FE Simulation of Fluid-Solid Interaction in Hydraulic Fracturing

B Chen, C F Li and D R J Owen

Zienkiewicz Centre for Computational Engineering, College of Engineering, Swansea University
Bay Campus, Swansea SA1 8EN, United Kingdom

Email: c.f.li@swansea.ac.uk

ABSTRACT

Since the first field test in Kansas in 1947 on a gas well in the Hugoton field [1], hydraulic fracturing has become a vital step to get a commercial or higher production from oil, unconventional gas, especially for low-permeability and tight reservoirs. Diverse simulators have been developed to optimize the design or understand some specific mechanisms. However, there are still some situations which have not been treated properly, for example, the evolution of lag in complex conditions. Improper treatment or assumption may result in inaccuracy results.

To predict the lag evolution during hydraulic fracturing, we propose a plane 2D model to simulate the complex evolution of fluid lag during propagation of straight or curved hydraulic fracture. Rock deformation and fluid flow are both modelled by standard finite element methods and are solved in fully coupled manner while linear elastic fracture mechanics theory is utilized to dictate the propagation of fracture. An elaborate adaptive remeshing strategy is adopted to update the unstructured mesh when new fracture surface is presented. Results from old mesh is mapped to new mesh by using a novel transfer operator. As a natural product of the solution system, lag is treated in a more proper way. Two different boundary conditions for fluid flow are switched for condition with and without lag when necessary to track the complex evolution of fluid lag. The model is verified by existing semi-analytical and numerical results. Depending on the stress condition or rock properties, the fluid lag may enlarge, diminish, vanish or emerge.

Some preliminary results are listed below:

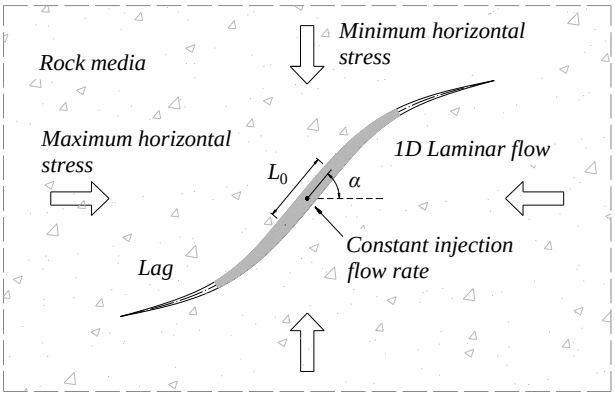

Figure 1: A 2D schematic diagram hydraulic fracture with a lag

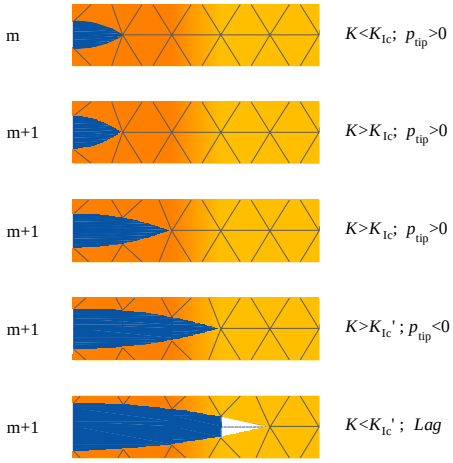

Figure 2: Initiation of lag from high-touhness area to low-toughness area

REFERENCES

[1] B.J. Carter, J. Desroches and A.R. Ingraffea et al., *Simulating fully 3D hydraulic fracturing, in Modeling in geomechanics*, Wiley Publishers: New York, 2000.