Application of a coupled VF/EF multi-scale method to cement media

Thomas ABBALLE, CEA Saclay

We present here the first results of a work on a multiscale resolution method using both Finite Volumes and Elements. Our method relies upon the coupling of grid scales: a coarse one and a fine one. The trick is to build a Finite Element basis on the coarse grid from problems solved on the fine one. In previous works on this subject [1] [2], the Finite Element method was used in both the fine and coarse scales, whereas, in our approach, the fine scale simulations are made via Finite Volumes. This way, we hope to increase the stability of the method in view of strong discontinuities and anisotropy of the studied media, and to keep the advantages of multi-scale finite element method (no strong assumptions on the media, parallelism of calculus).

This method is developed with the aim of solving large sized diffusion problems with highly oscillating coefficients. As an application example, we choose a model of cement media, where very strong variations of diffusivity occur [3]. As a by-product of our simulation, we also want to estimate the equivalent diffusivity of this media.

The first 2D tests of our method showed promising results, but also some weaknesses [4]. Indeed, the method was converging smoothly for academic benchmarks, but the error tended to stagnate in the cement media cases because of a boundary layer effect. We planed to solve the problem by oversampling the coarse elements on each other, making the Finite Elements nonconforming [5]. However, this method requires a very precise mesh on each rim and a well-chosen oversampling rate $\rho$.

As such precision exceeded our computational capacities, our method is currently being integrated in the computer code $MPCube$, based upon the calculus kernel of $TrioU$. Some simulations realized on this new implementation, using the $VFDiam$ Finite Volumes Method [6], will be presented. Finally, to determine the optimal oversampling rate $\rho$, we will discuss its link with the resolution error of the diffusion problem.

This work was conducted in collaboration with Grégory Allaire (École Polytechnique, CMAP) and Philippe Montarnal (CEA Saclay LSET).

Références


[3] SYRIAC BEJAOUI, BENOIT BARY AND CÉDRIC JULIEN, Modélisation de la relation entre microstructure et diffusivité effective des pâtes de ciment à partir d’une méthode numérique3D, CEA, Département de Physico-Chimie, DPC/SCCM/05-327-A, 2005


Thomas ABBALLE, CEA Saclay DEN/DANS/DM2S/SFME/LSET Bat 454, 91191 Gif sur Yvette Cedex

thomas.abballe@cea.fr