The Origin and Impact of Fluid Heterogeneity on Production Characteristics of Heavy Oilfields

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Abstract
Fluid property variations on field wide and reservoir scales are a defining characteristic of heavy oilfields. Traditionally, heavy oil and tar sand exploration and production strategies rely heavily on characterizing key reservoir heterogeneities and assessments of fluid saturations. While these are crucially important, variation in key fluid properties such as viscosity are sometimes even more important but are usually ignored by petroleum engineers despite both viscosity and permeability being equally key variables in Darcy's law. Heavy oil and tar sands are formed by microbial degradation of conventional crude oils, in which constraints such as charge mixing, biodegradation rate and critical controls such as water and nutrient supply to the organisms responsible for oil biodegradation, ultimately constrain the final distribution of API gravity and viscosity over geological timescales. Large scale lateral and small scale vertical variations in fluid properties resulting from biodegradation and charge mixing are common with up to orders of magnitude variation in viscosity being seen even on a reservoir thickness scale. Understanding the processes involved and advances in the numerical simulation of biodegrading oilfields often allows us to predict the viscosity distributions on a variety of scales which are often theoretically predictable in a gross sense. We describe and illustrate the quantitative geological controls on fluid property variations in heavy oil reservoirs and show how advances in reservoir fluid characterization through petroleum reservoir geochemistry, linked with advanced reservoir simulation can aid in heavy oil production.