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Mathematical Models for Fluids with Pressure-Dependent Viscosity Flowing in Porous Media

Prof. Angiolo Farina

Dipartimento di Matematica e Informatica 'Ulisse Dini'
Viale Giovanni Battista Morgagni 67/a, 50134 Firenze (FI)

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Abstract: We analyze three filtration problems through porous media, assuming that the viscosity of the fluid depends on pressure. After showing that in this case Darcy's law is "formally" preserved (meaning that the formal relation remains unchanged except for viscosity that now depends on pressure), we focus on the following problems: Green-Ampt infiltration through a dry porous medium; the Dam problem; the Muskat problem. For each model (which mathematically gives rise to a free boundary problem) we obtain explicit solutions that allow to quantify the detachment from the classical case, where with the word "classical" we mean that viscosity is taken constant. Of course many others problem can be studied using the modified Darcy's law. We mention the Buckley-Leverett transport model for two phase flow in porous media. Such model is mainly motivated by the overwhelming evidence that the crude oils viscosity is extremely sensitive to pressure variations. In this case the problem (that can be solved autonomously in the saturation S when discharge and viscosity are constant) becomes much more complicated.



Via Branze, 43
25123 Brescia, Italia
+39 030 3715.1

Segreteria Amministrativa e Contabile
Tel +39 030 3711247-248-250
Fax +39 030 3711249
PEC dicatam@cert.unibs.it

Segreteria Didattica
Tel +39 030 3715952