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Homogenization of the Navier-Stokes equations by means of the Multi-scale Virtual Power Principle

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Abstract

This work addresses the multi-scale modeling of fluid flow in highly involved media based on the concept of Representative Volume Element (RVE). The Method of Multi-scale Virtual Power developed by the authors is employed to construct a coarse-scale model from standard fluid flow model at a fine-scale. Kinematic conservation principles, duality arguments and the balance of virtual power between scales are employed to set the grounds of the scale transition of physical fields. This allows to derive in a variationally consistent manner (i) the fine-scale problem to be solved at the RVE, and (ii) the homogenization formulae for coarse-scale dual quantities, namely, the force-like and stress-like fields. Examples of application of flow in permeable media are presented to show the potentialities of the present approach.

Key words: Multi-scale, Fluid mechanics, Representative volume element, Virtual power, Permeable media

1. Introduction

Multi-scale simulation applied in the field of fluid mechanics has been largely acknowledged as a powerful tool to model complex flows, with special

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