modelling of complex porous materials.

an experimental approach

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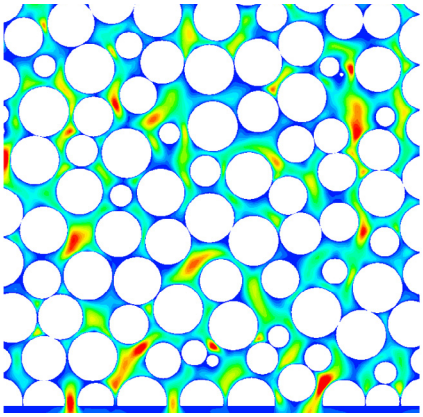
Goal

Fluid flow through porous media (materials containing pores or voids) is an interesting but also difficult and complex field of study. Fluid flow through a porous medium usually consists of an interpenetrating fluid or gas through a solid labyrinth. This solid labyrinth could for example be a randomly packed bed of beads, rocks, soil or sand or a pack of stacked straws.

The concept of porous media is widely encountered or used in the industry; filtration, ventilation, heat transfer, bio-engineering, drainage, oil extraction, drying processes and many more. These porous media are usually part of larger systems. The complex geometries of the porous media themselves are time consuming and almost impossible to simulate accurately in full detail. However, the porous medium can be modelled as a 'black box' that induces a pressure drop in the larger system and represents the characteristics of the porous material.

In order to replace the porous medium with this 'black box', the flow characteristics through the porous medium needs to be determined. An experimental method for the characterization of the porous medium has been developed and validated.



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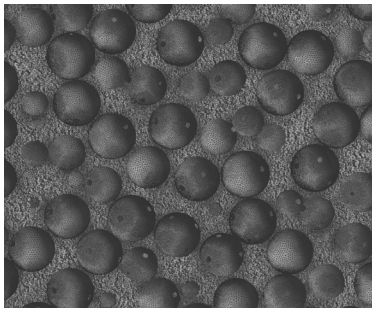
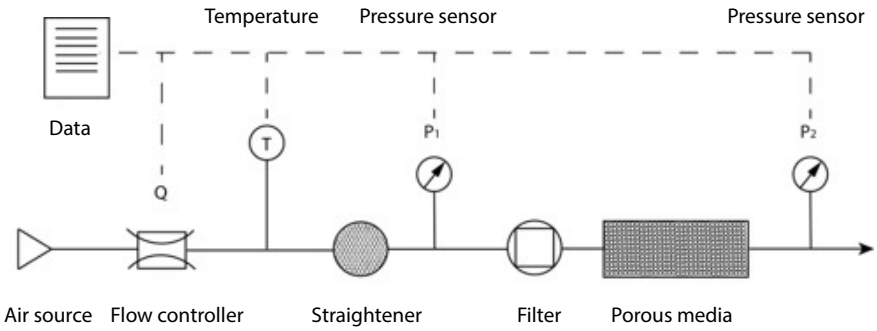
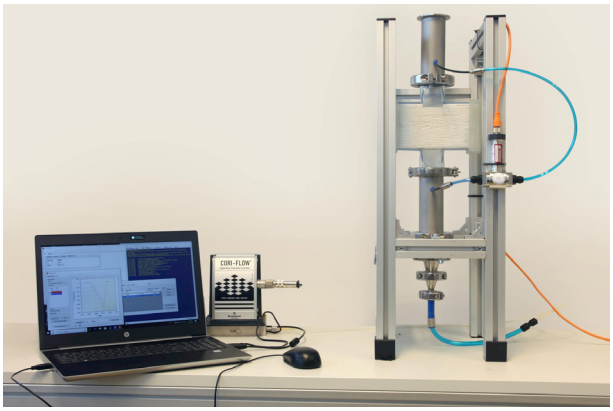




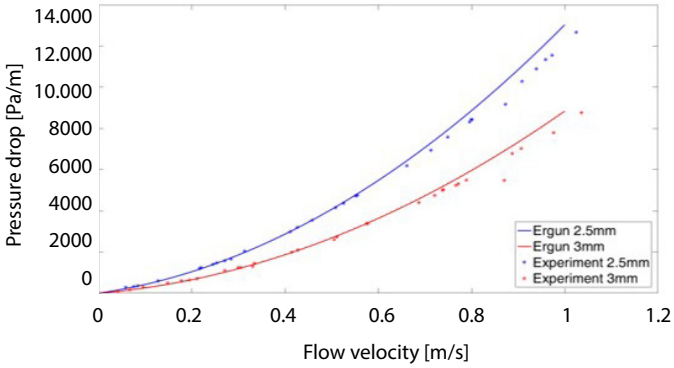
Approach

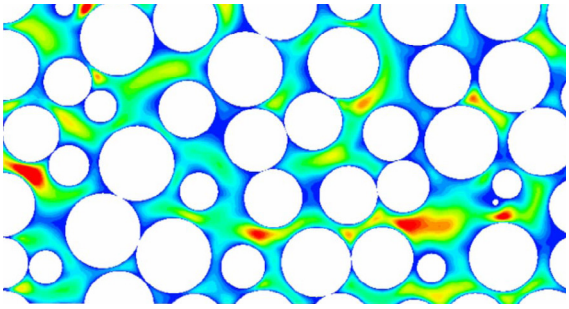
A fast modular set up is designed to experimentally measure the pressure loss through a porous medium. From the data of the experiment, a pressure drop relation dependent on the superficial flow velocity and length scale is extracted.

The results of the experiment are compared with analytical results, comparing Darcy's law (Darcy-Forchheimer) and the Ergun equation, and full detailed simulations, simulating the porous media to its full extend with similar void fraction and permeability.



During simulation, the pressure relation, as extracted from the experiment, replaces the geometry of the porous medium. This new 'black box' which simulates the behavior of the porous medium can now substitute the detailed porous media on a system level, making the simulation much faster, and applicable to use on a system level.





Results

A good comparison between Erguns theory, full detailed simulations, and the experimental setup was made. It was shown that the experimental approach is fast and reliable, and can be used for different types of porous media.

Extensive simulation effort can now be substituted by a fast and validated experiment. The experiment ensures real and accurate representation of the specific porous medium. This method can now generally be used to characterize all types of porous media.

If you have a challenge in your process including porous media type of fluid flow, don't hesitate to give us a call, and we can look how we can help you further!