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Comparing DFIT Interpreted Closure Stresses from both Fall-offs and Flowbacks

Robert C Bachman
CGG Canada

Summary

As part of the oilsand's permitting process it is required to quantify the minimum in-situ stress (closure stress) in the overlying caprocks. The closure stress of the caprock dictates the maximum operating injection pressure allowed under AER regulations for thermal injection projects. The stress state of the caprock is determined on a vertical test well by a Data Fracture Injection Test (DFIT). Usually DFIT's are run on multiple zones within the well. For a single zone, small volumes are injected above fracturing pressure followed by a pressure fall-off or production flowback. Flowback rates are at a fraction of the injection rate. This process is repeated between 3 and 8 times per zone. Normally a single zone's test is completed with 24 hours. Currently, different analysis techniques are applied to fall-off and flowback tests.
DFIT's are also performed on unconventional shale oil and gas wells in the toe stage of the horizontal well. Water is pumped above fracturing pressure into the well followed by a single fall-off of between 4 and 20 days. The purpose of this test is to determine closure stress and well properties such as initial pressure and hopefully permeability. This requires a lengthy after-closure period, hence the long test times.
There are still many DFIT interpretation challenges:

1) There is controversy regarding the closure stress pick from a fall-off. Two closure models have been proposed, tangent closure and variable compliance closure. This directly affects the oilsand's maximum operating injection pressure.
2) For unconventional shale wells, late time after-closure flow regimes may not be linear or radial flow. Initial pressure and permeability determination is difficult.

If a flowback test could be run in such a manner as to give closure stress and reservoir properties, an ideal situation would exist. Test times would be short and identifiable after-closure linear or radial flow regimes would occur.
Multi-cycle oilsand and caprock fall-off and flowback DFIT's are plentiful. This paper uses a PTA based methodology for analyzing both fall-offs and flowbacks; which is a first. This allows a serious starting point for exploring the identified challenges over a variety of tests and zones. A review of our interpretations and findings will be presented.

Theory / Method / Workflow

PTA approach to unify DFIT interpretation process

Results, Observations, Conclusions

Additional information about stresses obtained than traditional analyses

Novel/Additive Information

Re-thinking of what is going on in terms of flow regimes during a DFIT

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