Turbulent flow in porous medium - history, mathematical models, experiments on real media, maximum principle

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Abstract

In the first part of this talk we will discuss two mathematical models leading to the same Cauchy problem for parabolic p-Laplacian. In particular, we will study turbulent flow of water in an unconfined aquafier and also turbulent flow of natural gas in fissured rock. We will explain the process of the derivation of these two models from the historical perspective. The approach is based on a continuity equation and a nonlinear constitutive law similar to Darcy law for laminar flow in porous media. As the nonlinear analogy of Darcy law, we use the power law discovered by Smreker and verified by laboratory experiments by Kroeber, Izbash and Missbach in 1880's - 1930's. We will focus on pioneering work on development of these mathematical models due to Zhukovskii, Christianovitch, Leibenson and Barenblatt in 1880's - 1950's. This historical review was a joint work with J. Benedikt, L. Kotrla and P. Takáč. In the second part of this talk, we will discuss some very recent experiments done by D. Veselý and Z. Veselý on real porous media used in civil engineering. We will explain how the shape of the grains of the porous medium influences the parameter p in the p-Laplacian. In the third part of this talk we will present some recent results on maximum principles for the Cauchy problem for the parabolic p-Laplacian. This was a joint work with J. Benedikt, L. Kotrla and P. Takáč. We will shortly discuss their connection with mathematical models by Leibenson and Barenblatt and their physical meaning and limitations in the real world.