11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

A ONE-DOMAIN APPROACH FOR MODELING AND SIMULATION OF FREE FLUID OVER A POROUS MEDIUM

Huangxin Chen[1] and Xiao-Ping Wang[2]

[1] School of Mathematical Sciences, Xiamen University, Xiamen, China,
E-mail address: chx@xmu.edu.cn
[2] Department of Mathematics, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China,
E-mail address: mawang@ust.hk

Abstract. We propose a one-domain approach based on the Brinkman model for the modeling and simulation of the transport phenomenon between free fluid and a porous medium. A thin transition layer is introduced between the free fluid region and the porous media region, across which the porosity and permeability undergo a rapid but continuous change. We study the behavior of the solution to the one-domain model analytically and numerically. Using the method of matched asymptotic expansion, we recover the Beavers-Joseph-Saffman (BJS) interface condition as the thickness of the transition layer goes to zero. We also calculate the error estimates between the leading order solution of the one-domain model and the standard Darcy-Stokes model of two-domain model with BJS condition. Numerical methods are developed for both the one-domain model and the two-domain model. Numerical results are presented to support the analytical results, thereby justifying the one-domain model as a good approximation to the two domain Darcy-Stokes model.

Key words: *Brinkman equation, Darcy-Stokes equation, Porous medium, Boundary layer, Matched asymptotic expansion, Effective interface condition.*