

CONFORMNACE IMPROVEMENT IN THE HIGHLY FRACTURED KUPARUK RIVER UNIT



SITUATION

Kuparuk River Field, operated by ConocoPhillips Alaska, is a structural-stratigraphic trap consisting of two productive sands; Sand A with low permeability and the high permeability C sand.

The field currently has more than 1,100 wells under water flood, miscible or immiscible water-alternating-gas. Extensive faulting and drastic permeability distribution in C-sand has resulted in sever communication between injectors and their offset producers instigating high water production and low sweep efficiency.

CUSTOMER CHALLENGE

Injector I-1 was initially drilled as a single wellbore, completed to inject into the Kuparuk C sand. To increase the injectivity and support the offset production, later two sidetracks were completed in C4, C2 and C1 sands. After sidetracks the average injectivity of this well was about 6 bpd/psi and was at times showing as high as 9 to 11 bpd/psi while the field average for similar wells was in the range of 1 to 5 bpd/psi.

This is a summary of SPE 179649

Quick communication between this injector and its offset producers was confirmed by immediate gas breakthrough to the offsets during miscible gas (MI) injection (Figure 1). An inter-well tracer study also showed 30.2% of the injected tracer at injector I-1 recovered in three offset producers in 16 to 22 days indicating quick communication through highly conductive features/faults (Figure 2).

Figure 1. Immediate gas breakthrough after MI, a sign of direct communication (SPE 179649)

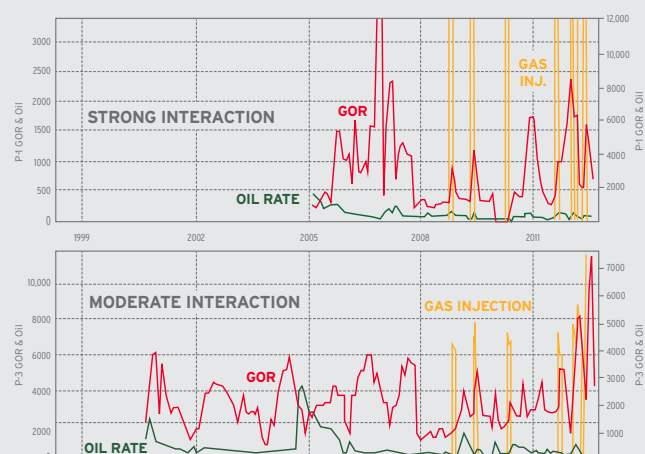
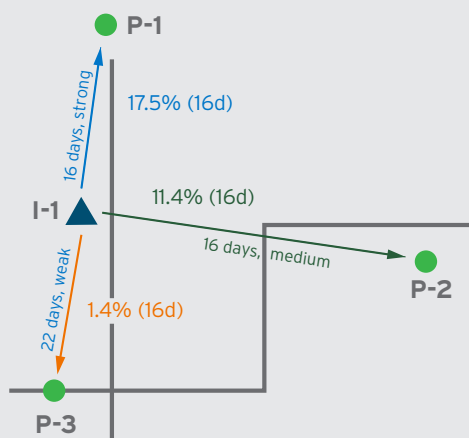


Figure 2. Tracer breakthrough to offset producers in 16 to 22 days (SPE 179649)

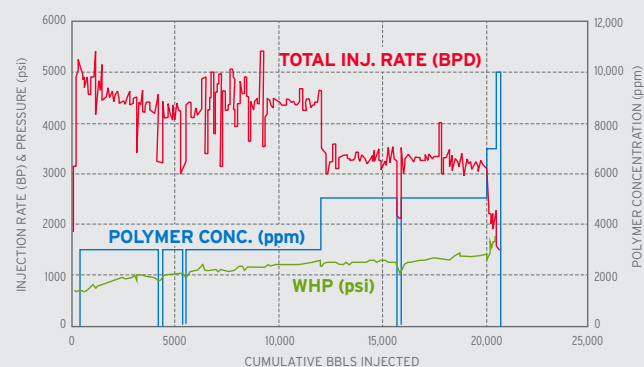


SOLUTION

A polymer gel conformance treatment was recommended to address the communication and improve the oil recovery in this pattern. Use of high molecular weight (HMW) crosslinked polymer was specifically suggested to avoid penetration into the matrix with lower permeability.

Roughly 20,000 bbl of HMW polymer was injected in stages from 3,000 to 10,000 ppm at 40:1 polymer to crosslinker ratio. The injectivity was reduced from approximately 7 bpd/psi to 1.3 bpd/psi during the treatment (Figure 3).

Figure 3. I-1 Conformance treatment summary



RESULTS

The polymer gel was placed in the high permeability feature responsible for high water production, quick gas breakthrough and low sweep efficiency in this pattern without damaging the low permeability rock.

The conformance treatment had an immediate impact on the injectivity of injector I-1, indicating the injection fluid being diverted to un-swept areas of the reservoir (Figure 4).

Increased delay in gas breakthrough and increase in oil production (Figure 5) proves that the means of communication has been addressed.

Figure 4. Hall Plot shows decline in injectivity as a result of the conformance treatment

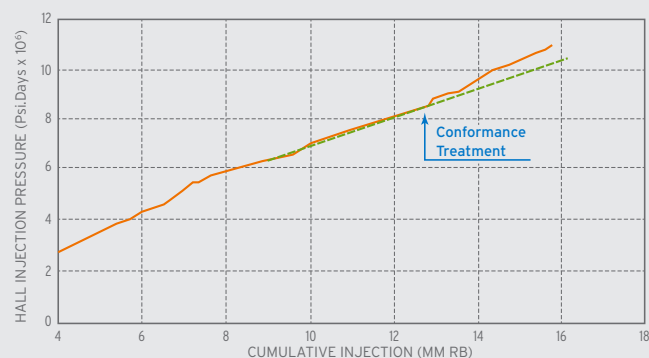
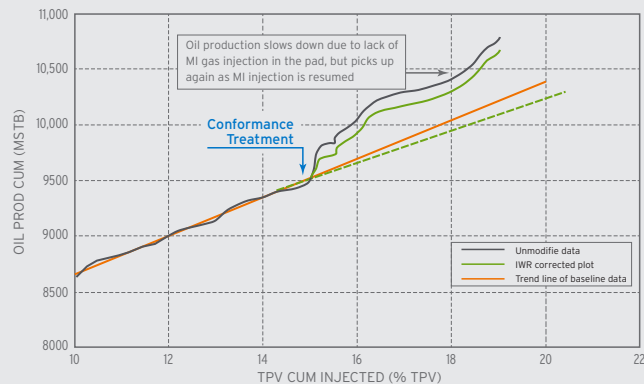


Figure 5. Incremental oil production from four offsets as a result of conformance treatment



In summary polymer gel conformance treatment resulted in total incremental oil of 460,000 bbl at effective incremental rate of 630 bpd for the pattern.

Incremental oil production had to be corrected for the time that injector I-1 was down until it returned back to normal injection. A temporary decline in the trend of incremental oil production can be observed which is due to lack of miscible gas injection in the pad.

460,000 BARRELS OF INCREMENTAL OIL / **AT EFFECTIVE INCREMENTAL OIL RATE OF 630 BPD**

Nalco Champion
Global Headquarters
11177 S. Stadium Dr.
Sugar Land, TX 77478
Telephone: +1-281-263-7000

nalcochampion.com

GOALZERO

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