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BroadBand Shield Service Boosts Oil Production up to 3,000% Near Water Zones, Serbia

Stimulation design control fracture geometry and limit permeability near the water zones, reducing water cut risks for NIS Gazpromneft

CHALLENGE

Improve oil production—but avoid water production—from mature wells in a tight sandstone formation with weak or thin barriers to nearby water zones.

SOLUTION

Minimize out-of-zone fracture growth and permeability near the water zone by designing two stimulation operations: Combine the BroadBand Shield* fracture-geometry control service with either conventional fracturing designs or the HiWAY* flow-channel fracturing technique.

RESULTS

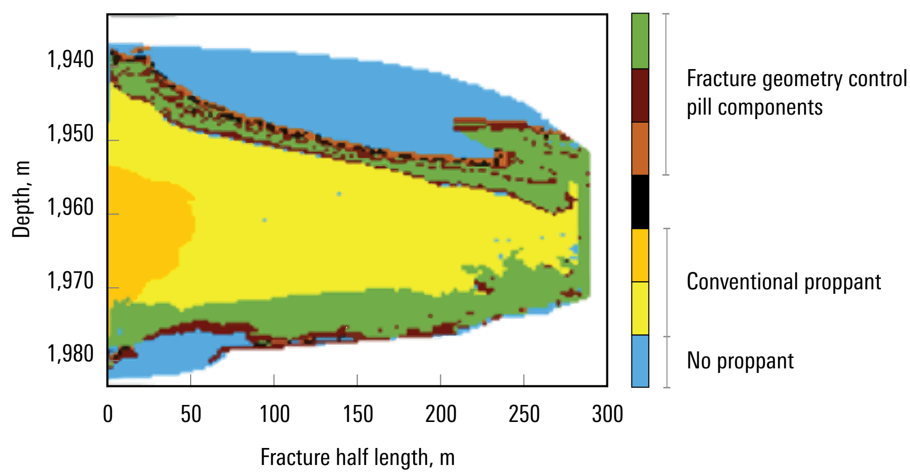
- Improved oil production by 300% to >3,000%.
- Reduced or minimally increased water cut, even in the riskiest well.

Tight sandstone reservoir produces with high water cut

A key field in Serbia has been producing industrial volumes of oil since 1984 from a tight (approximately 1- to 10-mD permeability) sandstone formation with narrow net pay (15 to 25 m thick) and weak barriers to nearby water zones. Hydraulic fracturing has been widely used in the field in recent years. On average, the wells produce with 65% water cut before fracturing and 75% water cut afterward, but some wells experience 100% water cut after fracturing.

In 2017, NIS Gazpromneft asked Schlumberger to fracture four wells in the field using the HiWAY technique, which had outperformed conventional fracturing for the operator in other fields by leaving wide channels in the fractures for maximum conductivity. Operations in the first three wells increased oil and water cut, but the fourth resulted in reduced oil production and 98% water cut because of fracture height growth into the lower water zone.

To further assess the potential of the field, NIS Gazpromneft asked Schlumberger to fracture three more wells: two more in the same field and one in a similarly tight field that had no fracturing history because of the high risk of connecting to water through the naturally fractured basement rock.



The BroadBand Shield service design for Well MA6 created low-permeability layers at the bottom and top of the fracture to limit height growth into water zones and to minimize permeability at the edges of the fracture—hindering the progress of any water that might reach it.

Stimulation design avoids the water zones

To minimize risks of breaking into the water zones, the Schlumberger engineers designed two stimulation operations using the BroadBand Shield service: one with conventional fracturing and one with the HiWAY technique. BroadBand Shield service uses a fluid system with a proprietary blend of multimodal particles to bridge the fracture tip and prevent excessive fracture growth outside of the designed fracture area. The engineers used an improved fracturing simulator to design optimal fracture operations for each formation and then used an internal expert workflow to optimize the diversion pill to minimize conductivity near the water zones.

The new simulator's algorithm comprises a fine-scale fracture hydrodynamics and in situ kinetics model. In contrast to conventional commercial modeling tools, it has sufficient resolution and other functionality to represent modern stimulation technologies: pulsing injection of proppant; mixtures of fracturing fluids, proppants, and fibers; material degradation; and other features. This simulator accounts for the influence of materials distribution on fracture propagation and calculates fracture conductivity distribution.

Oil production increases with improvement or small effect on water cut

The stimulation operations were pumped as designed in the three wells. After the flowback period, oil production in all three wells was higher (>300%) and water cut was reduced slightly in two wells and increased slightly in the third.

The extremely risky well in the new field saw a slight water cut reduction along with an oil production increase of >3,000%, which enabled it to flow naturally for the first time.

In addition, in the initial field, production improvement has been sustained in the well treated using the HiWAY technique, whereas the well that used a conventional design has experienced some declines, indicating the value of the HiWAY technique for long-term production performance.

MA and MO Field Fracturing Campaigns

		Water Cut (WC), %					
	Δ Oil, %	Before Fracturing	After Fracturing	Δ WC, %	Fracture Treatment	Proppant, t	Geometry Control
First campaign							
Well MA1	156	18	70	52	HiWAY technique	60	None
Well MA2	713	75	82	7	HiWAY technique	60	None
Well MA3	105	43	75	32	HiWAY technique	60	None
Well MA4	–79	24	98	74	HiWAY technique	60	None
Second campaign							
Well MA5	308	80	59	–21	Conventional	40	BroadBand Shield service
Well MA6	1,300	55	59	4	HiWAY technique	50	BroadBand Shield service
Well MO1	3,125	65	57	–8	Conventional	20	BroadBand Shield service

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