Fluid Flow through the Porous Media: Coupling of micro- and macro- scale fluid flow models

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ABSTRACT

In almost all fluid flow computations conducted for large physical domains, either a quantitative analysis cannot be performed as a result of not sufficiently refined numerical domains or a huge data advent hinders (interactive) processing of the computation results obtained on highly resolved domains up to several hundred billions of unknowns. Aware of these limitations, in this work we present an alternative approach of dealing with huge data sets, based on the coupling of two different models – a micro and macro scale flow solver, which are based on different mathematical laws.

The idea of treating a macro-scale model as homogeneous field, within which an arbitrary number of micro-scale models can be extracted and treated as a heterogeneous field in order to obtain further macro-scale information (such as permeability and porosity) can be applied to various porous media scenarios such as filters, asphalt, water reservoirs etc. In structural mechanics a similar approach would be the FE^2 numerical homogenisation.

Quantitative characteristics of porous media, due to its complex structure, are mainly obtainable through some physical and often very expensive experiments, which are conducted at some chosen local points. The main goal of our approach is to replace these physical experiments with the micro-scale calculations at the exactly same points, whereas due to our well-structured numerical domain, the high-resolution results on the fine scale can be delivered as well as a single scaled up value on the coarse scale, depending on the purpose for which these results will be used in the macro-scale calculations and the importance of that particular local point in the large scale model analyses.

In order to better understand the obtained results, an interactive visual data exploration tool [2] is applied, which enables both micro- and macro- scale models' experts to check these particular data on the different scales already during runtime of the coupled code and without interruption of the computation processes.

REFERENCES

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