# Numerical Analy of Mass Transform and Fluid Flow on Miscible Fluids


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**ABSTRACT**

Numerical simulations are employed to investigate the fluid flow and pressure loss in a heterogeneous block within a composite porous medium. The mean permeability of the heterogeneous block is seen to affect the overall effective flux significantly. The heterogeneous para- meters of the permeability field,such as the correlation length and variance, affect quite differently. Because of the channeling effects, the effective flux depends strongly on the realization of the permeab- ility for larger correlation length.Under a specific permeability field, higher effective flux results from smaller variances. The influences of the inertial factor are found insignificant within the range of practical interests. For miscible displacements in capillary tubes,the impact of a preexisting wall film on the tip velocity of the displacing fluid finger is analyzed by means of axisymmetric Stokes simulations. The wall film is assumed to have the same viscosity as the displacing fluid, which is less viscous than the displaced fluid. The finger of the displacing fluid is seen to move in a quasisteady fashion, with a tip velocity below the centerline velocity of an equivalent Poiseuille flow. The explanation for this behavior, which is in contrast to our earlier findings for miscible displacements without wall films, lies in the lubricating effect of the wall film.The condition is established for which the displaced fluid moves in a nearly solid body-like motion.



Keywords : Porous medium， Heterogeneous permeability， Effective flux， Correlation length,finger， wall film


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**REFERENCES**


[1] Hill,S."Channelling in packed columns"Chem.Eng.Sci.1. (1952) [2] Saffman,P. and TAYLOR,G. “ The penetration of a fluid in to -a porous medium of Hele-Shaw cell containing a more viscous - liquid ” ,Proc.R.Soc.London.Ser.A,245,312.(1958) [3] G. I. Taylor, "Deposition of a viscous fluid on the wall of -a tube" J. Fluid Mech. 10, 161 (1961).

[4] D. A. Reinelt and P. G. Saffman, "The penetration of a finger - into a viscous fluid in a channel and tube" SIAM J. Sci. St -atist. Comput. 6, 542 (1985).

[5] G.I.Taylor, "Dispersion of soluble matter in solvent flowing -slowly through a tube".Proc.Roy.Soc.A219,186(1853).

[6] B. G. Cox, "On driving a viscous fluid out of a tube" J. Flui -d Mech. 14, 81 (1962).

[7] D.Korteweg, "Sur la forme que prennent les equations du movem -ent des fluides si l'on tient compte des forces capillaires -causees par des variations de densite," Arch. Neel. Sci. Ex. -Nat. (II), 6 (1901).

[8] H.Davis, "A theory of tension at a miscible displacement fron -t. In: Numerical Simulation in Oil Recovery" IMA Volumes in -Mathematics and Its Applications 11, Springer (1988).

[9] D.Joseph and Y.Renardy, "Fundamentals of two-fluid dynamics" Part II, Springer (1992).

[10] P.Petitjeans and T.Maxworthy,"Miscible displacements in capi -llary tubes. Part 1: Experiments" J. Fluid Mech. 326, 37 (1996).

[11] J.Kuang, T.Maxworthy and P. Petitjeans, "Miscible displacements - between silicone oils in capillary tubes" submitted to Eur. J. - Mech. B/Fluids (2002).

[12] C.-Y. Chen and E. Meiburg, "Miscible displacements in capillary t -ubes. Part 2: Numerical simulations" J. Fluid Mech. 326, 57 (1996).

[13] Fu, W. and Huang, H. “ Effects of a random porosity model on heat t -ransfer performance of porous media ” Int. J. Heat Mass Transfer 4 -2, 13-25. (1999) [14] Tan, C. and Homsy, G. “ Viscous fingering with permeability heterog -ene-ity ” Phys. Fluids A, 4, 1099. (1992) [15] EskAmioo-Grami, M. and Munir, Z. “ Effects of porosity on the com-b -ustion sythesis of titanium nitride ” J. Am. Ceram. Soc., 73, 1235- -1239. (1990) [16] Roblee, R., Baird, J. and Tiern, J. “ Radial porosity variations in -packed beds ” AIChE J., 4, 460-464. (1958) [17] Benenati, R. and

Brosilow, C. “ Void fraction distribution in packe -d beds ” AIChE J., 8, 359-361. (1962) [18] Schwartz, C. and Smith, J. “ Thermal and material transport in non- -isothermal packed beds ” AIChE J., 15, 597-604.(1952) [19] Schwartz, C. and Bischoff, K. “ Flow distribution in packed -beds.Industrial and Engineering Chemistry ” 45, 1209- 1218.( 1969) [20] Poirier, D. “ Permeability for ow of interdendritic liquid in colum -nar-dendritic alloys ” Metallurgical Transaction, 18B,245- 255.(1987) [21] Cheng, P., Chowdhury, A. and Hsu, C. “ Forced convection in packed -tubes and channels with variable porosity and thermal dispersion ef -fects ” In: S.Kakac et al. (Eds.). Convective Heat Mass Transfer in - Porous Media, 625-653.( 1991) [22] Sinha, S., Sundararajan, T. and Garg, V. ” A variable property analysi -s of alloy solidifcation using the anisotropic porous medium approac -h ” Int. J. Heat Mass Transfer. 35,1865- 2877.(1992) [23] Yoo, H. and Viskanta, R. ” Effect of anisotropic permeability on the tr -ansport process during solidification of a binary mixture ” Int. J. H -eat Mass Transfer 35, 2335-2346.( 1992) [24] Lee, S. and Yang, J. ” Modelling of effective thermal conductivity for -a nonhomogeneous anisotropic porous medium ” Int. J. Heat Mass Transf -er 41,931-937.(1998) [25] Yang, J. and Lee, S. ” Effect of anisotropy on transport phenomena in an -isotropic porous media ” Int. J. Heat Mass Transfer 42, 2673-2681.(1999) [26] Homsy, G. ” Viscous fingering in porous media. ” Ann. Rev. Fluid Mech.19, - 271.(1987) [27] Yortsos, Y. ” Instabilities in displacement processes in porous media ” -J.Phys. Condens. Matter 2, SA443.19(1990) [28] Chen, C.-Y., Wang, L., and Kurosaki, Y. ” Numerical simulations of heat t -ransfer in porous media with the effect of Heterogeneities ” JSME int -ernational Journal, B, 45, 315.(2002) [29] Camhi, E., Meiburg, E. and Rutth, M. ” Miscible rectilinear displace-m -ents with gravity override ” Part 2: Heterogeneous porous media. J. Flui -d Mech. 420, 225.(2000) [30] Chen, C.-Y. and Meiburg, E. ” a Miscible porous media displacements in t -he quarter five-spot configuration ” Part 1: The homogeneous case. J. -Fluid Mech. 371, 233.(1998) [31] Chen, C.-Y. and Meiburg, E. ” Miscible porous media displacements in the -quarter five-spot con_guration ” Part 2: Effect of heterogeneities. J.Fl -uid Mech. 371, 269.(1998b) [32] Shinozuka, M. and Jen, C. ” Digital simulation of random processes and it -s applications ” J. Sound Vib. 25, 111.(1972) [33] Rutth, M. and Meiburg, E. ” Miscible rectilinear displacements with gravi -ty override ” Part 1: Homogeneous porous medium. J. Fluid Mech. 420,22 -5.(2000) [34] Meiburg, E. and Chen, C.-Y. ” High-Accuracy Implicit Finite Difference Si -mulations of Homogeneous and Heterogeneous Miscible Porous Media Flows ” -SPE J. June 5, 2.(2000) [35] Chiu, W. ” Study of heat transfer characteristics of electronic porous hea -t sink ” Master thesis, National Chung-ChengUniversity, Taiwan.17(2002) [36] F.B.Bretherton, "The motion of long bubbles in tubes".J.Fluid Mech.10,1 -66 (1961) [37] C.-Y. Chen and E. Meiburg, "Miscible displacements in capillary tubes: In -fluence of Korteweg stresses and divergence effects," Phys. Fluids. 14, 2 -052 (2002).
[38] C. A. J. Fletcher, Computational Techniques for Fluid Dynamics, Vol. 1, Sp ringer (1988).