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Hydraulic Fracturing of Shale: Challenges on Modelling Front; What we know and what we don't.

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Introduction

The size of hydraulic fracturing treatments being pumped into shale formations have become large enough to create their own logistical and operational challenges. On the modelling front, even though industry has made big strides, we still have a long way to go. Fracture simulators have become advanced enough to include full 3D, multi-stage modelling, cluster fracturing, and many more functionalities.

Background

The key issue in fracture simulation is lack of quality input data. Therefore, a proper representation of lithology, reservoir and geomechanical properties of the formation is the primary challenge for a shale or in general any fracture modelling. Proppant transport, near wellbore tortuosity, fluid rheology and proppant / fluid interaction for newer fluid systems especially energized fluids, fluids with proppant suspension enhancing chemistry and systems with nanoagents are some other topics that are not very well addressed. Complex fracture network and introduction of cluster fracturing and resulting stress shadows adds to the geomechanical complexity of problem which needs to be handled properly. Obviously, the list adds up.

Examples

In this paper, case studies from Duvernay and other shale formations in the Western Canadian Sedimentary Basin are presented. In order to provide some context on the size of these fracture treatments, an average 2017 fracturing job pumped into an East Duvernay wellbore has more than 50 stages, close to 50,000 m3 of fluid and 4500 tonnes of proppant. Larger fracture treatments with over 60 stages and 60,000 m3 of fluid and 7000 tonnes of sand have been executed on this formation too.

Workflow

Wellbore data such as deviation survey, pumping schedule, and log data are integrated into a fracture simulator to build hydraulic fracture models for selected shale wellbores. Minifrac / diagnostic fracture injection tests (DFIT) as well as routine core and special geomecanical lab testing data are used for the calibration of closure stress, pore pressure and permeability when applicable. A grid based numerical fracture simulator which uses continuum approach is used in this study. Figure 1 shows an example of a transverse hydraulic fracture model.

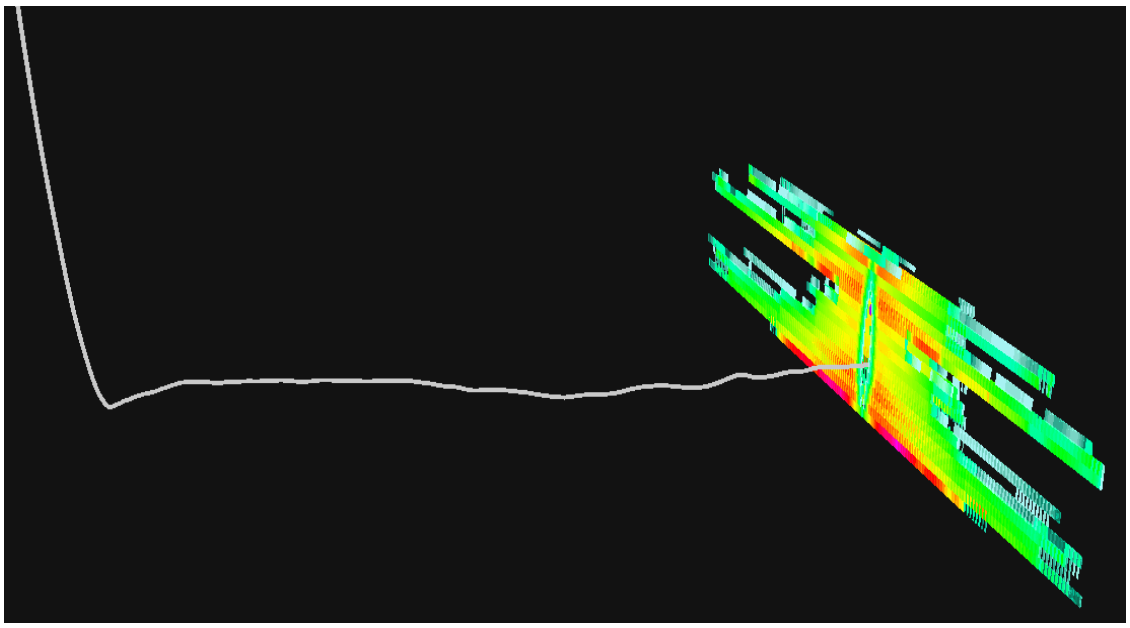

Figure 1. A transverse hydraulic fracture model

Conclusions

Some of the modelling challenges listed above will be discussed through cases studies. Deficiencies of the modelling tools available at our disposal are highlighted and suggestions and recommendations are made on how to improve the results.