Modeling of Geomechanical Stress Distribution During Polymer Injection for Enhanced Oil Recovery

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Abstract

Polymer injection is an enhanced oil recovery method that relies on the mobility control of the injected phase within the porous rock to increase volumetric sweep efficiency and maximize oil recovery. Polymer solutions are non-Newtonian fluids that exhibit a pseudo plastic behavior .The recovery of viscosity at low shear rates within the reservoir, during an injection process, translates in a decrease of the injected fluid mobility. The changes in mobility could affect the pore pressure distribution within the reservoir. The distribution of reservoir pressure can be estimated using numerical reservoir simulation. This work presents the application of a commercial reservoir simulator to model a polymer injection process for enhanced oil recovery, and to estimate changes in the stress distribution within the reservoir. Then, we assess if the magnitude of stress changes could trigger any potential rock failure, based on heterogeneous distributions of rock mechanical properties.

Several realizations of the reservoir properties distribution are generated using geostatistical methods. The reservoir fluids and different polymer solutions will be characterized in terms of its rheological properties. A numerical reservoir simulation study is presented that assess the oil reservoir response to the injection of different polymer solutions in terms of the stress distributions. The magnitude of the stress changes and any potential rock failure will be determined from the analysis of the simulation results.

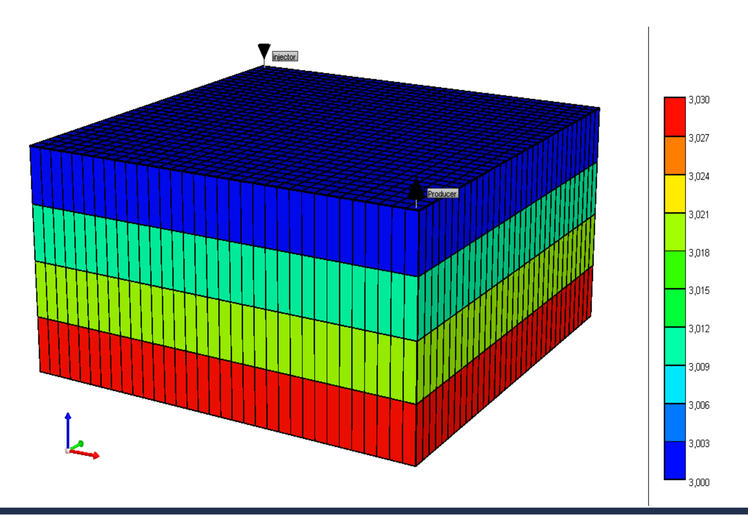
Reservoir Model

This Research project was done using the STARS simulator in CMG

The grid is – 33 x 33 x 4 Grid Top – 3000 ft Grid Thickness – 20 ft

Porosity -0.206 Permeability I – 100 Permeability J – 100

Water – 62.4 API Oil – 50 API Oil –Water contact – 3200 ft



Cases

Case 1: Shear Thinning -This model was created using Xanthan-gum as the shear thinning polymer.

Density – 62.4 API **MW -**10000 lb/lbmole

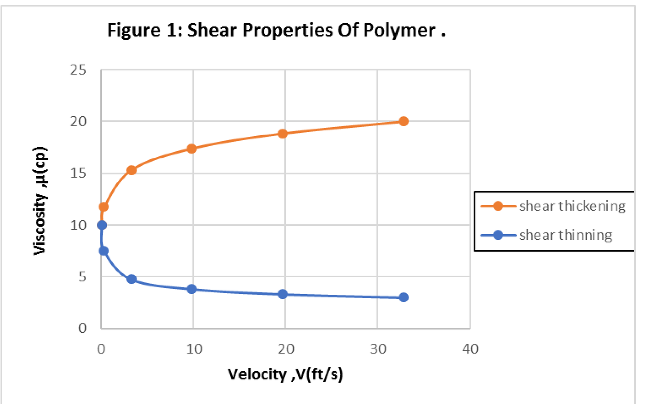
Pcrit – 3197.79 psi **Tcrit-**705.56 F

Case 2: Shear Thickening -This model was created using a shear thickening polymer.

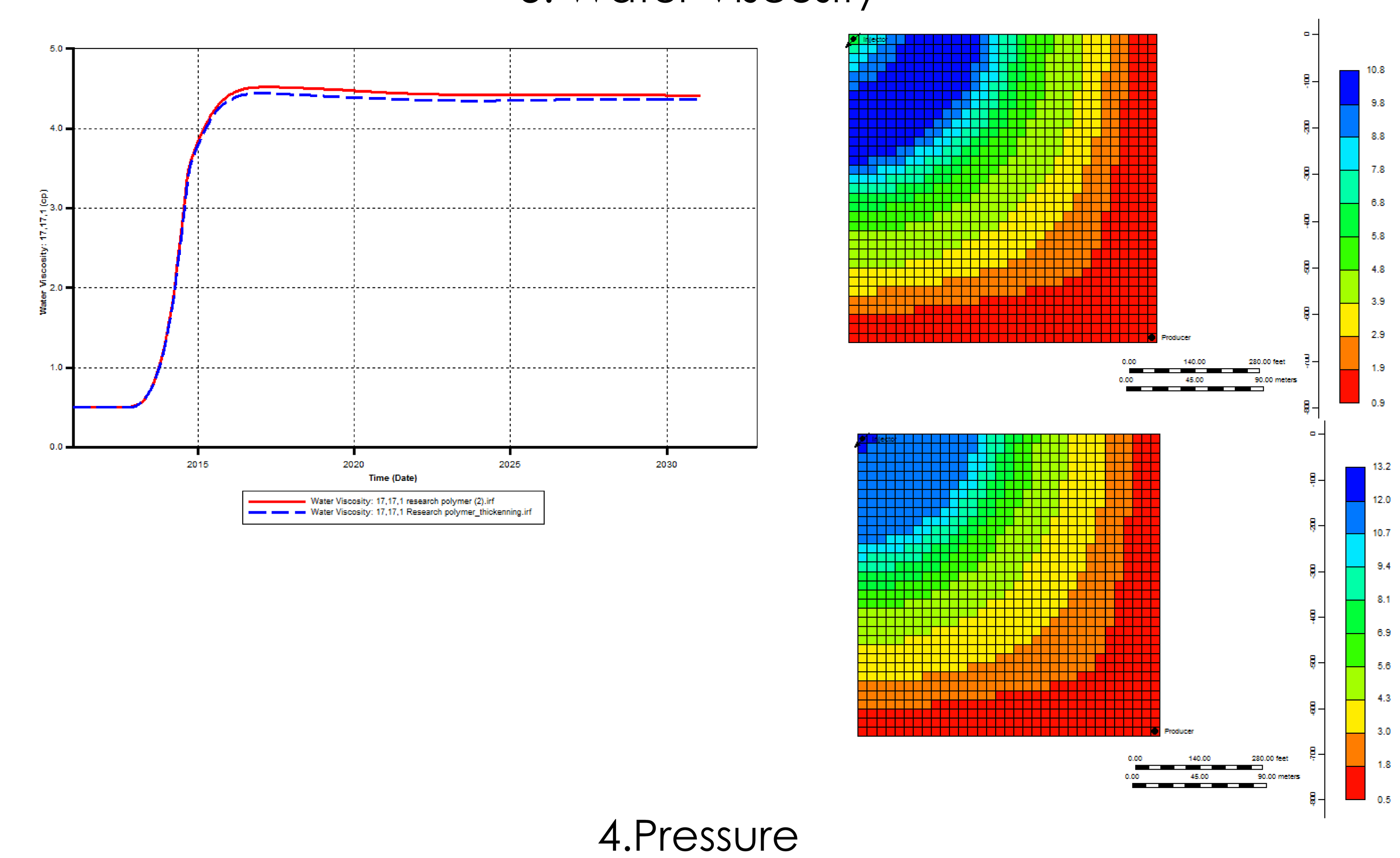
Density – 62.4 API **MW -**10000 lb/lbmole

Pcrit – 3197.79 psi **Tcrit-**705.56 F

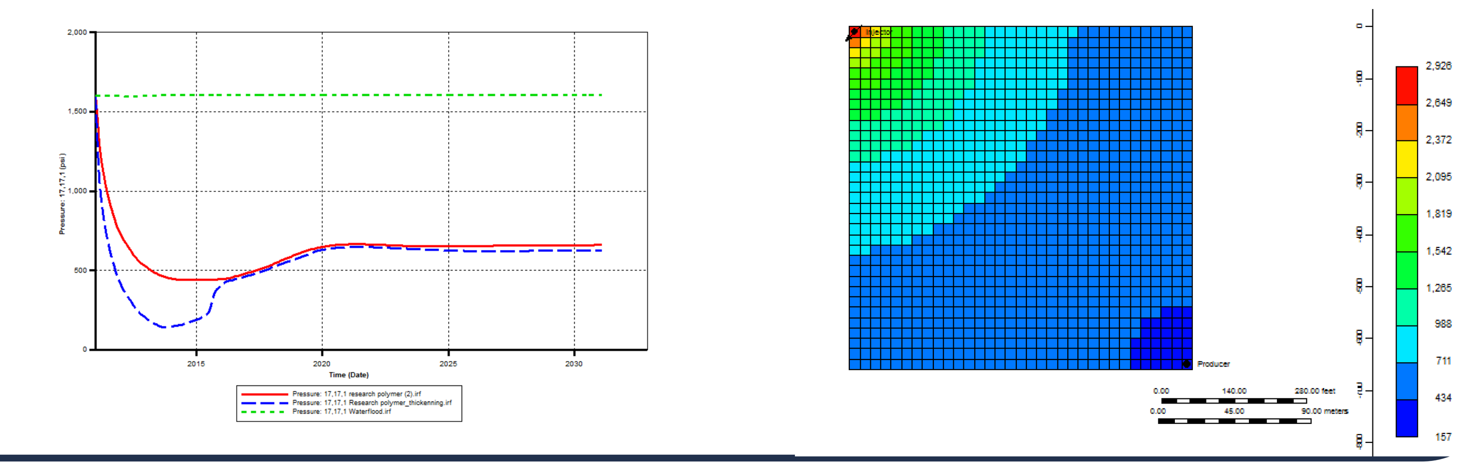
Case 3: Basic Waterflood Case



3. Water Viscosity

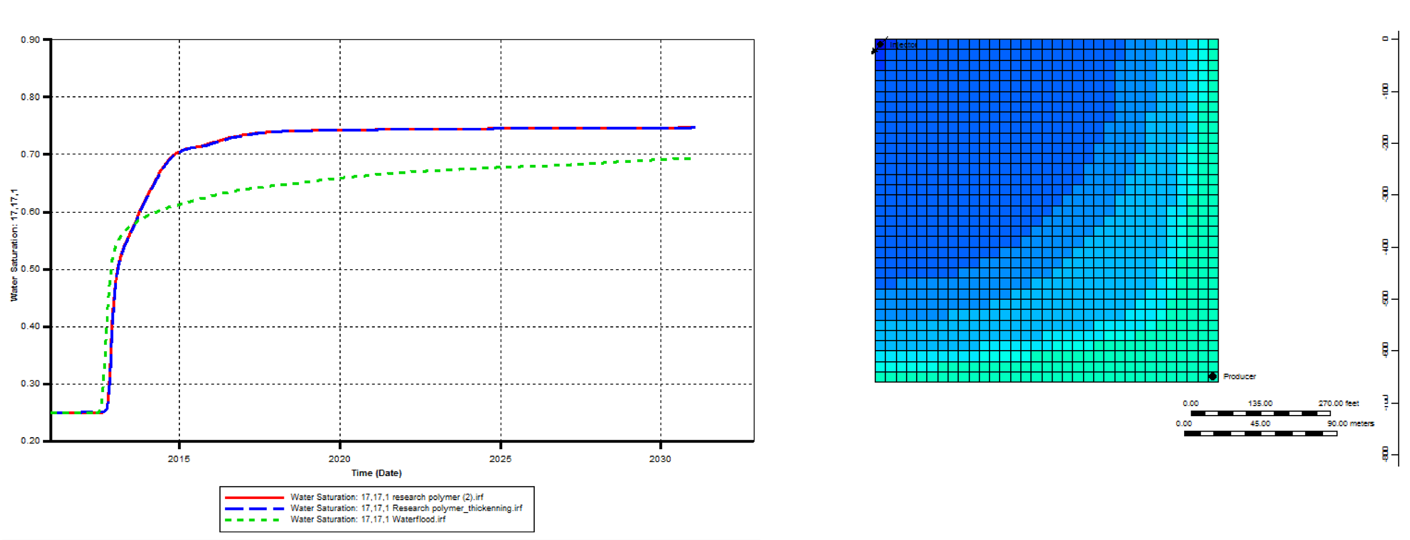


4.Pressure

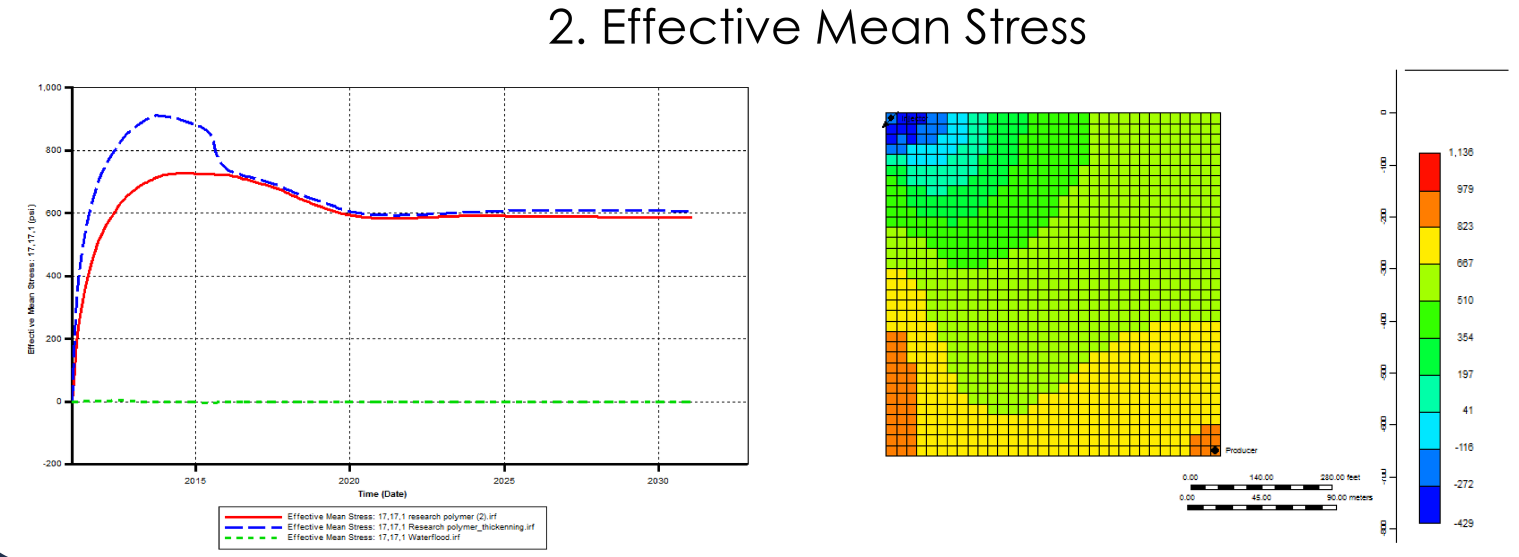


Results

1.Water Saturation



2. Effective Mean Stress



Conclusions

1. The reservoir achieves a breakthrough earlier during a waterflood as compared to the polymer flood cases.

2.It can be seen that there is a greater effective mean stress in the shear thickening case as compared to the shear thinning case.

3.The water viscosity trends make sense for both the shear thinning and thickening polymer .

4. The pressure is a constant in the case of the water flood while it decreases with the polymer flood and reaches a plateau.

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