

Q and viscosity – recent progress

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ABSTRACT

The estimation of seismic viscosity is crucial in simulating production history in heavy oil fields. While viscosity of heavy oil can be estimated at the borehole by using viscosity meters or by geochemical measurements, we wish to estimate viscosity variation between boreholes. Seismic data analysis provide such a possibility. Recent studies have shown that measurements of seismic absorption (or inverse-Q values) can be related to viscosity. In particular, Vasheghani and Lines (2008) showed that Zener's model describes rock physics observations. It is further shown that VSP measurements could possibly define the Q variations accurately enough to give viscosity estimates.

INTRODUCTION

Reservoir simulations of heavy-oil fields generally use some form of Darcy's Law to relate fluid flow, q , to pressure gradients, ∇p , the permeability of the medium, k , and the fluid viscosity, μ . For heavy oil reservoirs, the viscosity is extremely high and often ranges between 10,000 cp to 1,000,000 cp. The variation of these viscosity values has a huge impact on the simulation accuracy and its ability to match production history. Recent publications by Behura et al. (2007), Carcione (2007) and Vasheghani and Lines (2008) show that Q variation with viscosity as well as seismic measurements of Q. The Zener model for viscoelastic damping is the most general and agrees closely with experimental results.

RESULTS

The rock physics measurements of Behura et al. (2007) show that Q will initially decrease with increasing temperature of heavy oil (decreasing viscosity) to a local minimum at about 60-80 degrees Celsius before then increasing as reservoir temperature increases. This behaviour is consistent with Zener's model for viscoelastic damping. Hence, it would appear that we can relate Q to viscosity as long as we know the temperature range for our reservoir. Consequently, the estimation of viscosity can be accomplished by accurately estimating Q. From our present modeling, we have found the most effective means of doing this comes from the use of the centroid method to vertical seismic profile data (VSPs), as described by Quan and Harris (1997) and Hedlin et al. (2002).

CONCLUSIONS AND FUTURE DIRECTIONS

From both theories, numerical modeling, and rock physics measurements, we note that Q and viscosity are related, and that Q is best estimated by using observations of VSP data. Viscosity is a very crucial parameter in production history matching. Our next experiments will involve the use of real VSP data in a heavy field to estimate Q in order to accurately estimate viscosity. We would then use these viscosity estimates to hopefully improve our reservoir production history matching.

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