KREZOL GROUP

Equipment, technology and chemicals for remedial cementing, water isolation and straightening the injectivity profile

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RANGE OF WORKS ON CONSTRUCTION AND PRODUCTION WELLS

- *annular pressure elimination*
- *bottom water isolation*
- *casing leak repair*
- *lost circulation elimination during well construction*
- *selective water isolation*
- *repair and renewal operations*
- *gas leak repair*
- *behind-casing flow isolation*

Compositions for remedial cementing

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BACKFILL GAS-WATERPROOF COMPOUNDS

CHEMICALS are developed and used:

- Chemicals based on gastight gels;
- Compositions based on sodium silicate
- With controlled viscosity and time to hardness depending on the thermal regime for high-temperature wells;
- Crosslinked polymer systems on the basis of chemical production of polymer-silicone systems under reservoir conditions;
- On the basis of synthetic rubber for wells with reservoir temperatures above 266 F

We use:

- Water-base cement slurries
- Oil-based cement slurries
- Micro cements
- Thermohardening backfill
- Backfills based on resins

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GAS- AND WATERPROOF COMPOUNDS

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A new approach to gas and water- isolation treatment is developed:

•plugging of gas flows is carried out on a three-stage injection of gas-tight gel based on polymer cross-linked composition;

•The saturation of the pore space is carried out by forming silicone-based materials in the casing string annulus;

•The final restoration of the well support is carried out by backfill with hardening as a result of the heating up to reservoir temperature or by cements with fluid loss and setting time.

The main chemical compositions for water isolation operations

Precipitate-forming and gel-forming compositions for water isolation in oil and gas wells with temperature to 248°F are represented by the following chemical reagents:

- Alkaline and silicate solution
- On the base of sodium naphthenate and calcium chloride
- Inorganic acid mixtures with sodium silicate
- The composition based on sodium silicate and KR-5G
- Compositions based on resins
- Gel-forming compositions based on polyacrylamide
- water-and-gastight blocking composition

TECHNOLOGY

The resulting materials properties

High structural and mechanical characteristics, are not soluble in oil and water, have resistance to high temperatures (from 32F up to 356 F)

Technology basis

Physical and chemical transformation of water solutions coagulant into plastic mixture in contact with electrolyte.

The essence of technology

Multi-staged well plugging, including pumping chemicals into well to create waterproof viscoelastic barrier in the isolation zone with modified cementing slurry.

Chemical reagents

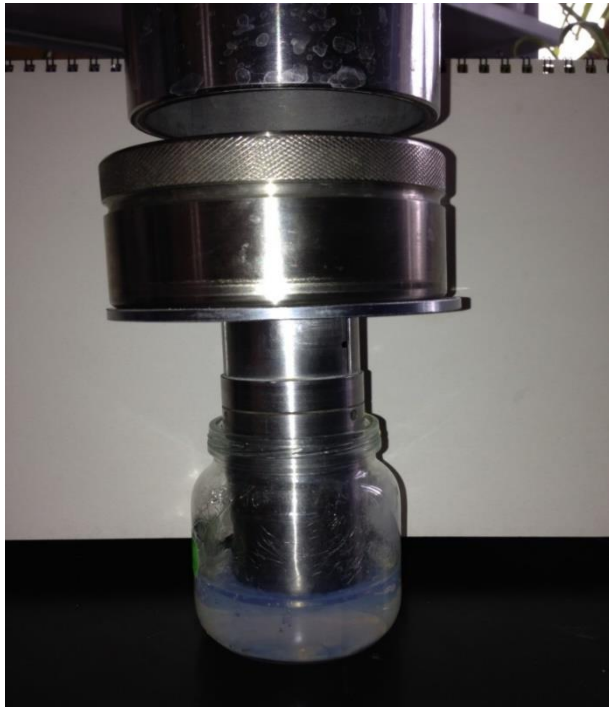
Own-produced reagents, calcium chloride, sodium silicate and some other.

Water isolation

Synthetic series of water-soluble polymers is successfully operating in different adverse conditions including high temperature and high salinity. Gel structure provides adhesion and clogging either formation pores or natural fractures.

Solvable problem: the elimination of water cone, bottom water isolation, behind-casing flow isolation from overlying or underlying water bed.

Gelling compositions - a colloidal solution comprising a dispersion medium – water and a dispersed phase - micelles of amorphous solution. The viscosity of the composition is close to the viscosity of water, that is why well treatment with any permeability is possible.



Isolation with low injectability

Compositions based on synthetic resins, which catalyst may be acid or alkaline mediums.

Advantages:

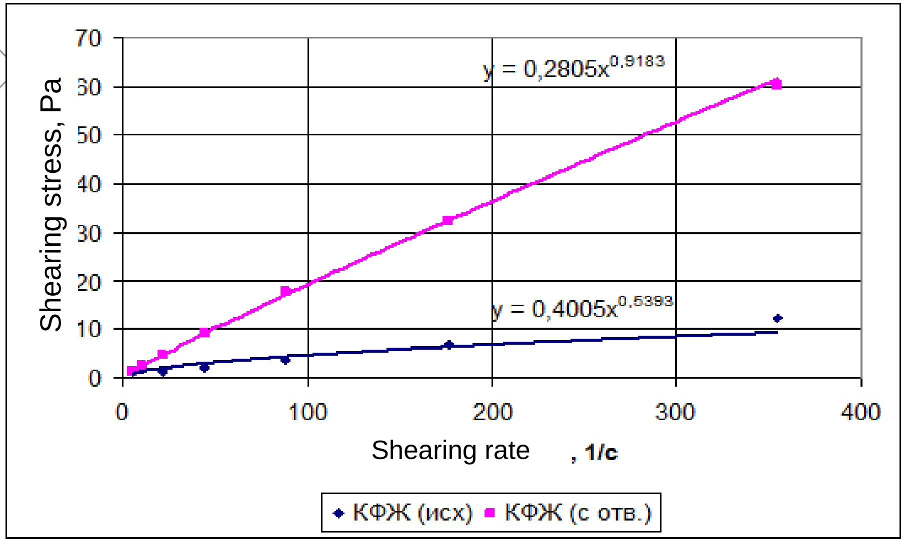
- ✓ Low viscosity at the time of injection
- ✓ Good penetrability
- ✓ Good adhesion between metal and rock
- ✓ Controlled hardening time
- ✓ High mechanical properties after hardening
- ✓ Resistance to acids, solvents

Range of application:

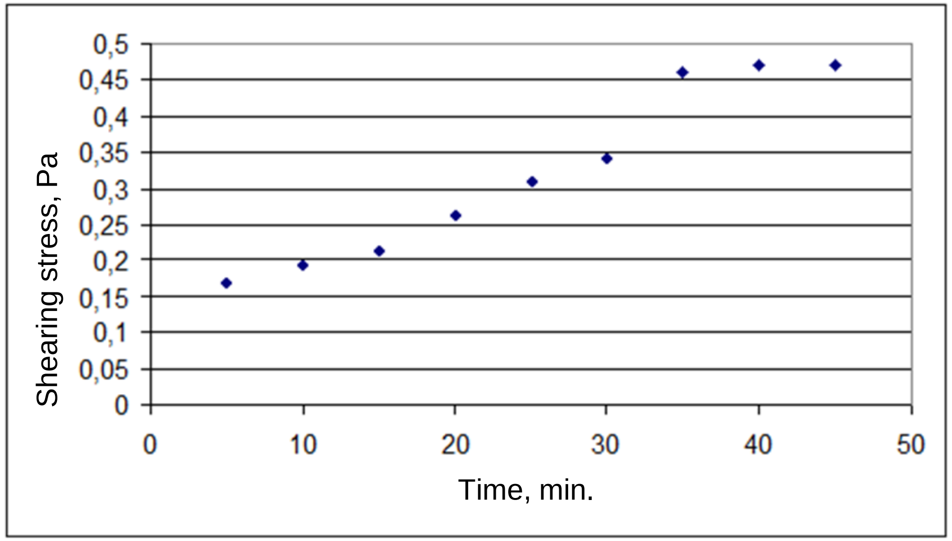
The whole range of remedial cementing РИР with low injectability (less than 7 062,934 ft^3/day at P=1469,595psi)

The preferred use during behind-casing flow isolation, bell and spigot joints leak.

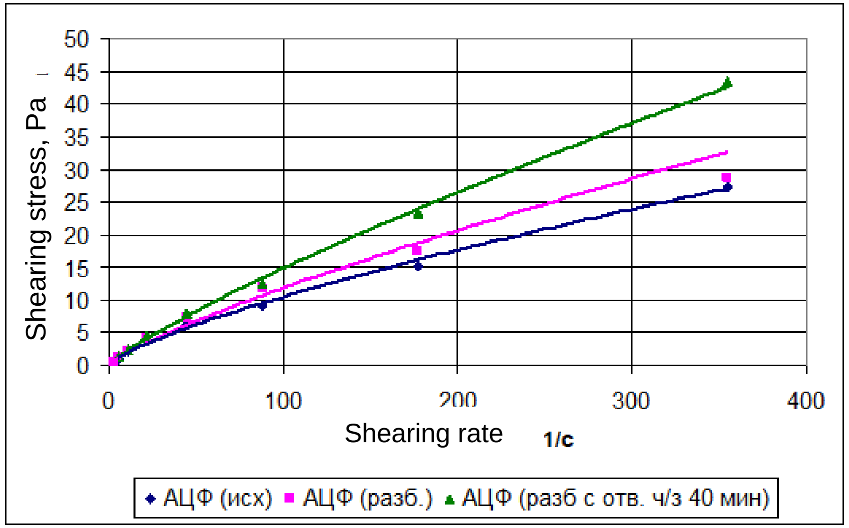
Operating temperature up to + 248 ° F.



Flow (rheological) characteristics of UF-resin



Determination of UF-resin rate of hardening



Flow (rheological) characteristics of acetone-formaldehyde resin

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Selective water isolation

Selective colmatation (mudding) can be used for colmatation of flushed zones on the objects with high salinity of reservoir water as the coreactant during water isolation operations. The colmatant is completely soluble in oil and hydrocarbon liquids.

The creation of a blocking barrier is achieved through the interaction of the composition with the reservoir water, with formation of stable polymer hydrocarbon gels. The composition is a mixture of an active concentrate and hydrocarbon media with the addition of higher alcohols and a filler.

Solvable problem: Selective water isolation in the water-producing wells, characterized by non-uniform structure of the productive section, high relative permeability for water and flooding of most permeable interlayers.

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Gas-insulation operations

For the purpose of behind-casing flow isolation, production casing leak repair and intercasing leak repair, the technologies are developed for gas-tight systems of 3 types:

- Based on gastight gels;
- On the basis of the chemical production of polymer-silicone systems under reservoir conditions;
- Insulation Technology of gas cross flow on the basis of synthetic rubber.

Blocking compositions

The company «Krezol Group" produces a range of blocking compositions. The product range of blocking compositions includes:
Blocking composition - stabilized suspension of solid bypass particles
KR-3G hydrophobic biopolymer gel
KR-3E high viscosity emulsion based on Devonian oil
KR-3E low-viscosity emulsions based on diesel fuel or hydrocarbon solvent

Non-damaging blocking of formations before isolation works

During mixing of the two components a non-damaging plugging chemical composition is formed (fragile gel), retained 100% full amount of working composition, nonshrink, with good adhesion. After injection of the composition in the absorption interval, this technology makes it easy to develop the formation and leads to the optimum performance.
Application of slightly gelled polymer systems with the addition of colmatans (vermiculite, cordage fiber, rubber crumb (granules) and crushed cellophane)
Solvable problem: Restore circulation for the normalization of the bottom hole and the commingling of the underlying beds.

Reducing intake capacity before cementing operations

During mixing of the two components viscoelastic plugging chemical composition is formed. The composition has a stronger structural-mechanical properties, good adhesion to metal and rock, resistant to aggressive media and high temperatures.
Solvable problem: Elimination of disastrous lost circulation during drilling operations and workover, before remedial cementing operations.

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The results for the plugging compositions based on resins

№	Field	Date	*Formation*	Perfora-ted interval, (ft)	Well operation before remedial cementing			Well operation after remedial cementing			Increase +/-	
					Oil flow rate, (BPD)	***Water cut (%)***	***Fluid level, (ft)***	*Oil flow rate, (BPD)*	***Water cut (%)***	***Fluid level, (ft)***	*Oil flow rate, (BPD)*	***Water cut (%)***
1	***	May 2013	Д1	7467,19-7500	25,79	95	6010,5	44,03	89	4895,01	18,24	-6
2	***	June 2013	Б2,Т1	5810,37-5875,98	2,51	94	3146,33	31,45	71	3677,82	28,93	-23
3	***	November 2013	Т1	6712,6-6738,85	42,14	92	5118,11	52,21	81	4160,1	10,06	-11
Total, average efficiency per well:											19,06	-13,3

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The results based on the blocking compositions in passing to underlying object

№	Field	Date	Formation	Perforated interval, (ft)	Work objective	The pressure test result of the abonded section by pressure and level decrease	Well operation before remedial cementing			Well operation after remedial cementing			Increase +/-	
							Oil flow rate, (BPD)	Water cut (%)	Fluid level, (ft)	Oil flow rate, (BPD)	Water cut (%)	Fluid level, (ft)	Oil flow rate, (BPD)	Water cut (%)
1	***	March 2014	A4	8093,83-8100,39	Formation insulation aimed to pass to the underlying bed	Leak proof	25,16	96	2034,12	203.2	15	7417,98	178	-81
2	***	January 2014	Pd	4091,21-4110,89	Formation insulation aimed to pass to the underlying bed	Leak proof .	14,47	84	1486,22	48,43	28	2230,97	33,96	-56
3	***	February 2014	O3	8047,9-8070,87	Formation insulation aimed to pass to the underlying bed	Leak proof	5,032	94	4757,22	31,45	30	5905,51	26,42	-64

The water isolation results

№	Field	Formation	Technology	Date	Well operation before water isolation		Starting up parameters after water isolation		Well performance after well interventions						Average increase of oil flow rate
									November 2010		August 2011		August 2012		
					Oil flow rate, (BPD)	*Water cut %*	Oil flow rate, (BPD)	*Water cut %*	Oil flow rate, (BPD)	*Water cut %*	Oil flow rate, (BPD)	*Water cut %*	Oil flow rate, (BPD)	*Water cut %*	Oil flow rate, (BPD)
1	***	БВ8(1-3)	ОВП	13.09.2010	57,87	98,6	167,9	53	128,3	61,3	56,61	81,5	67,93	77,5	15,72
2	***	АВ4-5	ОВП	09.10.2010	69,82	97,9	132,1	77,9	154,7	77	45,92	92,6	Additional well interventions		4,4
3	***	АВ4-5	ОВП	03.11.2010	18,87	98,4	44,03	88	39	89,7	39,63	92,8	30,19	96,8	3,59

The selective isolation results

№	Field	Date	Formation	Perfora-ted interval, (ft)	Well operation before remedial cementing			Well operation after remedial cementing			Increase +/-	
					Oil flow rate, (BPD)	Water cut %	Fluid level,	Oil flow rate, (BPD)	Water cut %	Fluid level,	Oil flow rate, (BPD)	Water cut %
1	***	March 2012	Б2	7641,08-7677,17	29,56	97	2424,54	69,82	90	3782,81	39,63	-7,0
2	***	July 2012	Б2, Т1	6309,06-6391,08	31,45	97	4839,24	44,03	94	5885,83	12,58	-3,0
3	***	July 2012	Т1	5764,44-5780,84	69,19	94	4104,33	100,6	87	4245,41	32,71	-7,0
4	***	August 2012	Б2	6038,39-6064,63	81,77	95	4301,18	132,1	90	4829,4	50,32	-5,0
5	***	September 2012	Б2, Т1	6817,59-6919,29	75,48	96	3051,18	81,77	94	3149,61	5,66	-2,0
6	***	September 2012	Д1	7486,88 - 7522,97	69,19	91	6824,15	119,5	87	6692,91	51,58	-4,0
7	***	Oktober 2012	Т1	7152,23-7175,2	44,03	97	5843,18	75,48	95	4878,61	33,96	-2,0
Total, average efficiency per well:											11,95	-0,7

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Implementation examples

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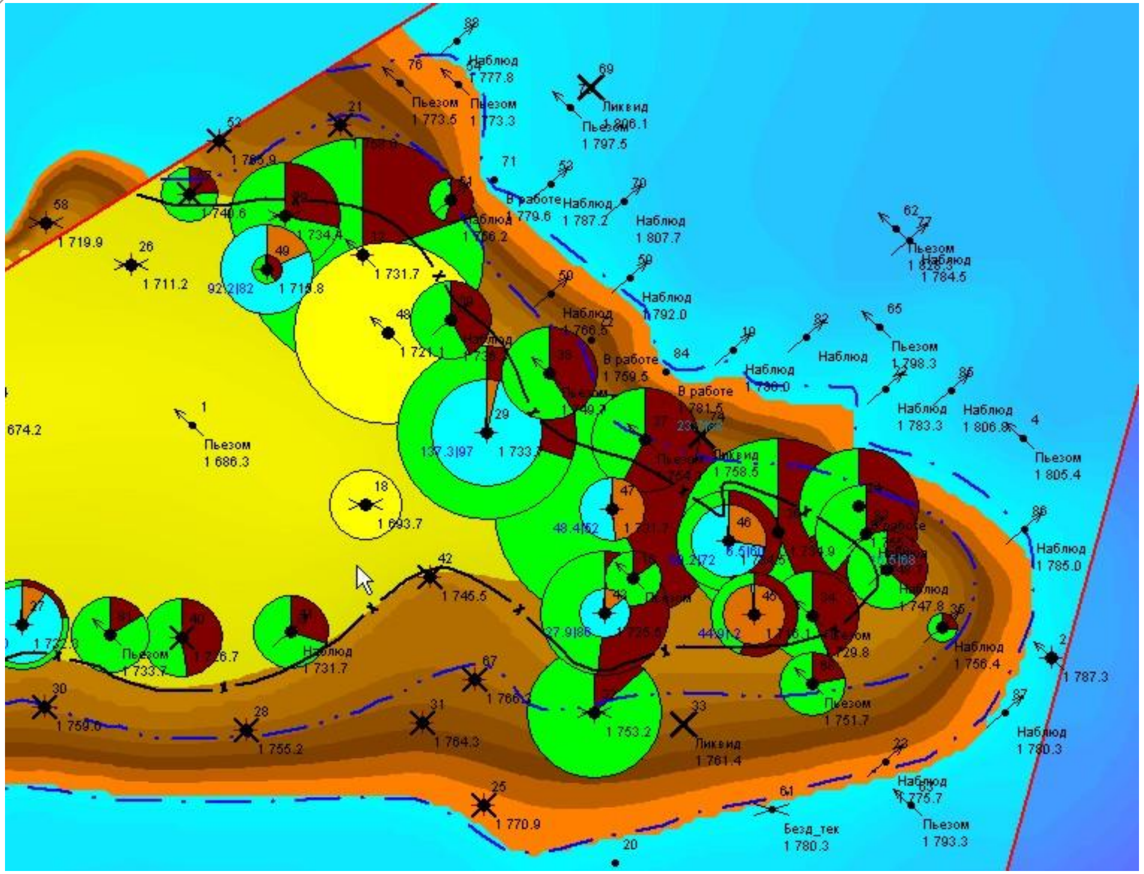
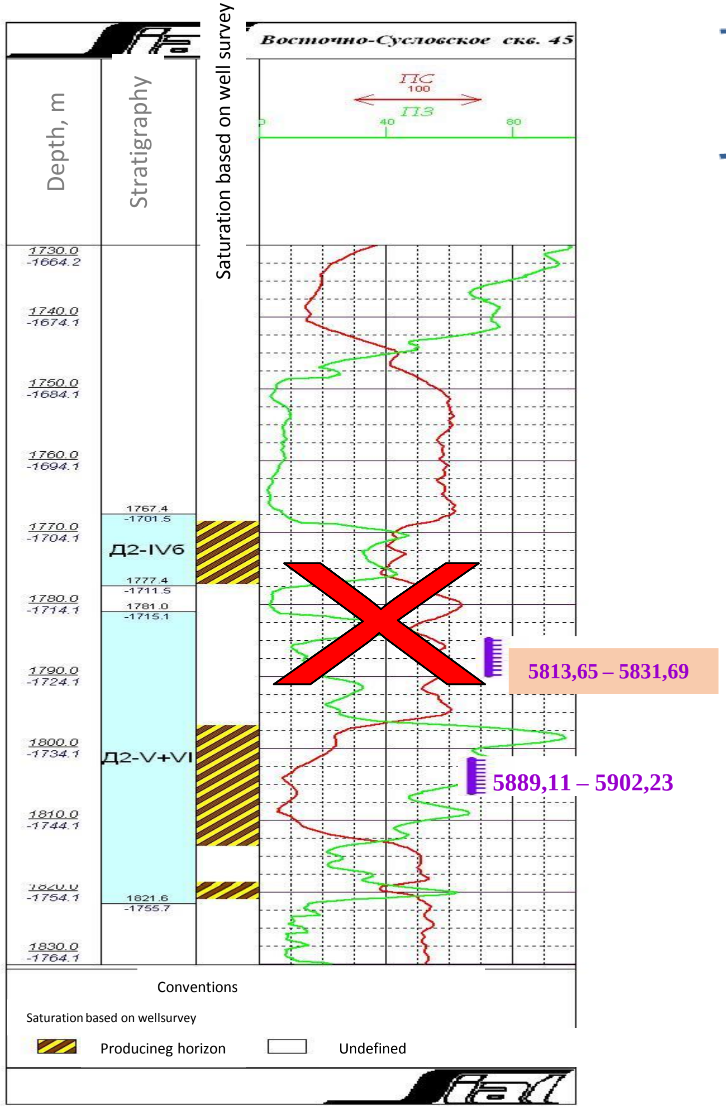
№ 45 well was under observation gas well stock before repair works (D2IVб formation) with turnaround maintenance Gas flow rate = 882 866,75 ft3/day;





The entry date after well repair works (insulation of gas overlying horizon) :

June 3, 2006   Working horizon -   D2vrV+VI
Starting up parameters: Oil flow rate=194,4 bbls/day Water cut=2,8%

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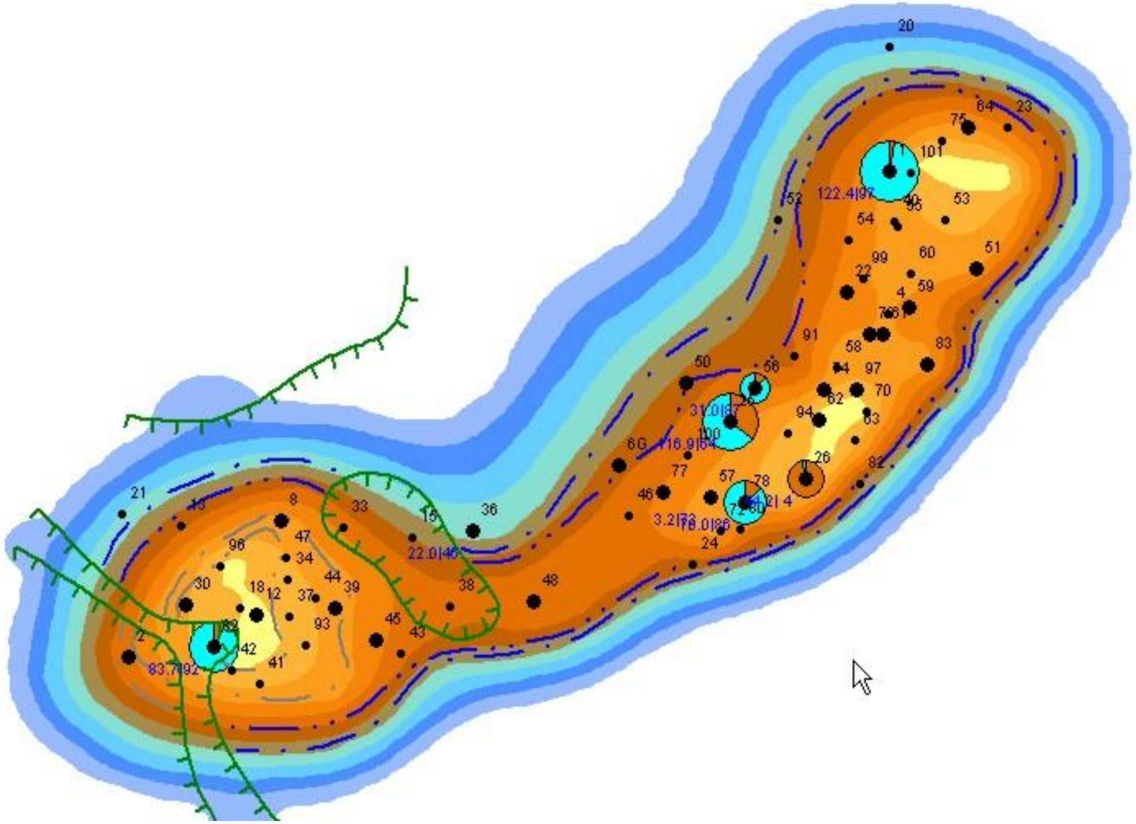
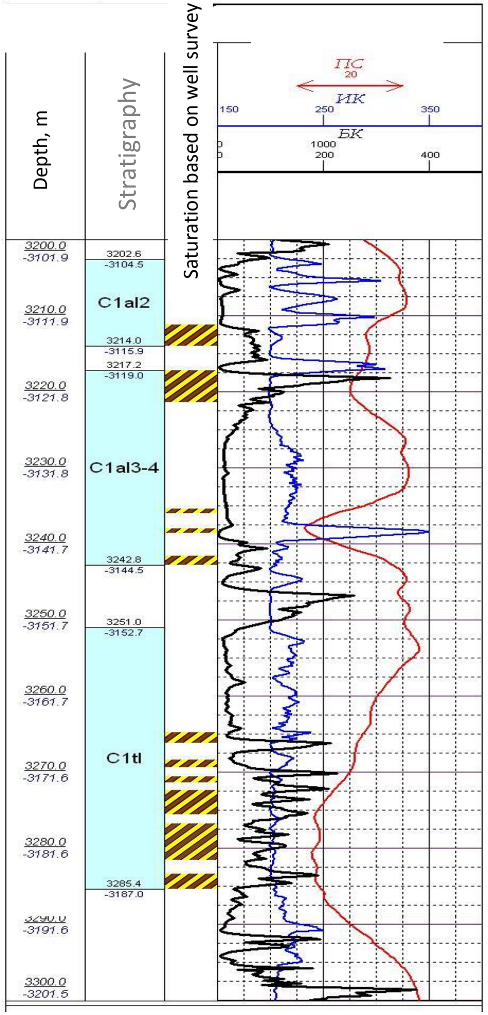
The well was under observation gas well stock before repair works (C1tl formation) with turnaround maintenance Gas flow rate = 1 059 440,1 ft3/day;



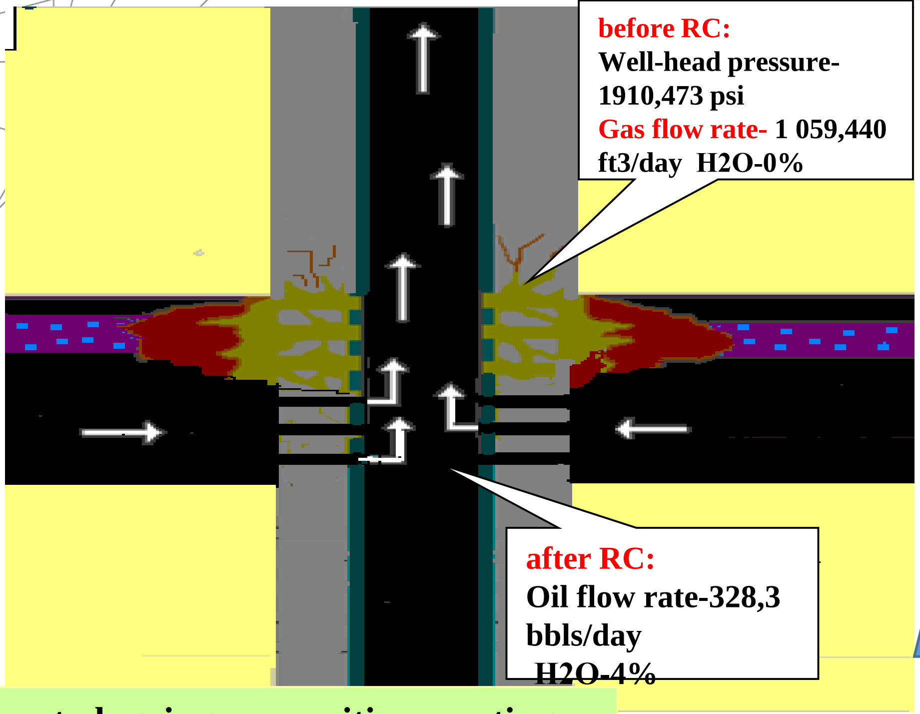


The entry date after well repair works (insulation of overlying working interval): August 21, 2006

Working horizon - **C1tl**

Starting up parameters: Oil flow rate=232,1 bbls/day, Water cut=3,4%

The well was under observation gas well stock prior repair works with parameters
Gas flow rate = 1 059,440 ft3/day;
The purpose: Insulation of formation C1tl in the interval 10721,78-10754,59 ft



At this well the insulation of the upper gas-saturated formation 10721,78-10754,59 ft was carried out, followed by reperforation of the oil interval 10738,19-10754,59 ft and additional perforation interval 10739.83-10766.08 ft.

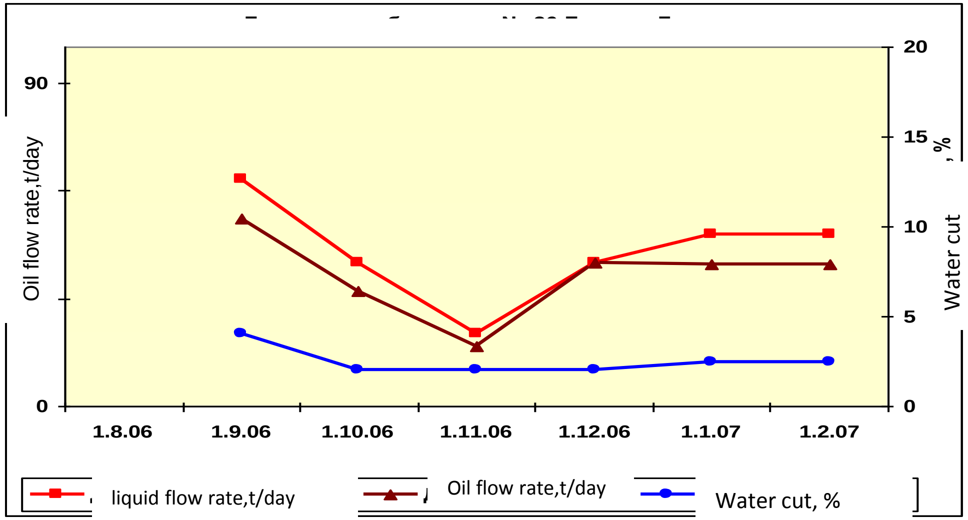
Technological works were carried out on a packer equipment installed at 164,04 ft from the top of the upper interval. Injectivity of the insulated interval before the remedial cementing (RC) - 16 951.042 ft3 / day. Technological works included injection of two-component plugging composition in the reservoir in a volume of V = 353.1467ft3 + tightening insulating composition (cement slurry) in a volume of V = 148,32 ft3. The final pressure while squeezing the insulating composition is P = 2939.189 psi. After the WOC time -36hours, the head of the cement bridge is met at a depth of 10574,15ft, hydraulic pressure test P = 2204.392psi, leak-proof (sealed). Drilling to a depth of 10810,37ft, hydraulic pressure test P = 2204.392psi, leak-proof (sealed). Conversion of well to oil, reducing to a depth of 3937,01 ft. Drawdown perforation: 10739,83- 10766,08 ft.

Two-component plugging composition creating waterproof barrier in the bottomhole formation zone.

Tightening insulating composition (cement slurry) with additives improving the rheological properties of the solution.

Oil zone

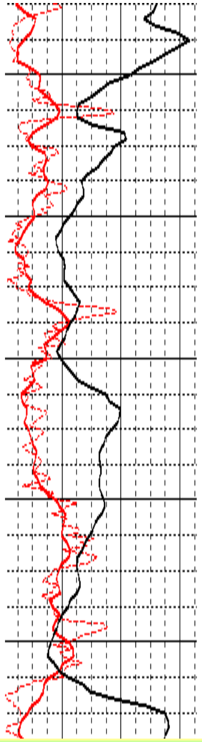
Gas zone

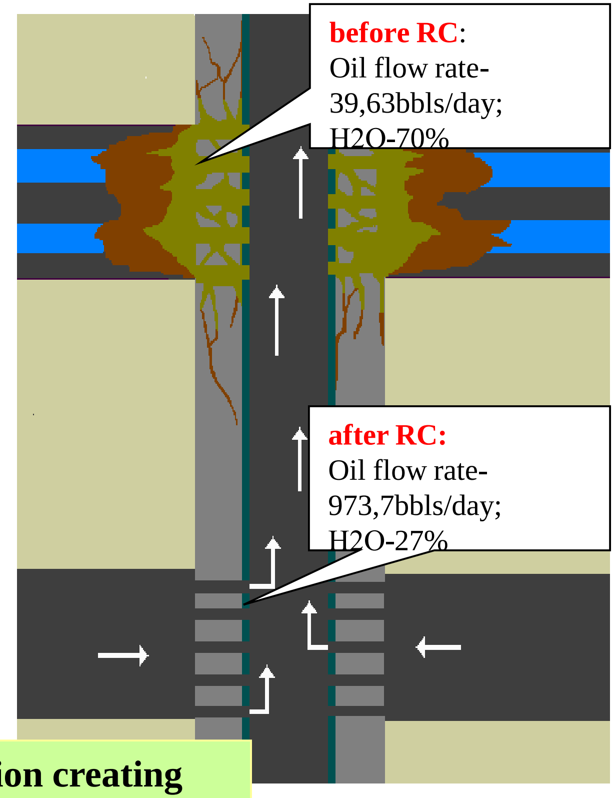


The well was under observation gas well stock prior repair works with parameters

Gas flow rate = 1 059,440 ft3/day;

The purpose: Insulation of O1 formation in the interval 8070,87-8097,11 ft





At this well, insulation of the upper reservoir interval O1, in order to move to the lower reservoir interval B2 (9081,36-9110,89ft).

Technological works were carried out on a packer equipment installed at 164,04 ft from the top of the upper interval.

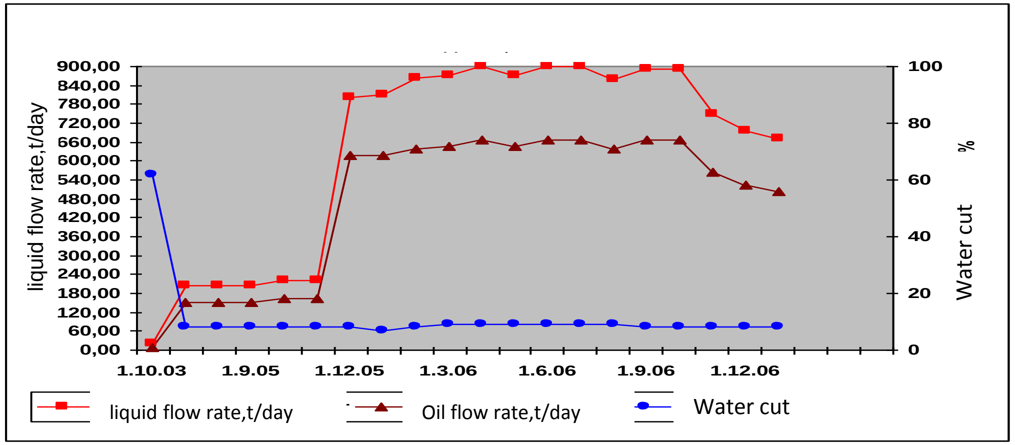
Injectivity of the insulated interval before the remedial cementing (RC) - 16 951.042 ft3 / day. Technological works included injection of two-component plugging composition in the reservoir in a volume of V = 466,153ft3 + tightening insulating composition (cement slurry) in a volume of V = 113,007ft3. The final pressure while squeezing the insulating composition was P =2939,190psi. After the WOC time -36hours, the head of the cement bridge was met at a depth of 7972,44ft, hydraulic pressure test P = 1469,595psi - leak-proof. Drilling to a depth of 8963,25ft, hydraulic pressure test P = 1469.595psi, leak-proof. Perforation of the reservoir B2: 9081,36-9110,89ft

Two-component plugging composition creating waterproof barrier in the bottomhole formation zon

Tightening insulating composition (cement slurry) with additives improving the rheological properties of the solution.

Oil zone

Gas zone



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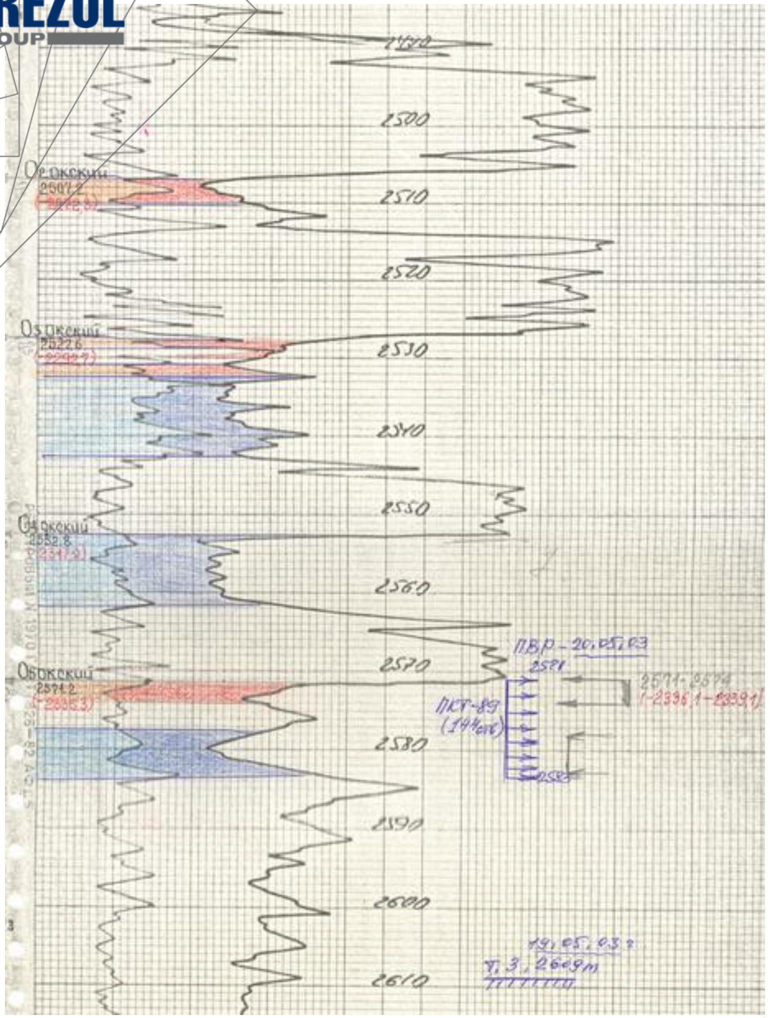
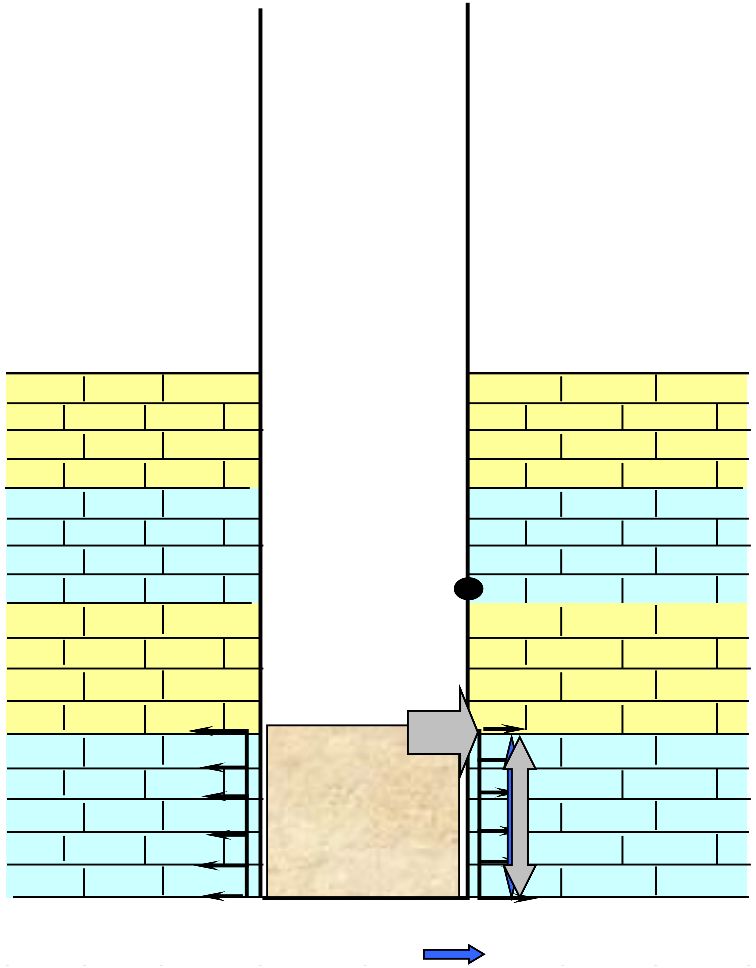


Remedial cementing (RC) technology of
behind-casing connection between formations



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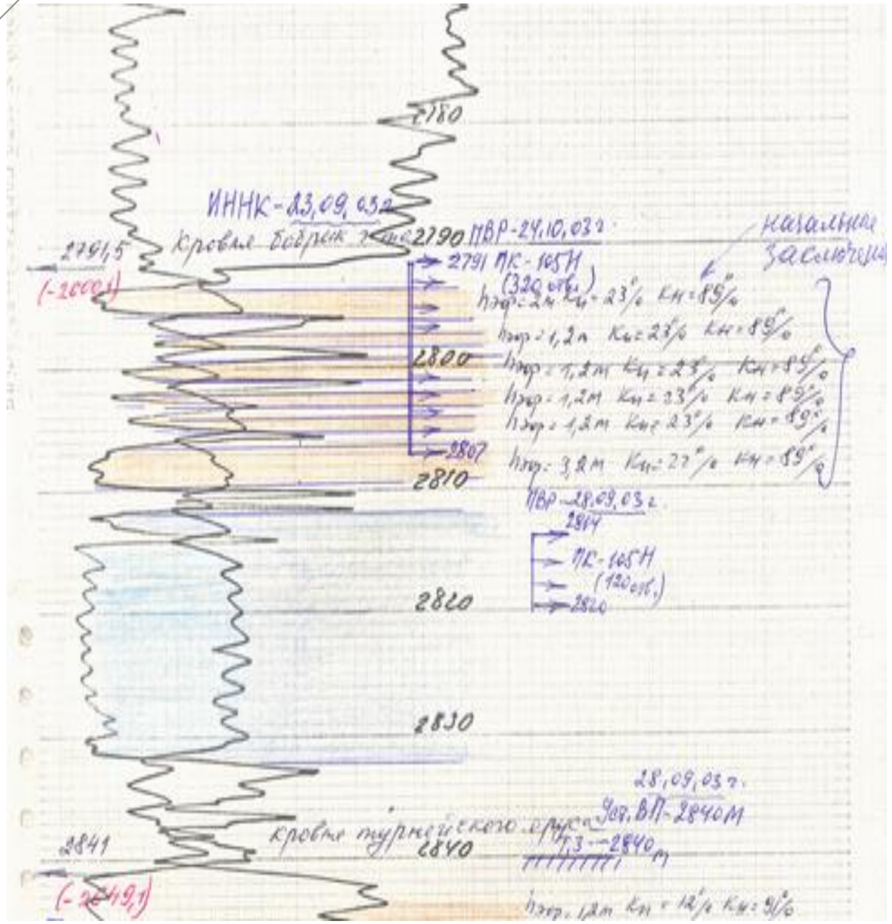
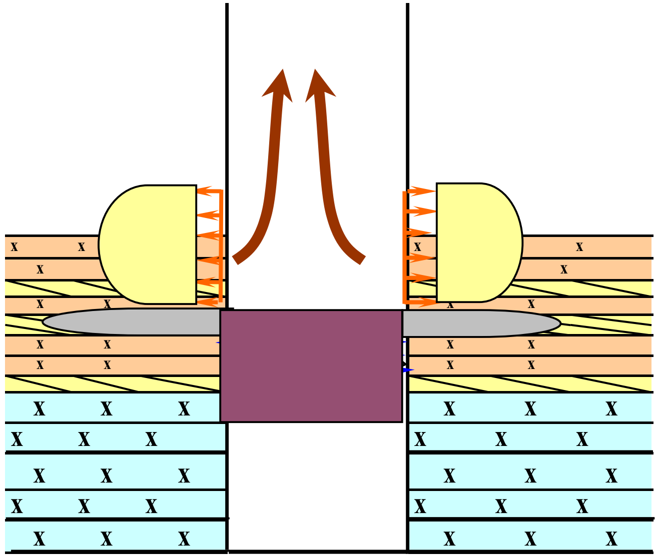
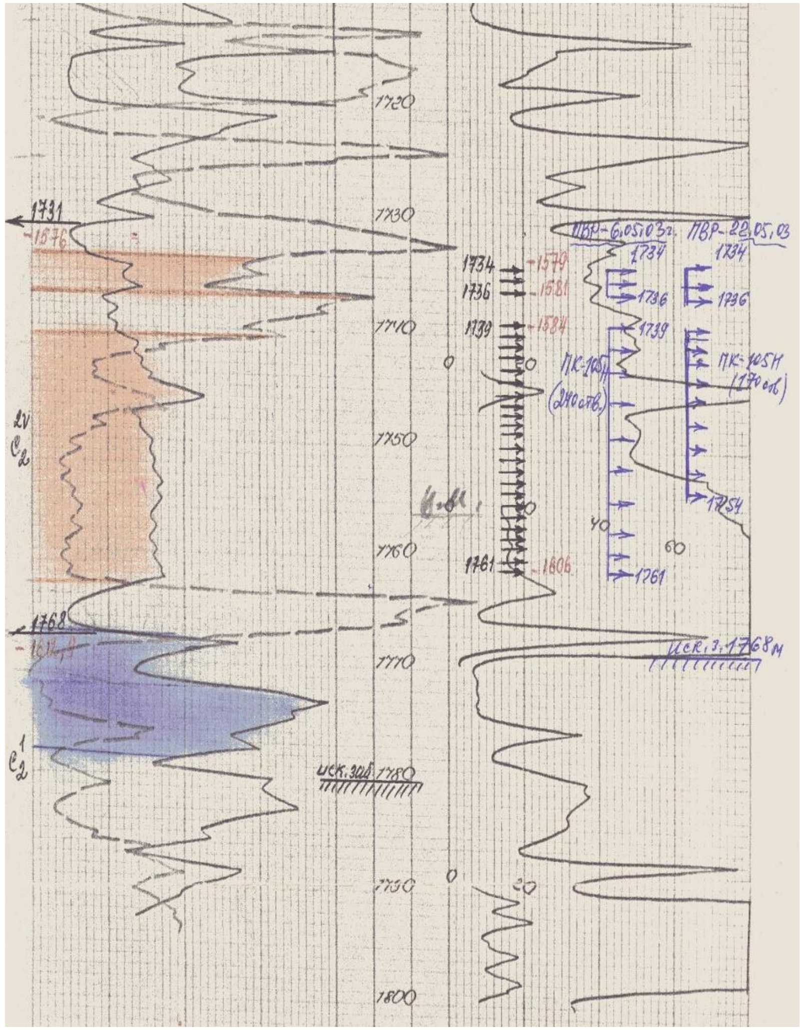
Remedial cementing (RC) technology with the installation of a barrier through special holes with subsequent hydraulic fracturing

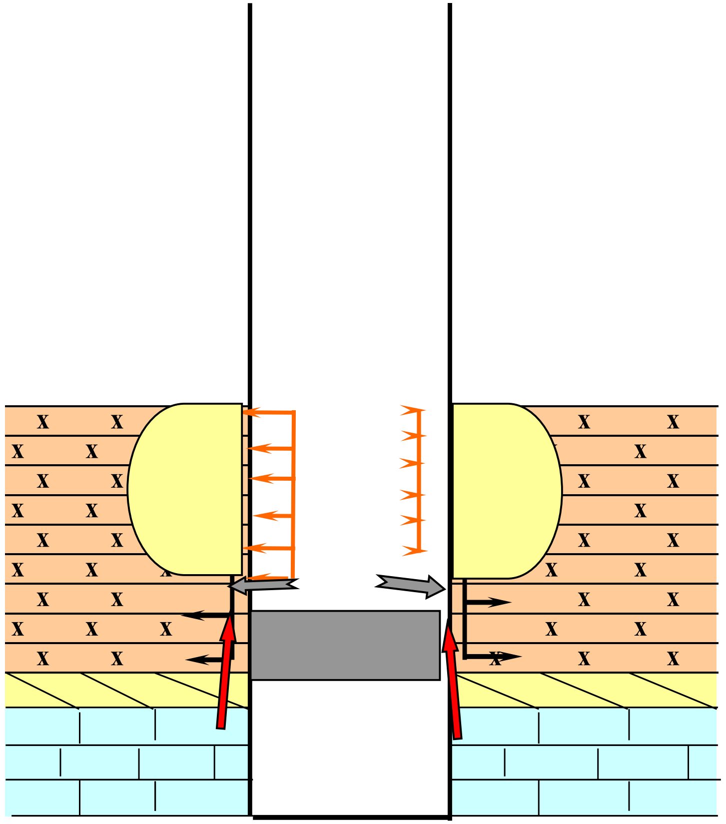




пл.Б2

The isolation of behind casing water crossflow through the perforation interval





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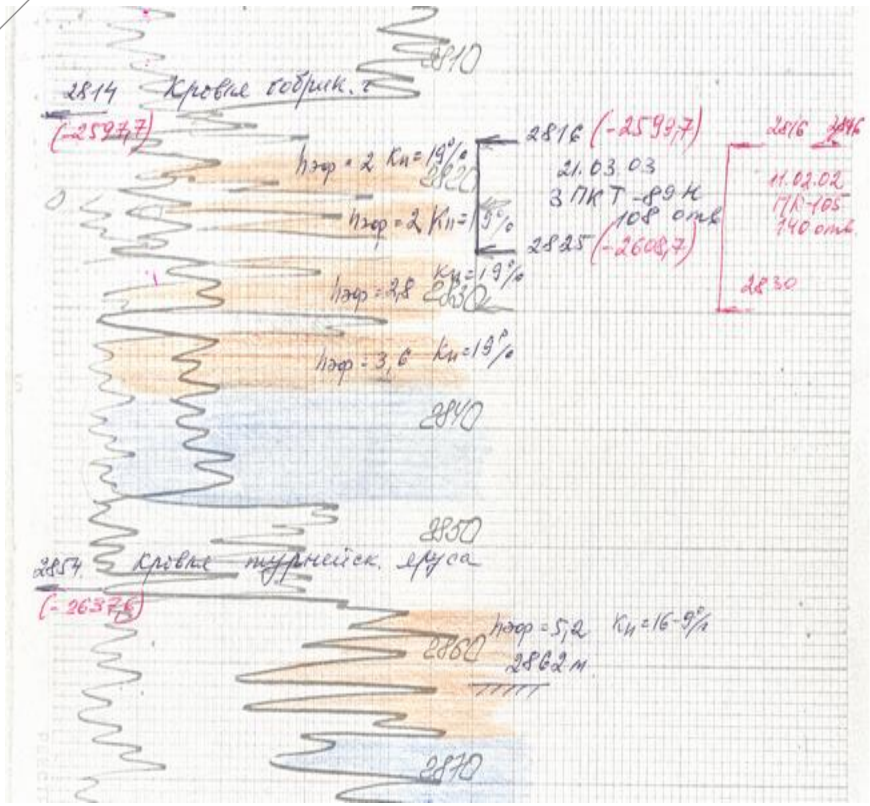
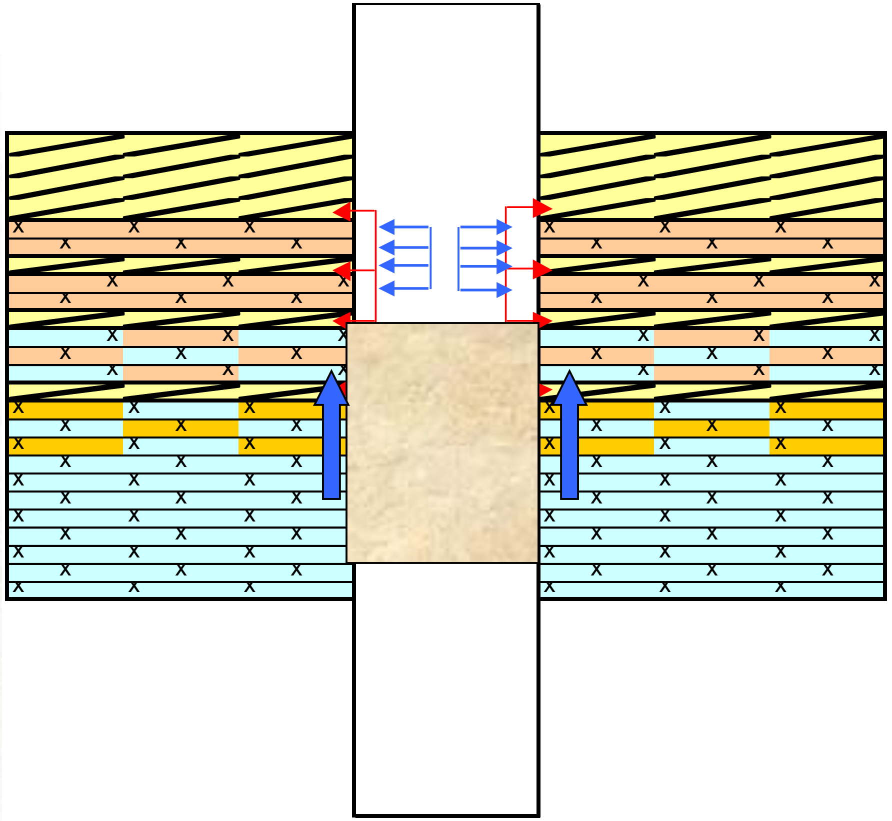
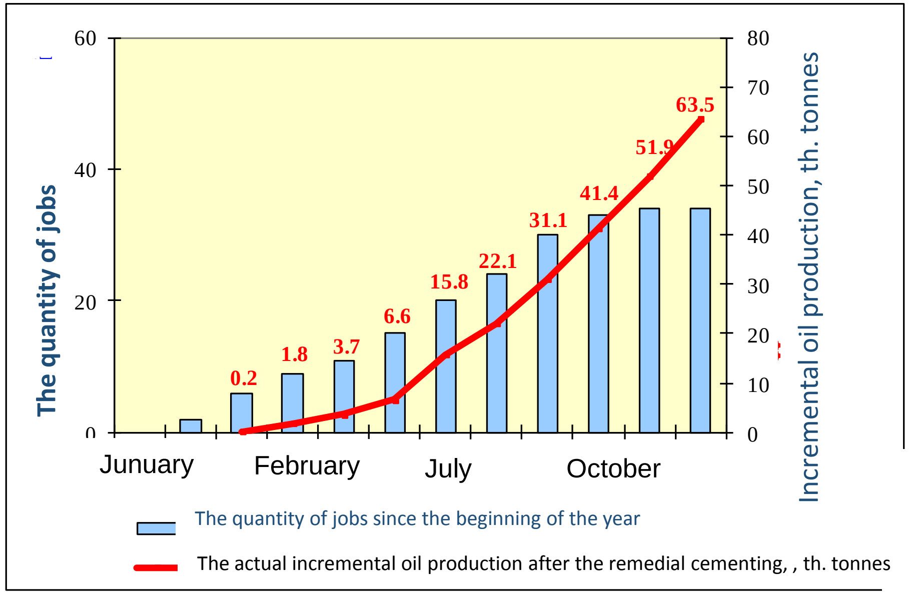
The isolation of behind casing water crossflow with the isolation of water saturated formations

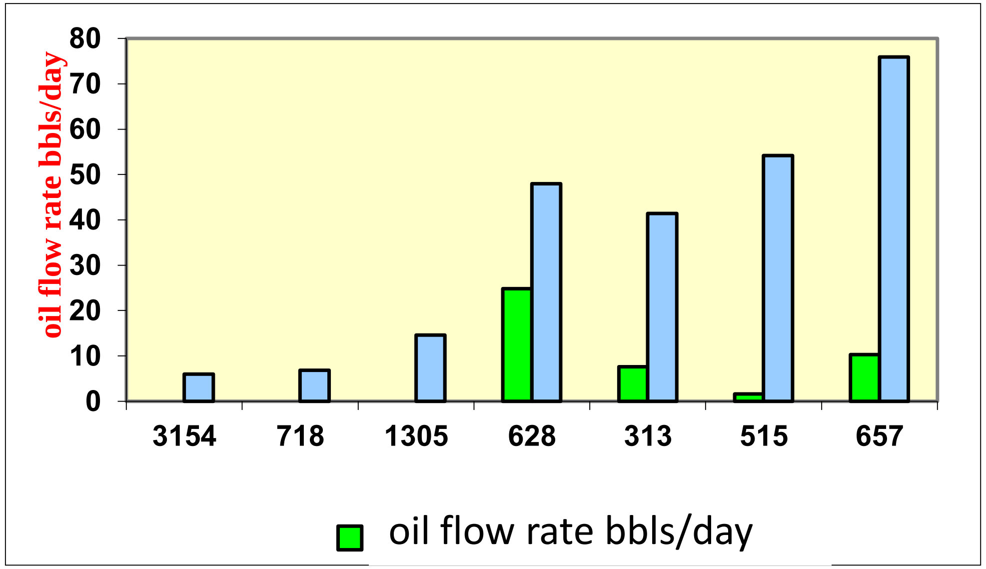




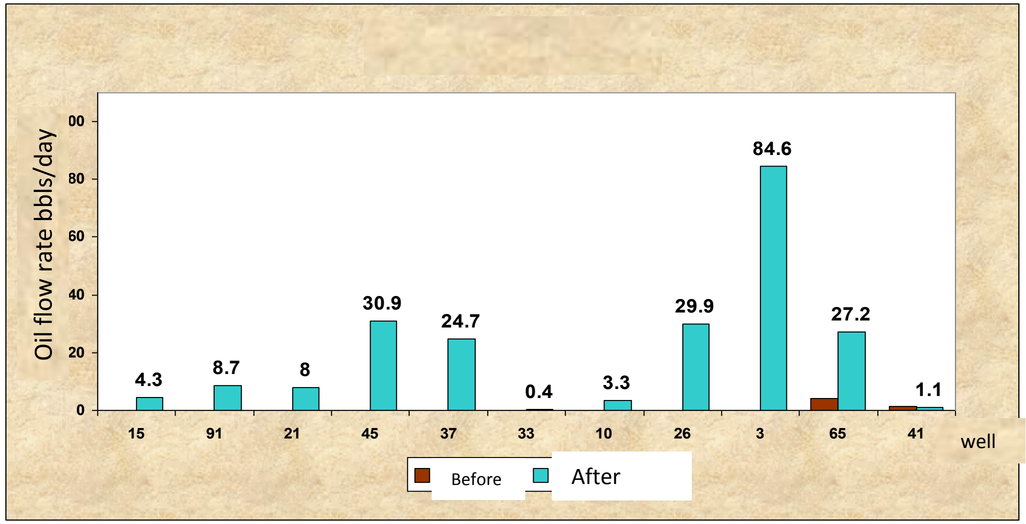
The effectiveness of the water isolation operations in Western Siberia wells

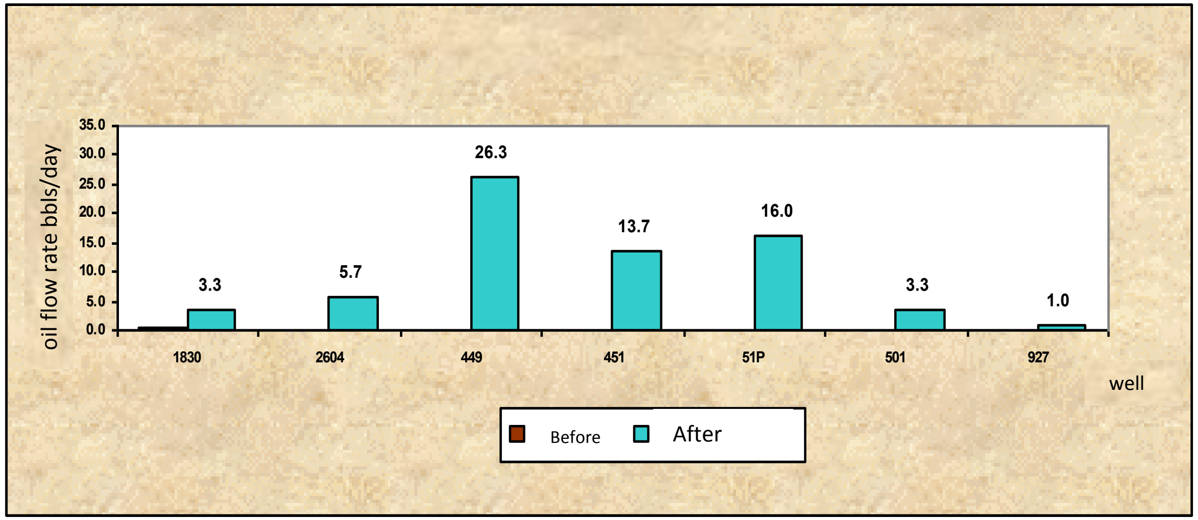


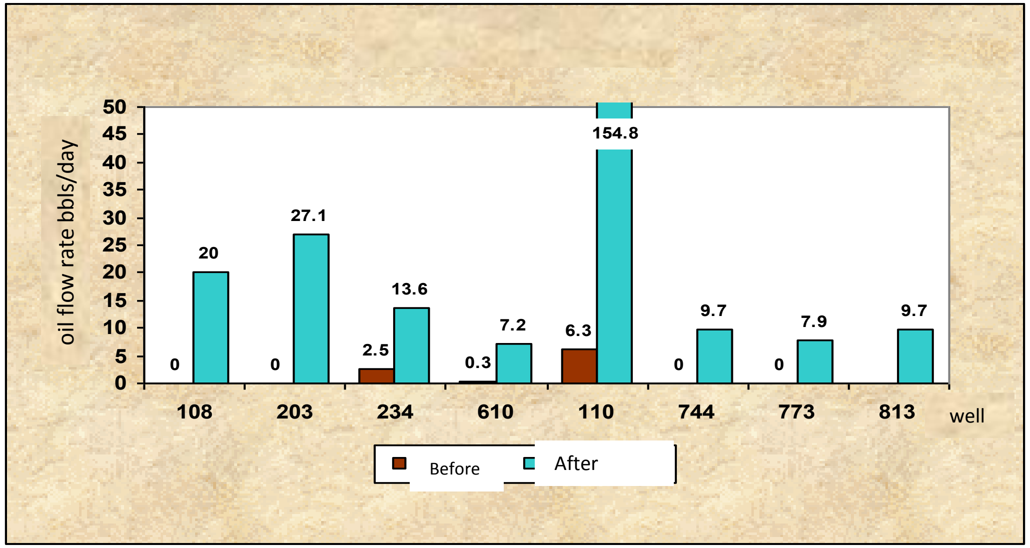
The incremental oil rate after the remedial cementing (insulation of formations and casing patch) for Western Siberia wells



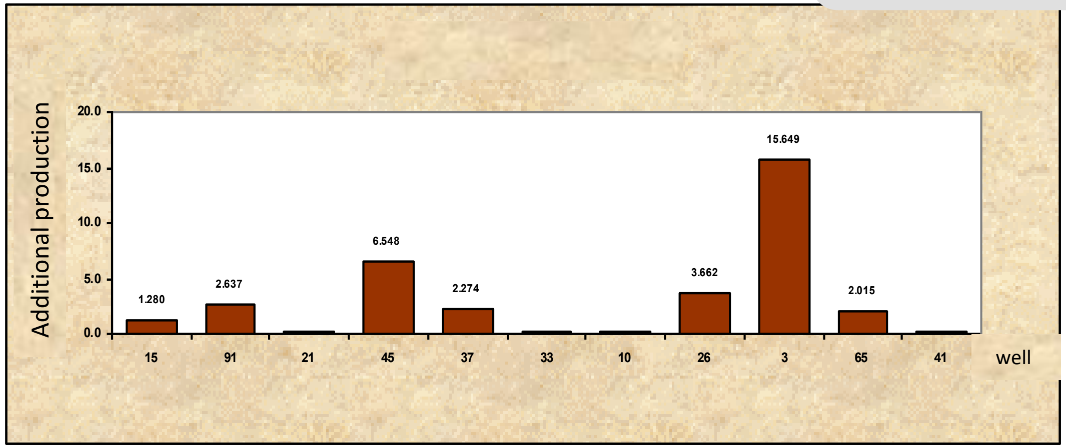
Change of the oil flow rate after the transition to the lower formation

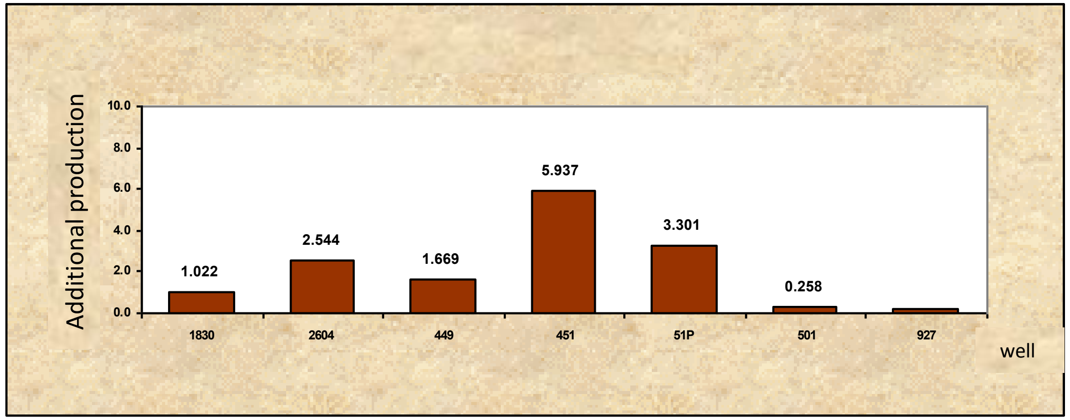


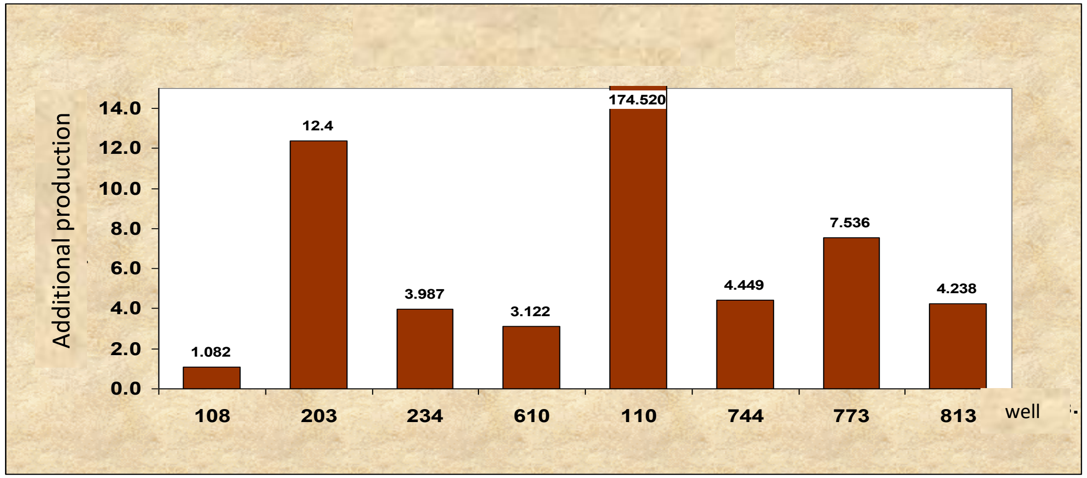




Additional production after the transition to the lower formation







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ANNULAR PRESSURE

According to field experience, the number of wells with annular pressure is quite large both in Russia oil and gas fields and abroad. More than 8,000 wells in the Gulf of Mexico, approximately 30% of "Gazprom“, JSC production wells (including more than 50% gas wells of the North), more than 40% of production wells of underground gas storage facilities in Russia, up to 30% of the wells of gas-condensate fields in Kazakhstan, almost 50% of the wells in "White Tiger" oil and gas fields (offshore Vietnam) and many others have annular pressure. According to domestic and foreign researchers, the cause of the between casing pressure are common to all fields.

Analysis of production data for the main oil and gas producing regions in Russia has confirmed that the number of wells, particularly gas, with signs of inter-casing leak (between casing pressure) is very large. In the northern part of the Caspian fields alone, the number of wells with the annular pressure of varying intensity is 50%.

Technology of between casing pressure elimination using a mechanical perforator and plugging composition with adjustable setting time has been designed and tested. Technology consist in installing a supporting bridge below the interval of down casing of the technical string, perforation of the production casing while maintaining the technical integrity of the technical string, jetting treatment of annular space in order to create a cavity or increase injectivity.

Technology and the sequence of works, as well as the formulation are done individually for each well.

Operational experience

Testing of elimination of annular pressure in a gas well

To solve this problem we proposed a number of measures aimed at restoring the cement sheath, slot perforator implementation – perforation of special holes in the interval of the shoe of technical string, using the plugging composition through special holes.

The composition for this particular task was made in an accredited laboratory on consistometer CTE Models 22-400. The only criterion for success was - the elimination of annular pressure through special holes in the production casing.

The annular pressure was successfully eliminated.

Elimination of cross flows in the underground gas storage well

According to the noise and temperature logging a behind-casing flow was detected from the producing reservoir into the overlying formation during the well construction.

According to the Customer there was no injectivity along the upper formation.

We proposed and implemented perforation of the upper formation with a mechanical perforator and jetting of the formation to create injectivity.

6 holes were made with 158 F phasing. There was no injectivity. After jetting through perforator the injectivity was 742,2 bbls / day, which allowed for plugging the borehole annulus.

Further studies confirmed full absence of cross flows behind the casing.

Thank you for your attention!

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