Exploiting Natural Variations in Fluid Properties to Solve Production Problems in Heavy Oil Reservoirs-Production Allocation, Viscosity Profiling and Barrier Detection

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Viscosity variations in heavy oil reservoirs may dominate reservoir permeability effects in controlling fluid mobility. At reservoir scale, gradients in oil composition and fluid properties result from preferential biodegradation of hydrocarbons, which gives oils a spatially variable molecular signature or "fingerprint" related to the level of degradation. These gradients are further impacted by baffles and barriers which compartmentalise a reservoir compositionally and in terms of fluid properties. High resolution profiling of oil composition can detect both production baffles, barriers and also to allocate production from long or multi-lateral completions to specific reservoir zones. In essence, a produced oil bears a distinct fingerprint, which is an integration of the fluid contributions from the highest mobility regions of the perforated zone along a production string. The produced fluid composition in combination with a compositional "map" or log along the producing zones, obtained from analysis of core or more routinely cuttings, can be used to understand the production behaviour of the well. While production allocation is not a new concept, the allocation of oils from complex compartmentalised, graded reservoirs or from evolving thermal recovery steam chambers requires a new level of spatial precision and we describe such approaches with field examples.

The key to effective production allocation is reliable, reproducible, quantitative geochemical methods that are effective in heavily or severely biodegraded polar compound rich heavy oils and bitumens where classical methods struggle. We use a multistep LC based analytical scheme and gc-ms with internal, external and recursive analytical standards to generate highly reproducible molecular fingerprint data and very precise aromatic and saturated hydrocarbon concentration data for over 200 components. This quantitative data from cuttings or core is analysed by multivariate statistical methods and spatial neural network methods to derive a compositional model. Production allocation may be applied toward assessment of recovery from compartmentalized reservoirs based on commingled production, allocation of production along horizontal wells in cold and thermal recovery and monitoring steam chamber growth in CSS or SAGD (3D allocation). Success of production allocation methods depends on performing high quality baseline fluid characterization from cuttings and core, so don't throw your cuttings away!