Streamline-Based Surveillance for Mature Floods

The surveillance of injection and production volumes of ongoing water/EOR floods and proper identification of well-pairs and patterns is critical to improving oil recovery and reducing fluid cycling. Good diagnostics and good surveillance are the starting point for good decisions to improve the state of an ongoing flood. Where to inject more water, where less? How much fluid is being lost to the aquifer? Which patterns (injectors and associated producers) have historically outperformed and which have underperformed? Being able to answer these questions quickly allows setting target rates to improve sweep patterns of a flood. And as new production/injection data is collected the analysis is repeated, allowing a nearly continuous rate-target management strategy to maximize field recovery with existing wells.

Streamsim Technologies has developed a unique numerical methodology based on streamlines to compute flow-based Well Allocation Factors (WAF) between injectors and producers, representing a step-change compared to the traditional, geometric-based approach to guessing WAF's (**Figure 1**). The streamline-based methodology is implemented in a simple-to-use but powerful interface called studioSL. studioSL includes the display of the WAF-based relationship between injectors and producers using Streamsim's patented Flux-Pattern Map as well as injection efficiency plots—the amount of oil being recovered attributable to individual injectors. The display of injector/producer pairs via the Flux Pattern Maps is particularly helpful in justifying well rates changes to management and the operations team. The Flux-Pattern Map represents a visual display unmatched by other software.

Because the surveillance workflow is not a simulation workflow, the level of expertise needed to work with studioSL is significantly lower than one required for building full-blown simulation models. Surveillance diagnostics can be extracted in minutes. studioSL offers flexible import tools to process required data using standard formats (OFM, geoSCOUT, AccuMap) and consequently allows engineers to generate relevant diagnostics quickly. The ease and simplicity of Streamsim's surveillance technology makes it accessible to a wide range of reservoir engineers, including junior staff.

An example using Streamsim's surveillance technology is being presented in paper SPE-166393-MS "Experiences with an Efficient Rate Management Approach for the 8th Tortonian Reservoir in the Vienna Basin" at the ATCE 2013.

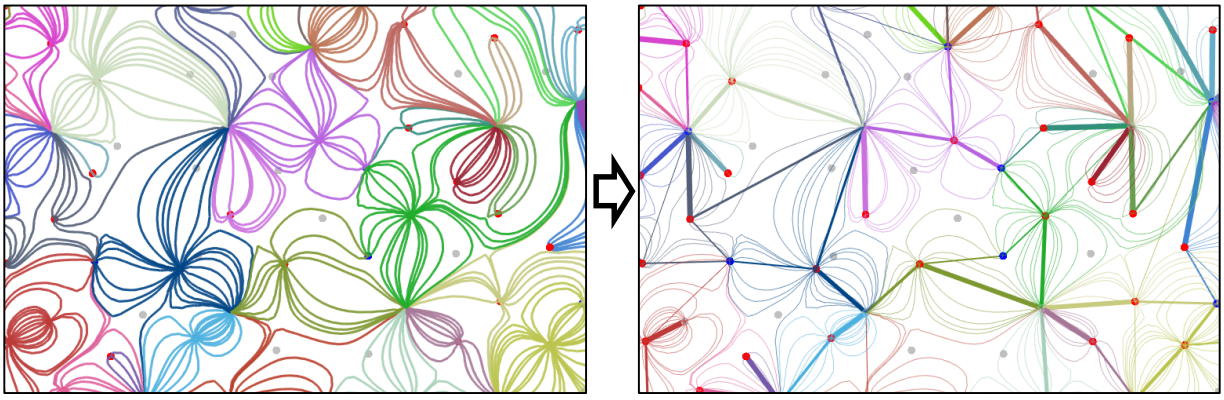

Figure 1. Streamline paths for a mature pattern waterflood (left) and the associated Flux Pattern map (right) with connection thickness related to each well's production allocation factor displayed in studioSL.

SPE-166393-MS

Experiences with an Efficient Rate Management Approach for the 8th Tortonian Reservoir in the Vienna Basin

Martin Kornberger[1] and Marco R. Thiele[2].
[1]OMV E&P, [2]Streamsim Technologies/Stanford University

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Abstract

Active well rate management to demote fluid cycling and promote efficient use of injected fluids is a simple way to increase recovery in brown fields while minimizing costs and preserving existing field/well fluid handling constraints. In this work, we present the application of an efficient flow-based surveillance technique to drive rate management decisions for the 8th Tortonian reservoir in the Vienna Basin, Austria. The 8th Tortonian is a typical example of a decade-long peripheral water flood on a long, steady decline for which it is difficult to justify expensive drilling/workover programs. Active rate management to improve pattern sweep presents a cheap solution to increase recovery. In case of the 8th Tortonian, Euro 10,000 (US$13,000) were spent to modify well rates resulting in ~5700 m³ (~35000 STB) incremental oil recovered over a 30-month period. The current oil rate remains above the oil rate before the start of the project.

Our approach takes advantage of streamline-derived well allocation factors (WAF's) to quantify injector-producer connections. It is simple and efficient to estimate WAF's using total historical well fluid rates, well locations, and a geological model. With the WAF's known, the ratio of produced oil to injected water (efficiency) for of each injector/producer pair can be estimated. Well pair efficiencies are the starting point for the rate management approach described in this work.

A simple, single homogenous layer system was used in conjunction with historical rates and well locations to estimate the WAF's for the 8th Tortonian reservoir. Connections were compared to available tracer data, and an area of interest was subsequently selected where both streamlines and tracer data confirmed oil recovery by injected water. A key constraint was to maintain the total gross rate of the area selected at current capacity. New target rates we determined and implemented resulting in a 30% increase of oil rate over a 30 month period. Considering the simplicity and efficiency of the approach, this is a notable result. The production response of the selected wells showed an increased recovery in conjunction with a decreasing water cut suggesting contact with previously unswept oil. All operations and modifications were done at minimum cost. There were no perforation changes or acidizing jobs involved and rate changes were obtained simply by changing pump sizes or increasing the number of strokes by changing the V-belt pulley.