CASE HISTORY

Optimized fracture program increases production, lowers costs in tight offshore pay zone

Higher conductivity of low-density ceramic proppant helps improve economics of challenging reservoir.

North Sea, Denmark

The challenge

A North Sea Operator's extended-reach field development program targets the Lower Cretaceous "dirty chalk" reservoir characterized by low permeabilities that require effective stimulation for economic drainage. Typically, the operator drills 16,000-ft laterals, with the toe completed using an acid stimulated limited entry, predrilled liner, and the upper 10,000 ft of lateral completed with 12 to 14 propped fracture stages. As part of its evolving completion and stimulation strategy, the operator was using 500,000 to 1 million lb of 20/40 natural sand in each stage, greatly exceeding stimulation vessel capacity. In addition to the on-site logistical challenges and costs, stimulation results from several wells showed substandard, and possibly uneconomic, production rates. Thus, a multi-disciplinary study was launched to evaluate all facets of the completion and stimulation program, including the fracture design and execution strategy.

The solution

The intensive evaluation led to 11 key findings, covering nearly all aspects of the stimulation program from the pumping schedule to post-closure pressure analysis. Among the recommendations arising from reservoir simulation work was to replace sand with CARBOLITE® high-performance, low-density ceramic proppant, which would deliver higher sustained conductivity and the opportunity to improve productivity by 20 to 50%. Furthermore, replacing half the mass of 20/40-mesh sand with larger 16/20-mesh CARBOLITE could reduce the proppant volumes required for the multi-stage treatments by 50%, thereby reducing logistics costs and risks considerably while still improving hydraulic fracture performance.

Well Data

Location: Danish sector of the North Sea

Operator: North Sea Operator

Well/stimulation design: 16,000 ft laterals; l2-14 propped fracture stages

Reservoir: Lower cretaceous

Reservoir characteristics: <0.5 mD permeability; >20% porosity; 25% insoluble fines

Proppant: 16/20-mesh CARBOLITE high-performance, low-density ceramic proppant

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The results

After the low-density ceramic proppant was employed on two wells, results of production log tests (PLT) confirmed the predictions of the reservoir stimulation analysis. Even though total proppant volume was cut in half, the zonal contribution of all the CARBOLITE-stimulated zones was better than those using natural frac sand. The 4 to 8 fold increase in fracture conductivity obtained with ceramic proppant improved productivity by roughly 50%. The incorporation of the low-density ceramic proppant, in combination with other completion optimization measures cleared the way for the successful development of flank wells that might otherwise have been deemed uneconomic.

Figure 1: Cumulative Production for 20/40 and 16/30 sand at 4ppsf vs 20/40 and 16/20 LDC at 2ppsf

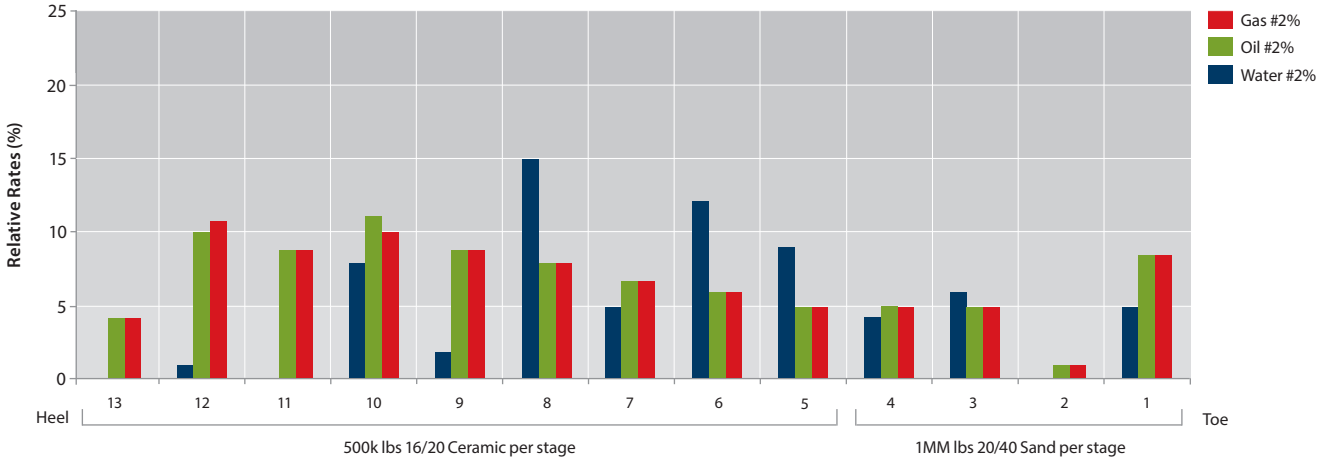
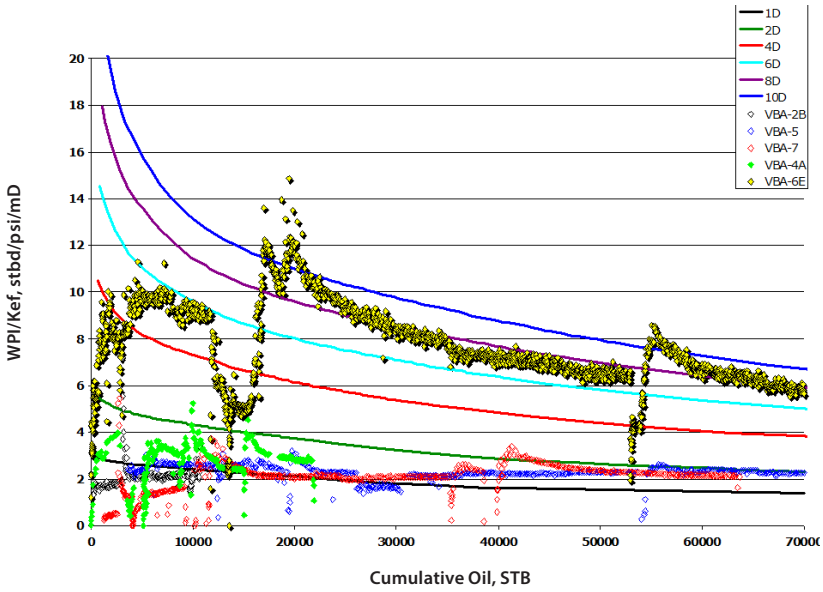


Figure 2: VBA-6E: SPF Performance Evaluation, Normalized Plot



Type curve analysis was used to analyze production data and determine fracture conductivity. The early wells where sand was employed matched a fracture permeability of 1 to 2 Darcies (blue, green, black and red diamonds in figure 2), these wells also showed a gradual improvement over time depicting a lengthy cleanup, resulting from the limited permeability of frac sand. The first well where CARBOLITE was implemented was flowed at a restricted drawdown during initial clean-up (yellow diamonds). Once the well was fully on line, the fracture permeability became stable much quicker than the previous wells and at a significantly higher level of 8 Darcies, evidencing a 4 to 8 fold leap in fracture permeability due to the implementation of low density ceramic proppant.

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