-phase flow. The cell is designed so that the following parameters can be changed:

- Fracture aperture (0.5 – 1.0 mm)
- Fracture geometry / Surface roughness
- Wettability: Oil Wet (native) to water wet (treated)
- Tilt angle: 0- 90 degrees
- Two phases can be injected simultaneously

This is achieved by constructing the main body from two interchangeable polycarbonate plates. They are distanced by a precision stainless metal spacer. The plates are supported by two 25 mm thick glass plates for avoiding deflection of the highly elastic polycarbonate material. The excellent machineability of polycarbonate material allows precise definition of the plate thickness and thereby the fracture aperture of flow setup. Surface of the plates can also be machined with a certain roughness or geometric shape. The native wettability of polycarbonate is oil-wet but by treating the plates with a hydrophilic coating the flow surface can be changed to intermediate wet or water-wet.

The experimental rig is set up with a camera for recording during the experiments, in addition flow rates and differential pressure is recorded. The recorded photos are post processed to automatically track the phase fronts, calculate phase fractions and phase velocities during the flow. A presentation of the cell and the first set of experiments will be given.