A Fully Coupled Method for Massively Parallel Simulation of Hydraulically Driven Fractures in 3-dimensions

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ABSTRACT

This presentation will describe a fully coupled finite element/finite volume approach recently developed at the Lawrence Livermore National Laboratory for simulating problems involving field-scale hydraulically driven fractures in three dimensions utilizing massively parallel computing platforms [1]. A detailed description of the governing equations, and numerical implementation is provided, including a discussion on assumptions to ensure a well-posed problem. In particular, methods to avoid numerical issues associated with the near tip-region will be discussed. We will outline different time integration strategies (explicit/implicit) for solving the fully coupled system, including a comparison of computational effort associated with the options. Crack-propagation is treated by adaptively duplicating nodes as the fracture evolves. The challenges of handling changes in mesh topology in a massively parallel distributed-memory computing environment will be discussed.

A series of numerical studies comparing the model to both analytical solutions and experimental results will be presented. The choice of a Finite Element Method allows the proposed method to provide a reasonable representation of local heterogeneities, layering, and natural fracture networks in a reservoir. To illustrate the flexibility and effectiveness of the proposed approach when applied to real-world problems, several field scale case studies will be presented and an overview of outstanding problems will be provided.

REFERENCES

[1] Settgast, R.R., Fu, P., Walsh, S.D.C., White J.A., Annavarapu, C., and Ryerson, F.J. *A Fully Coupled Method for Massively Parallel Simulation of Hydraulically Driven Fractures in 3-dimensions. Int. J. Numer. Anal. Meth. Geomech.* (2016) , doi: 10.1002/nag.2557.