Fracture mapping set to deliver $50m of value in the Wilcox sands

3D Fracture modeling optimizes well placement and fracture design, increasing production while reducing fracture job sizes for Pemex

Wilcox sands, Mexico

The challenge

Pemex is actively developing the Arcabuz-Culebra field in the Burgos basin and were seeking to improve the return on investment from the field. Long hydraulic fractures can significantly increase well productivity in these low permeability sands. The elliptical drainage patterns in these wells require accurate knowledge of fracture direction to optimize well spacing.

Well spacing and location is controlled by the in-situ stress-state, reservoir permeability, and fault distribution and orientation. Local variations in pore pressure due to compartmentalization or offsetting production can result in large variations in stress that can significantly impact reservoir production, fracture geometry and fracture direction.

Well placement strategy in the Culebra portion of the field should be based on fracture drainage patterns consistent with regional stress orientation (NNE-SSW). From geomechanical modeling studies performed, fracture azimuths in the Arcabuz portion of the field are expected to propagate parallel to the nearest fault.

The solution

STRATAGEN™ consultants undertook analysis to enhance well positioning, more effective drainage patterns, better hydraulic fracture treatment designs and an optimized production strategy.

STRATAGEN performed direct fracture diagnostic measurements on four fracture treatments in two wells and fracture model calibration to develop a predictive tool for fracture design. Well spacing and placement were optimized using a reservoir model to predict well performance.

3D fracture modeling with FRACPRO™ PT indicated long fractures and confined fracture growth in the Wilcox 4, and shorter fracture lengths in the Wilcox 2 and 3.

The difference in geometry between these sand packets was due to lower pore pressure from offset well drainage in the Wilcox 4. The significantly larger stress differences between the sand and bounding shale lead to good fracture confinement.

Fracture engineering, consisting of mini-fracs and stepdown tests, was performed to determine closure pressure and lack of tortuosity. Net pressure history matching was then performed to model the created fracture geometry, and to determine optimum proppant and treatment size.

Well Data

Location: Wilcox sands in the Burgos basin of Northern Mexico

Formation type: Tight gas sands

Reservoir type: Fault-bounded compartmentalized reservoir

Well Depths: 6,500 ft – 9,800 ft

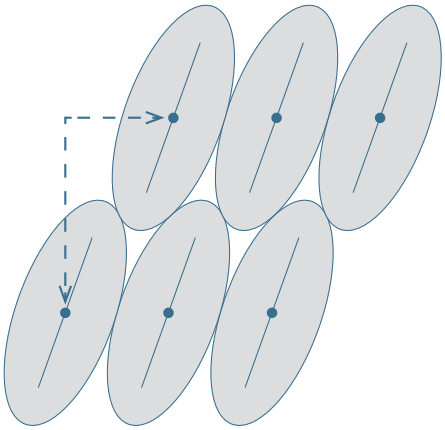
Original pore pressure gradient: 0.9 psi/ft

Average production increase of 3 BCF per well in new and refractured wells

Fracture job sizes reduced by 40%

Additional notes
Refer to SPE 60314 for more details

Optimum well placement



Optimum well placement in low-permeability Wilcox sands of Culebra portion of the field indicates an elliptical drainage pattern characteristic of low-perm hydraulically fractured reservoirs.

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Physical and chemical properties

Typical sieve analysis [weight % retained]

U.S. Mesh [mesh]	Microns	40/80
-18+20 mesh	+425	2
-20+25 mesh	-425+300	68
-25+30 mesh	-300+180	30
Median particle diameter [microns]		325
API/ISO crush test % by weight fines generated	@5,000 psi	0.5
	@7,500 psi	2.0

Sizing requirements: A minimum of 90% of the tested sample should fall between the designated sieve sizes. These specifications meet the recommended practices as detailed in API 19C.

Typical additional properties

Roundness	0.8	Apparent specific gravity	2.60
Sphericity	0.9	Absolute volume [gal/lb]	0.046
Bulk density [lb/ft^3] [g/cm^3]	0.91 1.46	Solubility in 12/3 HCl/HF acid [% weight loss]	3.3

Fracture and production modeling showed that 20-40 Ottawa sand substituted for higher strength resin-coated sand (RCS) would obtain the optimal fracture length of 500 ft for the Wilcox 4 and reduce the current fracture job size by 40%. The new fracturing strategy developed by StrataGen optimizes the economic return from fractures on new wells with little impact on productivity.

In the Wilcox 2 and 3, the new more efficient fracturing strategy reduced job sizes, and resulted in less fluid and proppant being placed outside the pay zone.

The value

Pemex have economically optimized the field through improved well positioning, more effective drainage patterns, better hydraulic fracture treatment designs and an optimized production strategy.

Integrating fracture mapping with the detailed fracture modeling study performed by STRATAGEN has identified significant economic opportunities. The new fracture design with a reduced treatment size and proppant costs has targeted savings of over $11 million.

Refracture treatments have been designed to take advantage of the intervals with higher stress contrasts, resulting in longer fractures than achieved in the original fracture designs, increasing recovery by an average of 3 BCF per well and increasing cash flow by over $6 million.

The total economic benefit to Pemex of applying fracture mapping and engineering to optimize this field is estimated to be more than $50 million dollars during the next seven years.

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Talk to STRATAGEN to find out how we can help you enhance your production.

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