MATHEMATICAL DERIVATION OF THE DARCY-TYPE LAW WITH MEMORY EFFECTS, GOVERNING TRANSIENT FLOW THROUGH POROUS MEDIA

by

Andro Mikelić, Lyon, France

Abstract. In this paper we derive a law connecting velocity and pressure gradient for nonstationary incompressible viscous flows through a porous medium. Starting from the nonstationary Stokes system in nondimensional form (and later from the nonstationary Navier-Stokes system) and using homogenization theory we obtain a new law which is nonlocal in time, but again gives a linear connection between velocity and pressure gradient. In contrast to the ordinary Darcy law which is valid for stabilized flow, this law holds true for all times. Furthermore, it includes the phenomenological models from oil engineering literature consisting of Darcy law with additional term taking into the account the conductance of the channels.

We present a convergence proof as the characteristic size of pores tends to zero for the periodic geometry of porous medium. Also, we prove that in the periodic case our law tends exponentially to the ordinary Darcy law when time tends to infinity.

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