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Hydraulic fracturing, acid fracturing technologies, using Krezol Group chemical reagents, experience in using chemicals and technologies

Krezol Group activity area

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Research:

Development of fracturing fluids thickeners and structurants based on polymer-free surfactants, acid fracturing fluids, thickened fracturing fluids destructors (including encapsulated)

Development of acid compositions for specific types of complications

Development of reagents for integrated chemicalization of oil production

Development of bottom-hole formation zone treatment technologies

Production:

Production of fracturing fluids thickeners and structurants based on polymer-free surfactants, acid fracturing fluids, fracturing fluids destructors

Production of high purity acid compositions, dry salt systems and heavy well-killing fluids without solid phase

Production of integrated chemicals:
- Hydrocarbon and mutual solvents

- Hydrocarbon, biopolymer and polysaccharide diverting systems

- Inhibitors of asphalt, resin, paraffin deposits, scale inhibitors, hydrate formation, corrosion inhibitors

- Demulsifiers

- Bactericides

Service:

Hydrofracturing technology implementation and support, enhanced oil recovery, non-damaged well killing, integrated chemicalization of oil production, hydraulic jet perforation

Bottomhole formation zone treatment:

- Thermal-foam-acid treatments

- Alcohol-acid treatments with KR-4D acid composition

- Selectively-directed treatments of absorbing wells with diverting systems of KR-3G, KR-3E

- Treatments of clay terrigenous reservoirs with buffer and sedimentation control

- Treatments of low temperature wells with high-viscosity oil

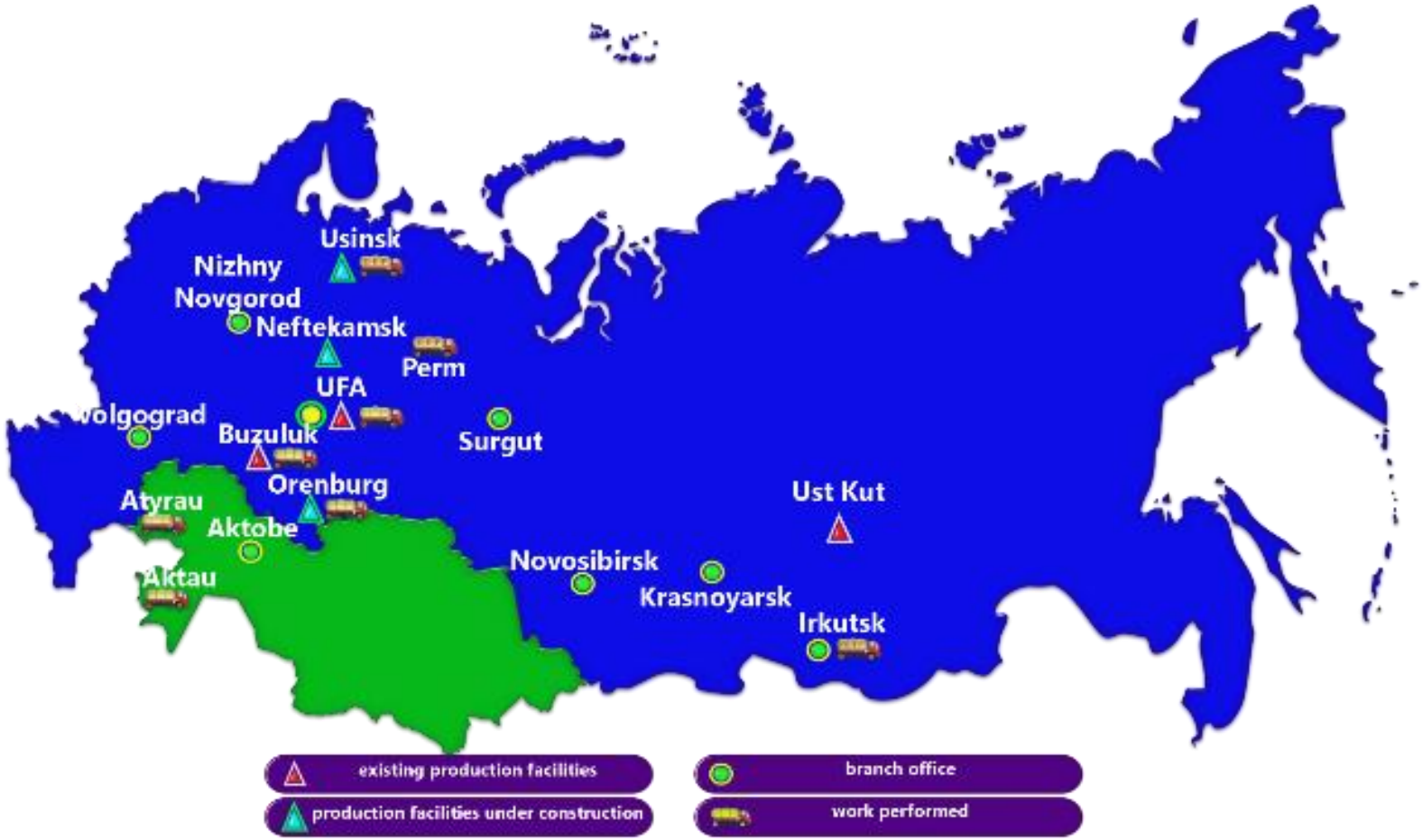
- Treatments of high temperature wells by delayed action compositions

Well killing operation:

- Formation damage minimizing well killing with abnormally low reservoir pressure with KR-3G,KR-3E blocking compositions; Formation damage minimizing well killing with abnormally high reservoir pressure.

Integrated chemicalization of oil production

GEOGRAPHY OF PRODUCTION AND SUPPLIES OF KR-COMPOSITIONS



TECHNICAL EQUIPMENT OF KREZOL GROUP

- Modern scientific research institutes and industrial laboratories;
- Qualified specialists, programs for design simulation of the matrix treatment of the bottomhole formation zone - StimPT CARBO Ceramics, acid hydrofracturing;
- Stations for control and recording injection parameters - Cementing Monitoring Stations and field laboratories;

- Industrial facilities for the production of high purity acid compositions, process fluids and reagents;
- Storage facilities;
- High-performance special-purpose machinery for bottom-hole treatment, well killing, complete chemicalization of wells.

Technology of oil production stimulation

For any oil field the quantity and quality of well production is considerably determined by the current filtration characteristic and the bottomhole formation zone.

During well operation the changes in the bottomhole formation zone can be caused by two reasons:

- Rock characteristic changes as time passed,
- Characteristic change of fluids in motion

Stimulation of oil production – this operation at the well is aimed to oil production stimulation or oil recovery increase

Technology of oil production stimulation

By the nature of the influence on bottomhole formation zone, all methods are divided into:

- chemical,
- mechanical,
- thermal,
- integrated (physical-chemical)

The impact on bottomhole formation zone can be reduced to:

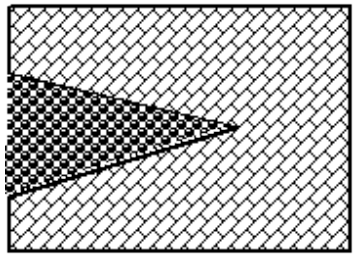
- impact on the rocks,
- impact on the fluids in the bottomhole formation zone,
- Removal of corrosion products

Hydraulic fracturing

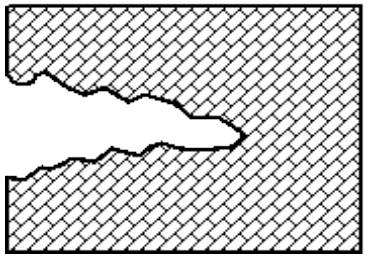
There are two main types of hydrofracturing:
hydrofracturing with fixing of a crack (proppant hydrofracturing);
hydrofracturing without fixing of a crack (acid fracturing).

Types of hydraulic fracturing

Hydrofracturing with fixing of a crack



hydrofracturing without fixing of a crack

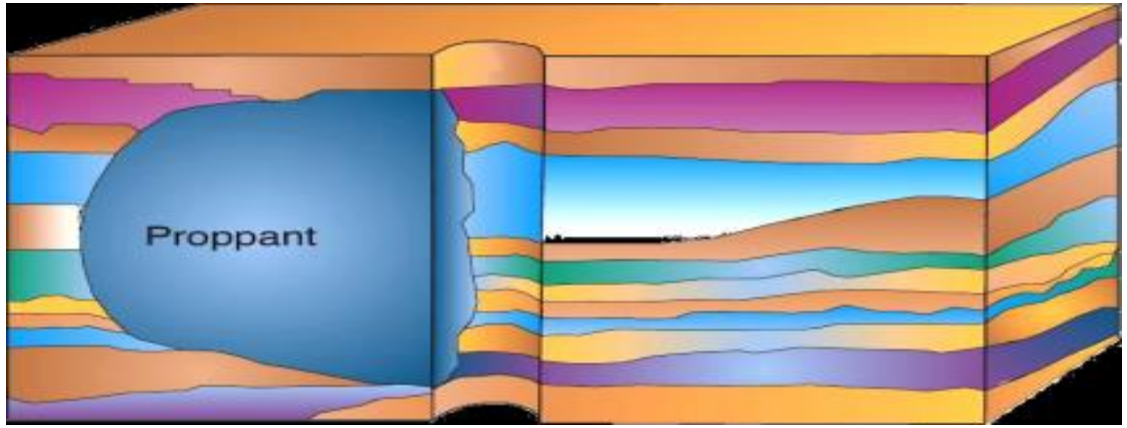


Acid fracturing is applied generally in carbonate reservoirs, hydrofracturing with fixing of a crack is applied in terrigenous
reservoirs.

During the Skin fracturing proppant material is transported in the cracks with the help of special liquids - sand carriers; proppant fixes the cracks in the open state after the excess pressure relief.

Fracturing method has a lot of technological solutions, due to the special characteristics of a particular object of treatment (oil, gas or injection well) and due to the achieved aim.

Fracturing technologies differ primarily in injected amount of process fluids and proppants and accordingly the size of cracks:
- Skin fracturing: the length of formed cracks is 32,81-65,62 ft ,
- The classic fracturing: the formation of long cracks, the optimum length of the fixed crack typically 131,23-196,85 ft;
- Deep-fracturing: 262,47-393,7 ft;
- Massive fracturing: from 393,7 to 3280,84 ft and more.



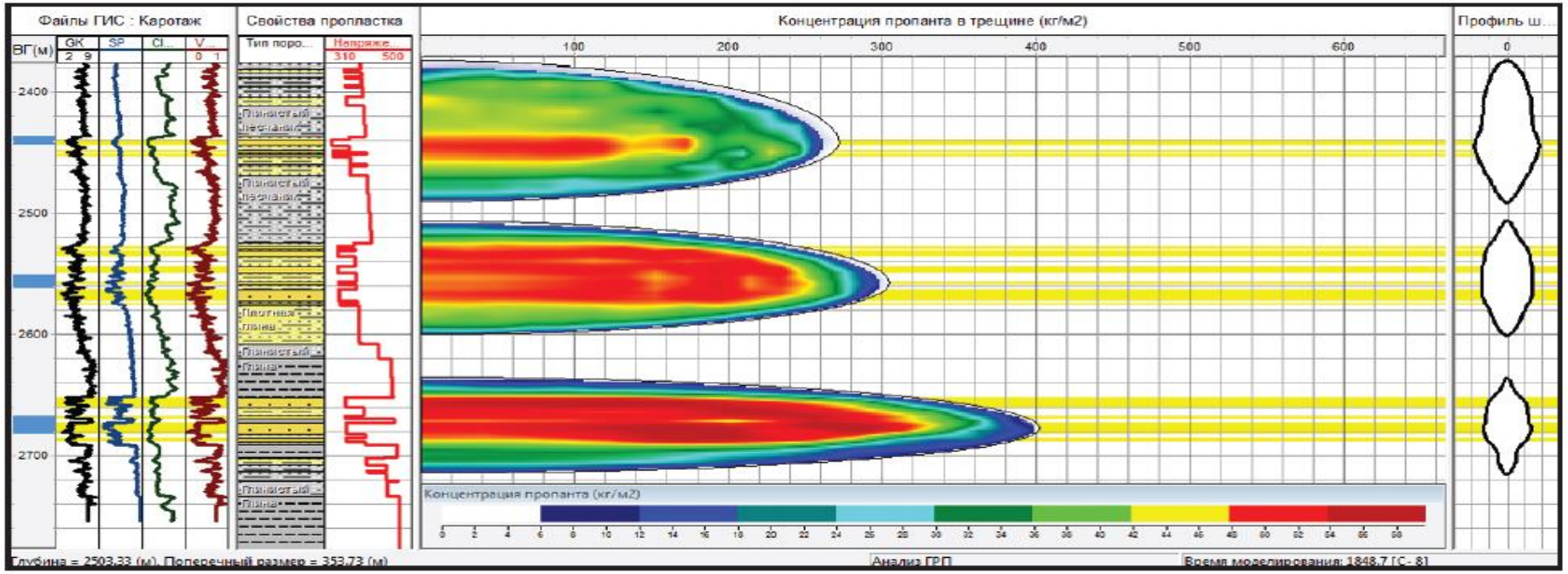
Purpose and objective of Skin fracturing

Skin fracturing purpose:

1. stimulation of the current oil production in the development of low-permeability reservoirs;
2. Ultimately increasing of oil recovery

Skin fracturing objective:

1. Skin factor removing of the bottomhole formation zone with minimum costs for hydraulic fracturing;
2. reducing the risk of breakthrough the shale breaks of productive formation;
3. the possibility of several approaches with hydraulic fracturing to restore the effectiveness of enhanced oil recovery.



Hydraulic jet perforation purposes

- Tight reservoirs penetration, both homogeneous and heterogeneous permeability.
- Crack formation (cracking) in a given interval of formation before hydrofracturing
- To cut the pipe in the well during repair operations

Hydraulic jet perforation

Hydraulic jet perforation of oil and gas wells has a number of advantages over traditional methods of well blasting operations.

Such method of penetration essentially eliminates the negative effects on the formation explosive loads and production string; and the produced holes significantly bigger than during cumulative charges using under similar conditions.

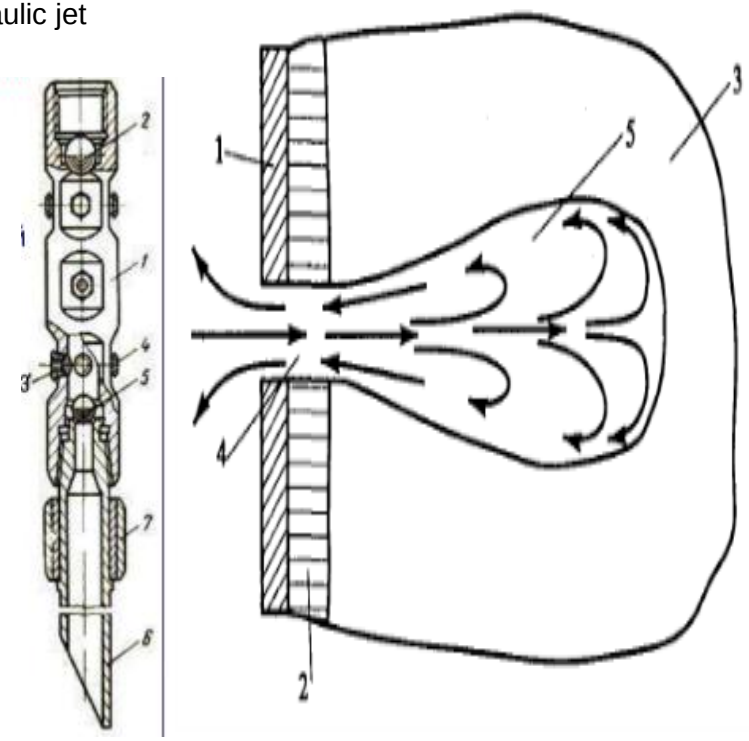
Work performance is possible in almost any wells: large hole curvature, the presence of the production liner (4,49 or 4,02 inches) or the absence of the strengthened production string (grade E) are not an obstacle

During hydraulic jet perforation, the formation of holes in the string and the formation of channel in the rock are achieved by high speed of sand-liquid jet and high-pressure drop. Pear-shaped cavity is washed out in the rock, facing a narrow cone to the perforations in the string.

Although there are some restrictions.
If the formation absorbs the liquid, the hydraulic jet perforation application is impossible.

Device for hydraulic jet perforation

1.Body
2.Pressure test valve
3.Nozzle assembly
4.Blank flange
5.Back pressure valve
6.Shank
7.Centralizer



Hydraulic jet perforation

Requirements to materials and liquid

When passing the mixture through a mixing tank, pump unit, piping lines, tubing and well annulus, the mixture parameters should accordingly be different, but the carrier fluid should provide at different temperatures maintenance of the sand in suspension by passing all sections in the way of injection and the required level of friction, not exceeding 4261,83 psi.

Thus, the mixture must pass through the low-pressure hoses, what requires a higher viscosity fluids to maintain the sand in suspension, and then - through the tubing, which require lower viscosity and lower friction at strong flow of pumping and restrictions on the circulating pressure.

During operations in the horizontal wells, where the mixture is conveyed in the tubing at a low circulating pressure, even higher fluid viscosity is required.

Technical characteristics:

- The concentration of sand in the working fluid - 80 ÷ 100 kg / m3
- Discharge pressure of working fluid in the tubing - 10152,64 psi
- Pressure drop in the destruction of rocks - 1740,45 ÷ 2900,75 psi
- The rate of sand-liquid jets - up to 328,08 ft / s
- The length of the tunnels in the rock - 19,69 inches.
- Perforation tunnel diameter - 0,55 inches.
- Exposure time on the barrier - no more than 20 minutes.

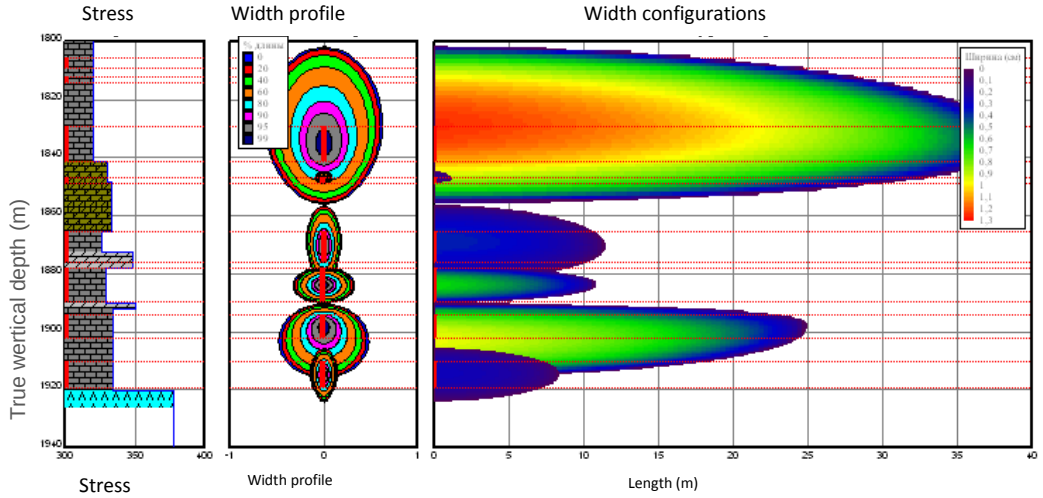
As the abrasive sand proppants can be used or silica sand of various sizes. Preferably silica sand size 35-40.

If unforeseen prolonged well shutoff, the well should be immediately washed at reverse circulation.

Design for a gas well

Rock properties

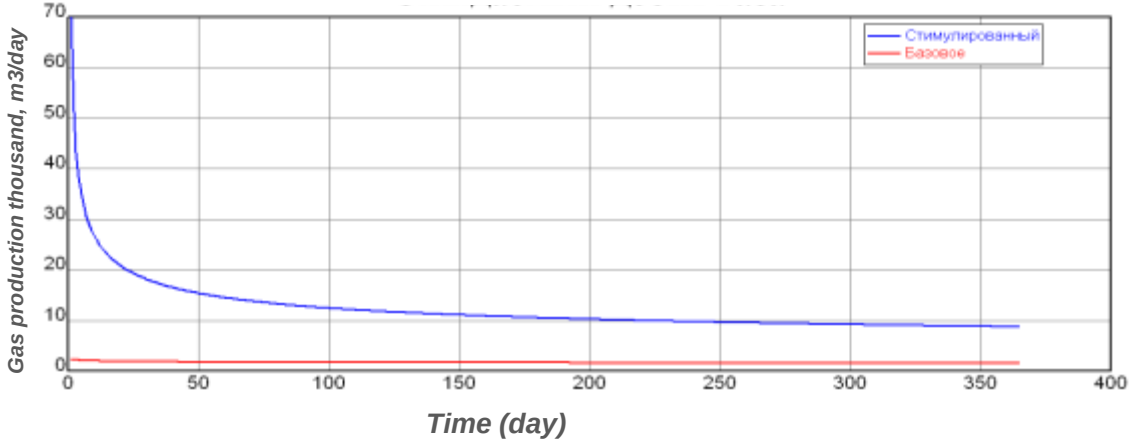
Zones	True vertical depth (bottom) (m)	Measured depth at the bottom (m)	Stress gradient (atm./m)	Stress (atm.)
Anhydrite	1754,3	1755	0,19627	344,33
Anhydrite	1796,3	1797	0,19627	352,57
Limestone	1841,3	1842	0,17413	320,63
Limestone dolomitic	1848,3	1849	0,1786	330,1
Limestone dolomitic	1865,3	1866	0,1786	333,13
Limestone	1872,8	1873,5	0,17413	326,11
Dolomite	1878,3	1879	0,1853	348,03
Limestone	1890,2	1891	0,17413	329,15
Dolomite	1892,2	1893	0,1853	350,62
Limestone	1920,2	1921	0,17413	334,38
Anhydrite	1926,2	1927	0,19627	378,07



Zone data

	Zone	Productive zone from (m)	to (m)	Permeability (mD)	The number of perforations	Diameter (mm)
1.	P5	1805,3	1809,3	0,0218	72	7
2.	P5	1812,3	1814,3	0,0218	36	7
3.	P5	1829,3	1841,3	0,0218	216	7
4.	P5	1846,8	1848,8	0,0218	36	7
5.	P5	1865,3	1876,3	0,0218	198	7
6.	P5	1877,9	1889,8	0,0218	132	7
7.	P5	1894,2	1902,2	0,0218	144	7
8.	P5	1910,2	1919,2	0,0218	99	11

Expected gas production



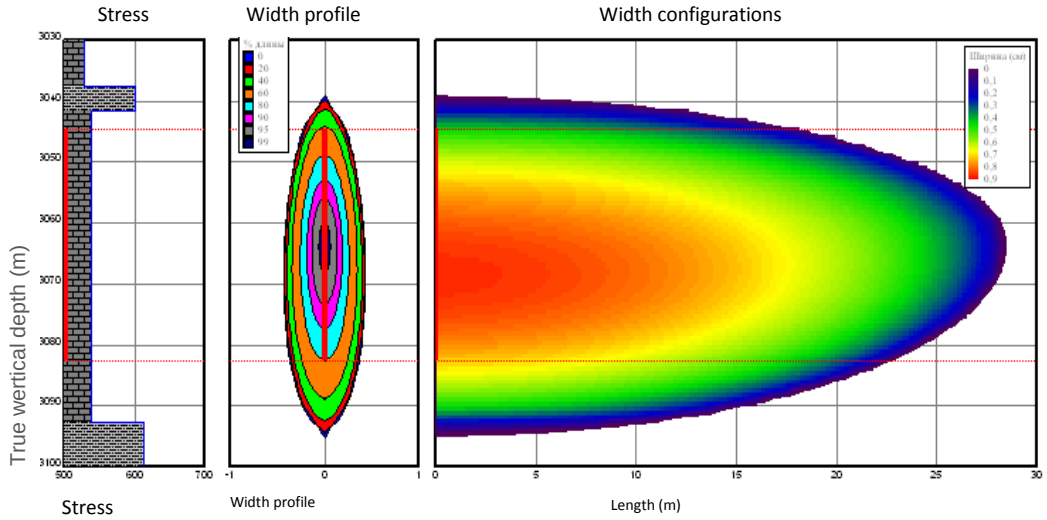
Design for an oil well

Rock properties

Zone	True vertical depth (bottom) (m)	Measured depth at the bottom (m)	Stress gradient (atm./m)	Stress (atm)
Limestone	3037,6	3208	0,17413	528,96
Marl	3041,6	3212	0,19744	600,53
Limestone	3092,6	3263	0,17413	538,53
Marl	3109,6	3280	0,19744	613,95

Zone data

	Зона	Productive zone from (m)	to (m)	Permeability (mD)	The number of perforations	Diameter (mm)
1.	A4	3044,6	3082,6	15	684	7

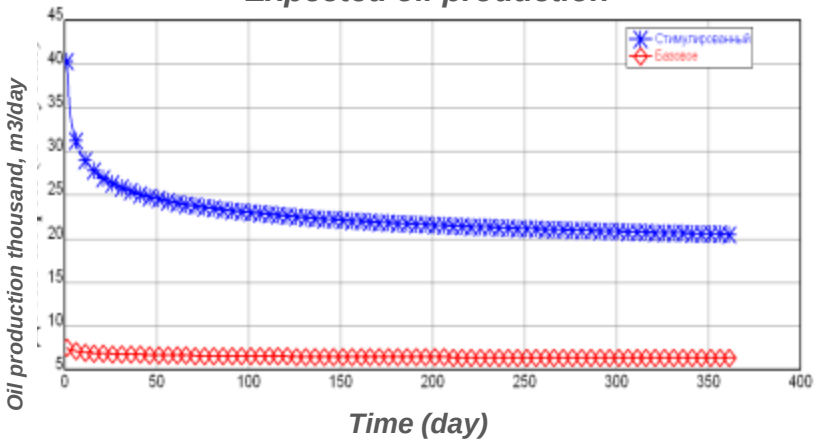


Inlet Treatment Plan (bottomhole)

Type of treatment plan	Bottom hole	
Type of displacement fluid	Kcl 2%	
The amount of recycling	0	(m³)

№ stage	Mixture flow rate (m³/min)	Liquid volume by stages (m³)	Stage time (min)	Stage type	Fluid type	Acid type	Inlet acid concentration (%)
1	1,9	17	8,9474	Acid	KR-1	R/A01	15
2	1,9	8	4,2105	packing	KR-3G	R/A00	0
3	1,9	10	5,2632	Acid	KR-1	R/A01	15
4	1,9	8	4,2105	packing	KR-3G	R/A00	0
5	1,9	10	5,2632	Acid	KR-1	R/A01	15
6	1,9	6	3,1579	packing	KR-3G	R/A00	0
7	1,9	29	15,263	Acid	KR-1	R/A01	15

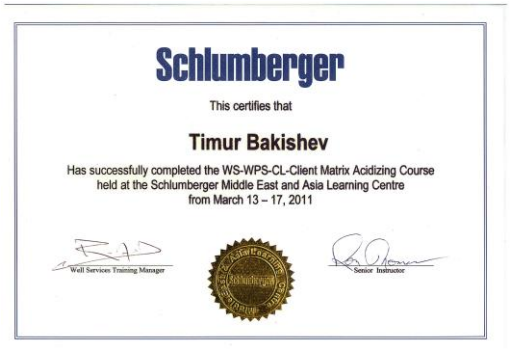
Expected oil production



Hydraulic fracturing Krezol group staff

The provision of services are carried out by highly qualified specialists of Krezol Group:

- **trained and certified to perform hydraulic fracturing, acid fracturing, bottomhole treatment (the training courses: Schlumberger, Meyer & Associates, Weatherford, NSI, CARBO Ceramics);**
- **which has considerable experience of hydraulic fracturing, acid fracturing, large-volume bottomhole treatment in the leading companies.**



Hydraulic fracturing

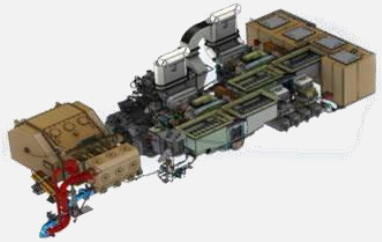
№	Parameters	Values
1	The maximum injection pressure of working fluids and mixtures at the outlet of the pumping unit, psi	11 603,02
2	Hydraulic fluid consumption provided by acid fracturing, m3 / min	0,01 - 3
3	Tanks for the preparation of acid fracturing fluids, 40m3	2
3	Operating temperature range, degrees Fahrenheit	-49…+104
4	Automatic operation of the equipment is provided in acid fracturing mode, maintaining a predetermined flow of the working fluid and the mixture, dry and liquid chemicals, with control and registration of necessary process parameters.	

HYDROFRACTURING EQUIPMENT PACKAGE

- Management and control station/laboratory – 1 piece;
- Pumping units – 5 pieces;
- Mixing unit – 1 piece;
- Power fluid tanks – 40m3 – 2 pieces;
- Tanks for acid compositions – 50m3 – 2 pieces;
- Manifold unit – 1 piece;
- Technological transport – 7 pieces.

HYDROFRACTURING EQUIPMENT PACKAGE

PUMPING UNIT

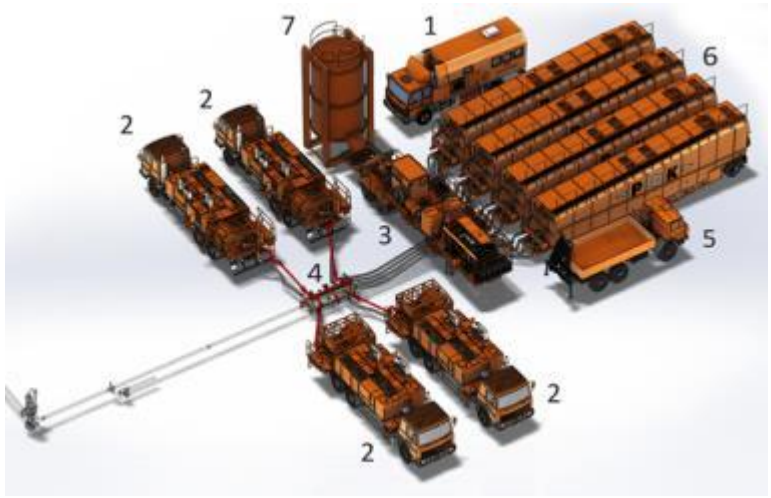


MANAGEMENT AND CONTROL STATION

Hydrofracturing technology adoption performens and support and maintenance

Mixing unit

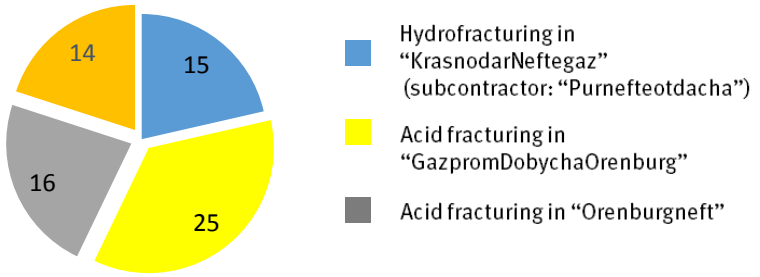
Hydrofracturing equipment package:



1 – management and control station/laboratory;
2 – pumping unit;
3 – mixing unit;
4 – manifold unit;
5 – machine manipulator;
6 – gel tank;
7 – proppant bunker

HYDROFRACTURING EQUIPMENT PACKAGE
PERFORMED OPERATIONS

Hydrofracturing, acid fracturing performed operations – Quantity of job



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Thank you for your attention!

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