The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A TENSOR-BASED GEOLOGY PRESERVING FORMULATION FOR UPSCALING HETEROGENEOUS PERMEABILITY FIELDS

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Keywords: *Reduce Order Modeling, Upscaling, Multi-fluid flows, Proper Orthogonal Decomposition, Control Volume Finite Element Method*

Reservoir models are in general complex, nonlinear, and large-scale. The porous media community has been investigating the challenges of appropriately representing heterogeneous properties (e.g., permeability) for decades. The challenges considered here are two-fold. First, it is impossible to obtain the value of per- meability at every point in a field scale geological domain. Secondly, the large scale data set involved with running the most realistic and accurate simulations are expensive in terms of computing resources and the time required to run the simulation. These challenges gave birth to upscaling, a model order reduction method. Since in reservor modelling, permeability entries are all non-negative hence it is only meaningful to find a non negative tensor decomposition method for model order reduction. In this work, a reduced-order model (ROM) based on High order non-negative proper orthogonal decomposition (HONPOD) method is integrated with a control volume finite element method-based (CVFEM) multi-fluid flow dynamics model. In this tensor-based approach, the HONPOD method reduces the dimension/rank of the permeability space whereas it mantains its fundamental features, whereas the simulator is able to capture detailed flow and transport dynamics with high-order accurate numerical schemes.

REFERENCES

[1] L. Lestandi *Low rank approximation techniques and reduced order modeling applied to some fluid dynamics problems*, Université de Bordeaux, 2018.

[2] J.L. Gomes, D. Pavlidis, P. Salinas, Z. Xie, J.R. Percival,Y. Melnikova,C.C. Pain, M.D. Jackson. *A forcebalanced control volume finite element method for multiphase porous media flow modelling*, International Journal for Numerical Methods in Fluids. 2017 Feb 20;83(5):431-45

[3] S. Afra *Heterogeneous Reservoir Characterization Utilizing Efficient Geology Preserving Reservoir Parameterization through Higher Order Singular Value Decomposition (HOSVD)*, A&M University Texas, 2015.