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Cost-Effective Integration of Geologic and Petrophysical Characterization with Material Balance and Decline Curve Analysis to Develop a 3-D Reservoir Model for PC-based Reservoir Simulation to Design a Waterflood in a Mature Mississippian Carbonate Field with Limited Log Data

Kansas Mississippian shallow shelf carbonates reservoirs, operated by small independent operators, have produced over 1 billion barrels of oil and presently represent over 40% of Kansas annual oil production. Despite prolific production, recovery efficiencies are low (12-18%) due to reservoir heterogeneity, variable drive support, limited geologic and engineering data, and lack of application of integrated reservoir evaluation tools. The goal of this DOE-funded project is to develop and demonstrate applications of a number of low-cost modern tools and techniques that independent operators can employ to characterize assets to evaluate secondary recovery applications. In the field studied, only porosity and gamma logs were available for most wells making it difficult to determine initial water saturation distribution. Also, oil production rate data for individual wells was sparse. Spreadsheets were used for advanced decline curve analyses to complete oil production history, estimate reservoir connectivity, and strength of reservoir drive. Completed well production histories were used in spreadsheet-based material balance calculations to estimate original oil-in-place (OOIP) volumes and effective aquifer properties. Lacking core from this field, data from a regional Mississippian rock-catalog were used to develop relative permeability and capillary pressure curves for porosity-permeability pairs. Wireline log signatures, capillary pressure data, and OOIP volumes were integrated in a 3-D reservoir model that described reservoir architecture, distribution of flow-units, and properties (including initial water saturation). A PC-based reservoir simulator used this model to map remaining oil saturation and it indicated that minimal capital is needed to enhance recovery from an under-produced region of the field.