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Intraformational Lean Zones in Oilsand Reservoirs

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Summary

Oilsand reservoirs often consist of sequences of sands with no barriers to vertical flow. However, there are often intraformational gas or lean zones that are layers having higher gas or water saturations.

These are present, not because of any vertical permeability barriers or baffles, but due to capillary threshold effects. At the geological sequence boundaries, overlying finer-grained sands have smaller pore throats. In order for gas to rise and penetrate these smaller pore throats, the pressure in the gas has to exceed the capillary pressure forces. This equates to a capillary pressure threshold. A minimum pressure difference is needed to overcome the entrance pressure into the finer-grained material. As a result, smaller pore throats can retain a column of gas below the sequence boundary, resulting in these intraformational gas accumulations. Lean zones are merely drowned intraformational gas accumulations.

These sequence boundaries are not barriers to vertical flow but impose a small capillary threshold pressure. During SAGD operations, the steam chamber pressure will easily overcome this threshold. Once steam has risen through the sequence boundary, capillary pressure effects are eliminated.

A case study is presented in which a profile of grain size distributions was used to generate a capillary pressure profile, from which intraformational gas caps were predicted. These were compared to saturation profiles in the same well.

This paper describes the physics behind intraformational lean zones and provides a methodology to calculate the probable lean zone thickness based on a grain size analysis of the oilsands. From this, a capillary pressure profile can be constructed and implemented into reservoir engineering models.

The presence of the lean zones themselves pose challenges to any injection process, given that they are layers of higher transmissibility within the reservoir. As such, operations must be tailored to adjust for the effect that these zones may have on fluid movements within the reservoir.

A better understanding of intraformational gas and lean zones has applicability to many of the SAGD projects currently under development, with extension to solvent-assisted recovery projects.