Experimental Investigations on Multi-Phase Systems with X-Ray Micro-CT

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Introduction

Micro-computed-tomography (micro-CT) provides a powerful tool for the visualization of interfaces in multi-phase systems. Obtained data can be used to validate or challenge existing models and hypotheses on multi-phase fluid displacement mechanisms and is essential in the derivation of boundary conditions for numerical simulations.

Material and Methods

Calibrated micro-porous model bodies of different complexity will be infiltrated with several fluid and scanned with the micro-CT setup, available at the University of Bergamo. The setup consists of a prototype X-ray source 160 kVp @ 200 µA, a high-precision air-bearing rotating stage and a custom-designed flat panel X-ray detector, based on an amorphous silicon sensor array. (See also [1])

For the current set of experiments, high-precision glass spheres were chosen to build up the solid matrix and water, air and n-dodecane present the variety of fluids.

Through scanning, the geometrical features of the solid structure can be characterized and the quality of the scans can be validated by comparing CT-derived parameters, such as porosity, specific surface area and pore size distribution to their analytically available values. The interfacial characteristics of the fluids can be analyzed and their evolution can be studied by conducting multiple scans at different states of saturation.

Preliminary Results and Discussion

Experiments, conducted to this date, illustrate the need for refinement of scanning strategies, in order to allow for accurate reconstruction of the scanned materials. Parameters, such as the voltage and amperage of the X-ray source, the sampling time and the used filters must be carefully optimized.

Another challenge poses the adequate segmentation of the resulting images. Here, different methods (e.g. Otsu [2]) need to be evaluated and post-processing strategies must be defined. (For further information see [3])

Robust and reliable algorithms need to be developed in order to analyze the obtained data thoroughly.

Pore network models can be generated from the obtained data and used to run simulations by help of an open-source software package [4].

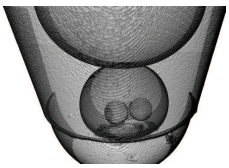

Figure 1. Reconstructed image of two glass spheres of a diameter of 1 mm , immersed in water and dodecane with air above

References

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