Assessment of sweep from inter-well water tracers

Operator used water tracers to verify polymer effect and identify un-swept oil

Challenge

An operator wanted to use tracer data to overall connections, connection magnitudes and sweep-efficiency in an off-shore reservoir with horizontal water injectors and producers.

Solution

Unique RESMAN interwell water tracers were deployed in each injector shortly after injection start-up and monitored in the producers. The tracer data were then interpreted using RESMAN's interpretation method.

The early deployment of tracers enabled remediation of the issue of poor sweep by drilling additional injectors to improve sweep.

Application

All producers in the field were monitored. In two producers a significant and rapid breakthrough of tracer was seen after three months (cf. Fig. 1).

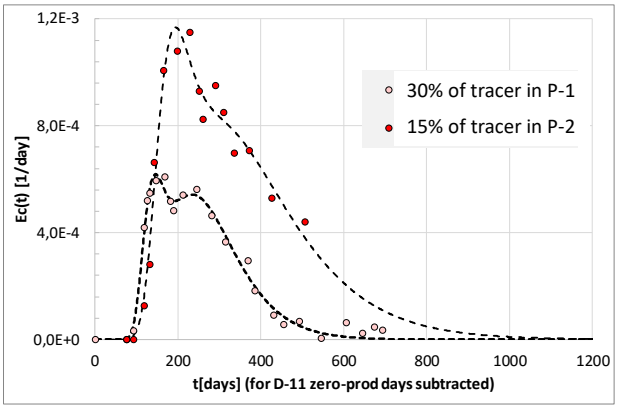

Fig. 1 – Tracer from one injector in two of the adjacent producers in the field. The symbols correspond to measured tracer data, transformed into a residence time distribution (RTD). The dashed lines correspond to RESMAN's model curves, used to extrapolate the RTD beyond the last data points.

Residence time distribution (RTD) analysis of the data provided quantification of the connection magnitude as well as the sweep volume for each injector-producer pair. The result shows that almost half of the injected water (45%) cycles fast from one of the injectors to the injectors P-1 (30%) and P-2 (15%). The sweep volumes from the injector towards the producers P-1 and P-2 are 263 and 90 thousand m^3, respectively.

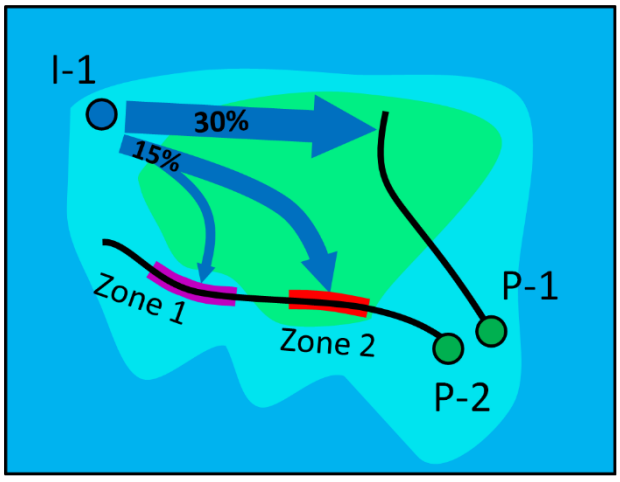

Fig. 2 – Summary of flow characteristics from one injector (I-1) towards two producers (P-1 and P-2) in the field. Flow directions and magnitude are illustrated as arrows where the arrow widths are proportional to the percentage of water from the injector towards each producer.

RESMAN inflow tracers were also installed in the producers. These tracers were used to give an assessment of the location in the producers where the main water breakthrough occurred.

Results

Comparing the sweep volumes calculated from the tracers to the inter-well reservoir volume reveals that less than 5% of the pore space has been swept and that flow occurs in small cross-sectional areas. The tracer data thus provide direct proof of poor sweep and implies that a substantial oil volume remains untouched.

In general, the tracer data provide actionable information. In general, water injection can be re-routed, producers of parts of the producers can be closed off or in-fill wells can be drilled. In the present case, the operator decided to drill additional injectors to remediate the poor sweep.