USE OF RHEOLOGICAL MEASUREMENTS TO DETERMINE THE VELOCITY PROFILE IN THE CLOSE VICINITY OF A POROUS MEDIUM INTERFACE

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The determination of the velocity flow field in a domain partially occupied by a porous medium is crucial in many different area as in filtration processes, ground water pollution, cartilage joint lubrication, marine microbiology, etc. The transition zone between the two domains results fundamental for the determination of the entire velocity profile and many theoretical, numerical and experimental studies were specifically dedicated to this topic. As regard the experimental investigation, the best available tests were performed by using optical systems as PIV or LDA which allowed seeing the flow field up to 200 μm circa from the interface. In this work we propose the use of rheological tests since it is possible to measure the velocity up to a distance of only 10 μm above the interface.

We performed simple shear measurements with a rotational constant stress rheometer equipped with parallel plate geometry with different porous media glued on the lower plate. The porous media were commercial sandpapers with three different grits. The adopted fluid was a Newtonian PolyIsoButene. With this experimental tool, it is possible, for the first time, to detect the deviation of the velocity profile from linearity in the free fluid region due to the presence of the porous interface.

The experimental results were nicely compared with predictions obtained integrating the Brinkman extension of Darcy law in the porous medium together with Stokes equations in the free fluid coupled at the interface by the continuity of velocity and by the momentum balance suggested by Ochoa-Tapia and Whitaker (International Journal of Heat and Mass Transfer (1995) 38:2635) It was also possible to measure, for the first time, the stress jump coefficient introduced by the latter authors.