LOST CIRCULATION STRATEGY

MATERIAL & TREATMENT

TROUBLESHOOTING GUIDE

Lost Circulation

Causes:

- Permeable sands
- Cavernous formation
- Natural fractures and fault zones
- Induced fractures

Poor Hole Cleaning

Causes:

- Low rheology
- High ROP
- Sliding / Low Rotation
- Low flow rate
- Hole instability / washout

Swelling, Dispersive and Sloughing Shale

Causes:

- Chemical / mechanical instability of shale
- Lack of mud inhibition
- Lack of encapsulation in mud
- Lack of MW

Hydrogen sulfide (H_2S)

Causes:

- Gas influx from formation
- Thermal degradation of organic mud additives
- Bacterial degradation of organic mud additives

Differential Sticking

Causes:

- Poor filter cake quality
- Lack of mud/filter cake lubricity
- Depleted sands/Permeable sands
- High ECDs
- Mud losses to formation
- High solids content

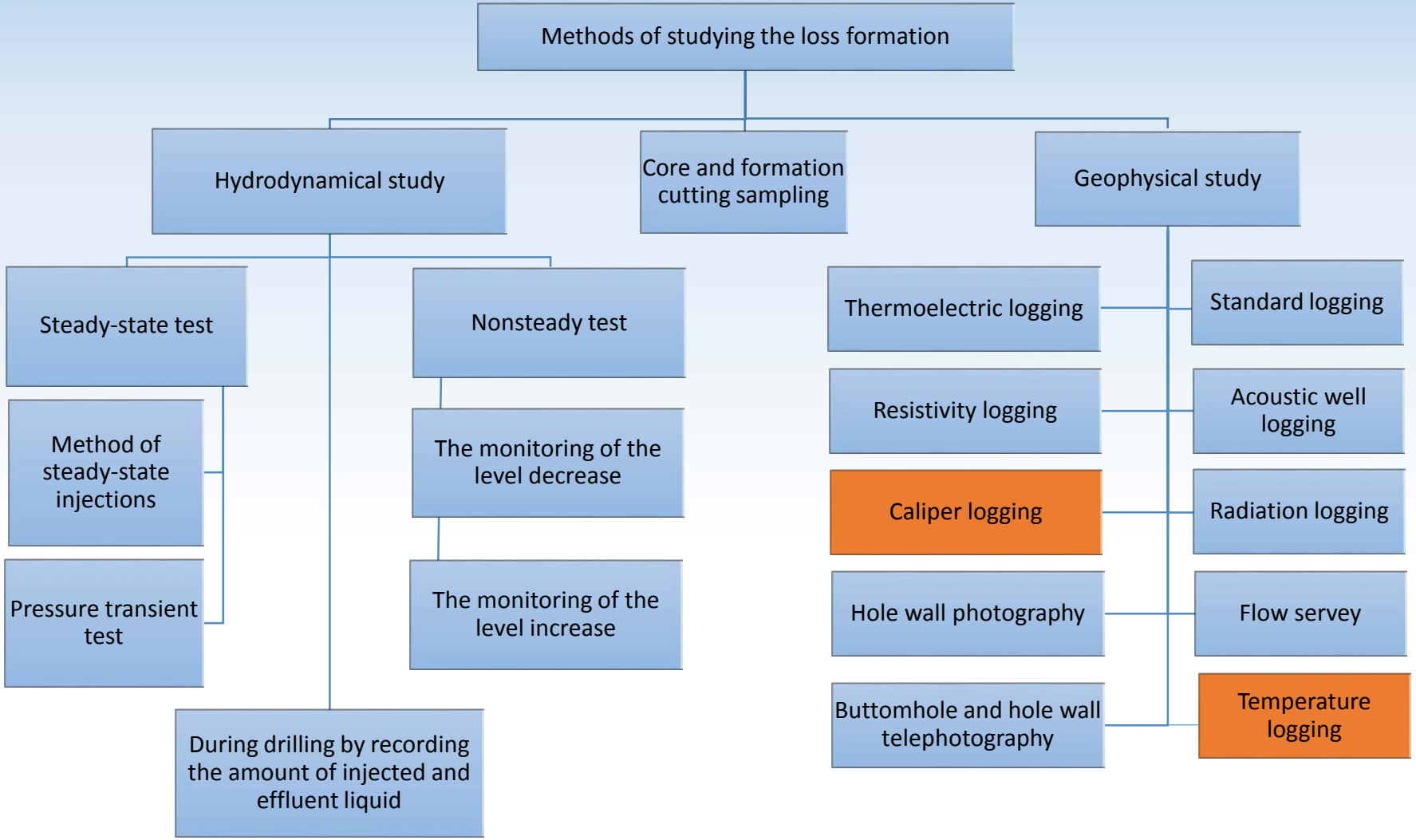
DISADVANTAGES OF EXISTING APPROACHES OF SOLVING DRILLING PROBLEMS

The lack of objective information about the absorbing interval (Loss zone thickness, injectivity, the presence of failures, geometry of the absorption channels, reservoir pressure, etc.)

The reluctance of carrying out hydrodynamic and geophysical studies of absorbing intervals at the initial stage

The lack of the necessary tools to study the absorbing intervals (packers, packoff, depth gages, downhole flowmeter, pressure gauges, etc.)

The lack of software for processing and analyzing information for the selection of efficient materials and reagents


Methods of studying the loss formation
Hydrodynamical study
Core and formation cutting sampling
Geophysical study
Steady-state test
Nonsteady test
Method of steady-state injections
The monitoring of the level decrease
Pressure transient test
The monitoring of the level increase
During drilling by recording the amount of injected and effluent liquid
Thermoelectric logging
Standard logging
Resistivity logging
Acoustic well logging
Caliper logging
Radiation logging
Hole wall photography
Flow servey
Buttomhole and hole wall telephotography
Temperature logging

LOST CIRCULATION STRATEGY

SEEPAGE LOSSES

Static 0.2-1.0 m3/h

Dynamic <10%

INITIAL ACTIONS:

Reduce R.O.P.

Minimize Flow Rate

Minimize Mud Weight

Use LCM in the drilling fluid

Pump high-vis pills with LCM&CaCO3

PARTIAL LOSSES

Static 1.0-10.0 m3/h

Dynamic 10-30%

INITIAL ACTIONS:

Reduce R.O.P.

Minimize Flow Rate

Minimize Mud Weight

Use LCM in the drilling fluid

Pump water-swellable polymer suspension

Pump Bentonite paste or Diesel-Bentonite suspension

LOST CIRCULATION STRATEGY

SEVERVE LOSSES

Static >10.0 m3/h

Dynamic 60-95%

Pump water-swellable polymer suspension

Pump Bentonite paste or Diesel-Bentonite suspension

Pump two component composition

POLY TGP

Combination of cement or gypsum plug

Pump high-speed hardening polyurethane composition

TOTAL LOSSES

Dynamic 95-100%

Pump water-swellable polymer suspension with cement or gypsum plug

Pump high-speed hardening polyurethane composition

Pump two component composition

POLY TGP with cement or gypsum plug

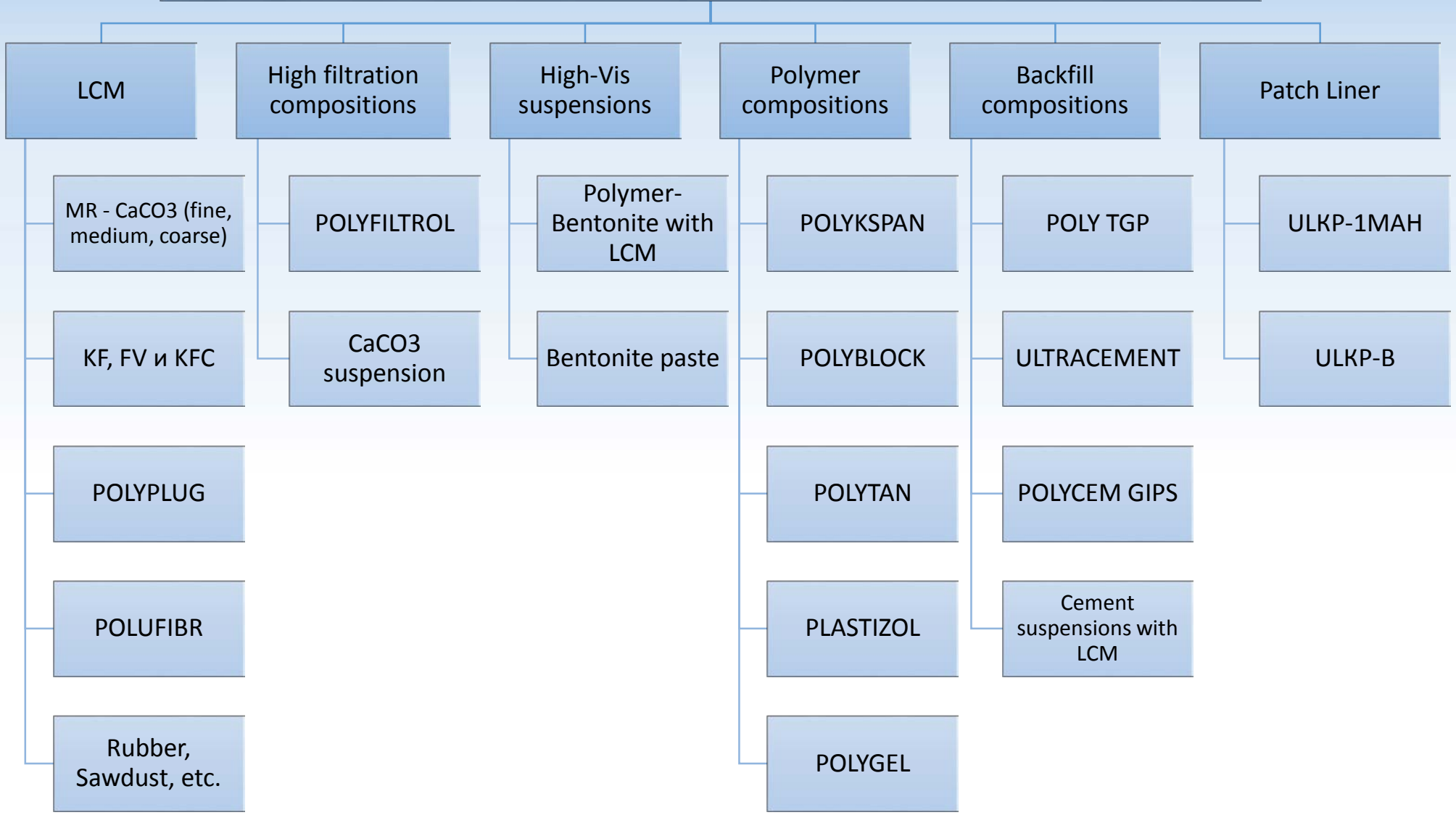
RIH patch liner

ULKP-1MAH

Use water as drilling fluid & pump high-vis pills with LCM

Run casing & cementing

LOST CIRCULATION MATERIAL



LOST CIRCULATION MATERIAL

Granulated	Lamellated	Scaly	Fibred	Polymineral	Flexible water/oil swellable	Combined
MR - CaCO3 (fine, medium, coarse)	KF-R	KF	POLYFIBR	POLYFILTROL	POLYBLOCK	KF-C
Siderite	KV (vermiculite)	Nutshell	Salamander wool	Modified Bentonite	POLYKSPAN	POLYPLUG
Barite		Rice hulls	Cordage fiber			
			Sawdust			

- NBS product

LOST CIRCULATION MATERIAL

KF, KF-C

POLYPLUG

POLYFIBR

KF-R

(acid solubility 99%)

POLYFILTROL

NUTSHELL

POLYPLUG-6A

RUBBER

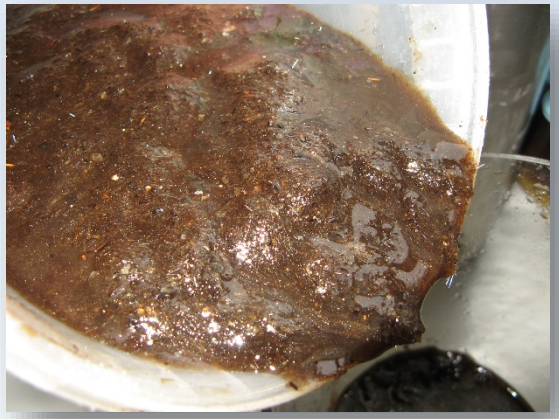
Filler-colmatant POLYPLUG-B for intensive lost-circulation control




The procedure for preparation and injection:

Prepare mud at a concentration of 5-7%. Install casing drill pipe above the absorption zone of 10-20 meters. Pump the solution using a cementing unit through a mud hopper in a mud pump and into the tube space. At the same time add filler POLYPLUG-B through the mud hopper at a rate of 30-50 kg/m^3. Pump into the well using mud or technical water in an estimated amount.

Filler-colmatant POLYPLUG-B 30
for high intensity lost-circulation control



POLYFILTROL

TU 2458-048-97457491-2011

High-performance, high-strength additive is a single-sack proprietary blend designed for wellbore strengthening applications and a wide variety of lost circulation scenarios, including, but not limited to, fractures and matrix permeability. This product is applied in the form of a squeeze pill which, depending on the application, de-waters or de-oils rapidly to form a high shear-strength plug. POLYFILTROL additive can be used in water-based or non-aqueous drilling fluids (NAF) for wellbore strengthening applications and to cure losses extending from partial to a wide range of severe lost circulation scenarios, at temperatures up to at least 177° C (350° F).

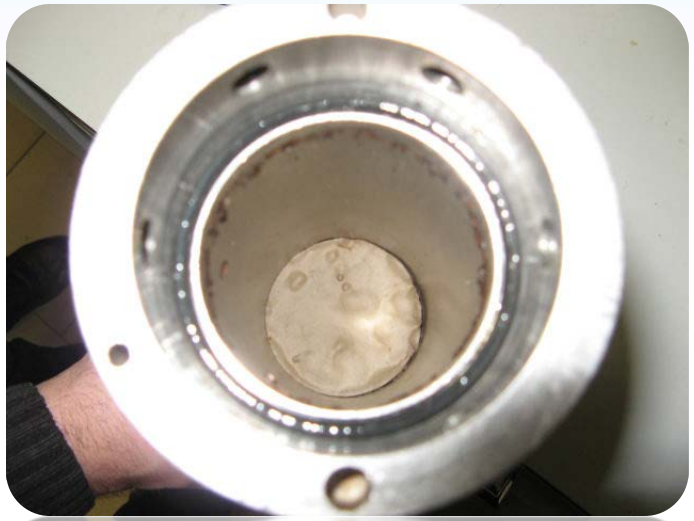
Typical Physical Properties

- Physical appearance - Gray powder
- Specific gravity -1.30 – 1.40
- Spread rate (30% conc.) – >25 sm

POLYFILTROL

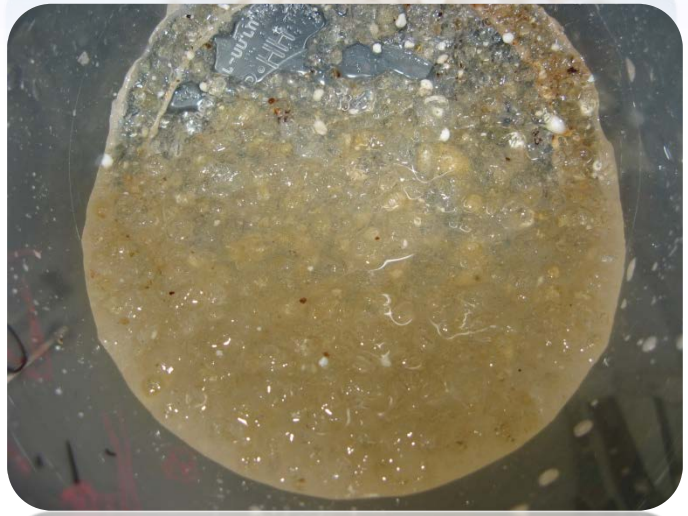
Product is designed to be used for:
•Wellbore strengthening applications
•Curing partial to wide ranging severe loss situations
•Open hole remedial and/or preventive lost circulation squeeze
•Improving casing shoe integrity
•Cased-hole squeeze for sealing perforations and casing leaks

Advantages:
•Quick-acting plug for wellbore strengthening and lost circulation applications
•Single-sack system, though higher densities may require the addition of a thinner
•High-performance, High-shear strength pill
•Easy to mix and pump with standard rig equipment
•Does not require an activator or retarder
•Does not depend on time or temperature to form a rigid plug
•Can be pre-mixed well in advance of pumping provided pill is agitated continuously



POLYBLOCK - water swellable polymer

TU 2458-037-97457491-2010



POLYBLOCK – lost circulation material is a 100% active, water-swellable, synthetic polymer. POLYBLOCK polymer LCM absorbs hundreds of times its own weight in water.

The use of POLYBLOCK absorbent polymer can assist the following:

- Lost circulation material for horizontal directional drilling
- Prevent inadvertent returns in river crossing applications
- Stabilize borehole in cobble and gravel
- Stabilize unconsolidated formations

Advantages:

- Rapid water absorption
- Effective in mitigating lost circulation
- Economical – small quantity yields large volume
- Easy to use
- Non-fermenting

Typical Properties:

- Appearance - off-white crystals
- Specific gravity - 0.75
- Dry screen analysis - 96% through 5 mesh (4.0 mm)
- Swelling capacity in fresh water - 3.5 ft3/lb (0.22 m3/kg)

POLYBLOCK POLYMERIZATION

POLYBLOCK

POLYBLOCK-S

POLYEKSPAN Flexible water swellable polymer

TU 2216-024-97457491-2010

Dry POLYEKSPAN supplied in 25 kg bags

Liquid POLYEKSPAN supplied in 200 kg drums .

POLYEKSPAN PROPERTIES

GLYCOL BASED

BRINE BASED

EXPERIENCE OF APPLICATION POLYEKSPAN

№ well, field	Losses interval, m	Losses rate, m^3/h	Type of losses	Pill Volume, m^3	Quantity pills	Waiting time	Material take-off, kg
#3 Imbinskoe	2400-2404	> 80	Total + Gas kick	5,0	1	3	Polyekspan - 960
#I-18-11 Dulisminskoe	89-98	60	Total	2,0	1	3	NaCl-120 KF – 80 Polyekspan – 200 kg
#I-18-07 Dulisminskoe	95-120	50	Total	2,5	1	4	NaCl-150 KF – 100 Polyekspan – 200
#321-74 Chayandinskoe	410-425	> 30	Severe	4,0 5,0	2	6	NaCl-2250 Polyekspan – 875
#ПО-98 Yamsoveyskoe	86-110	>20	Severe	4,0	1	6	NaCl-1000 Polyekspan – 550
#321-72 Chayandinskoe	440-462	25	Severe	4,0	2	6	NaCl-1000 Polyekspan – 500

Dry blend POLY TGP

TU 2458-010-97457491-2007

POLY TGP - lost circulation material, specially designed for total losses in terrigenous and carbonate formations, including cavernous-porous formations;

Composition consist from blend of polymineral components which mixing with water. This technology based on chemical colmatation while two components of POLY TGP agitating in losses interval. Thus as a result of chemical reaction (around 2 minutes) the volume of composition increase (2-3 times). The final form of the composition represents a porous stone without free water and high plastic strength.

Experience of introduction of lost-circulation control technology using PolyTGP

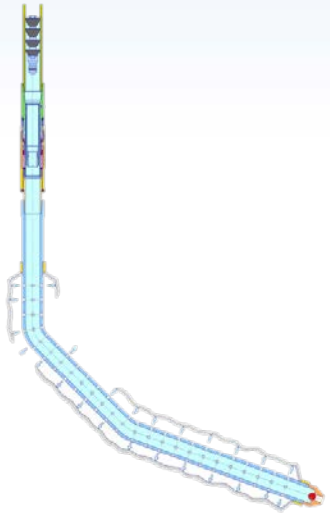
Geological and technical conditions in wells while performing the works	Well № 9044 Orenburgskoe oil and gas-condensate field	Well № 3 Tsaricanskoe oilfield	Well № 12081 Orenburgskoe oil and gas-condensate field	Well № 998 Kuleshovskoe oil and gas field
Current depth, m	550	3310	1491/1922	2508
Absorption interval, m	541-543	3168-3180	1992	2450-2497
Static fluid level, m	Not determined	324	350	Gas, oil and water show Ptubing = 5,5 MPa Pannulus = 6,8 МПа
Absorbtion intensity, m^3/h	Total	Total	Total	Total
The injected volume of PolyTGP, m^3	16,0+1,5	30,0+4,8	32,0+5,0	30,0+5,0
The injected volume of cement plug, m^3	2,7+1,5+3,0	6,4	Not placed	8,0
Circulation after drilling out, %	100	100	100	100
Operating result	No absorption	No absorption	No absorption	No absorption

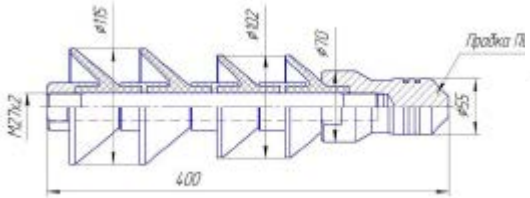
Cementing slurry Polycem GIPS (gypsum) TU 2458-055-97457491-2012

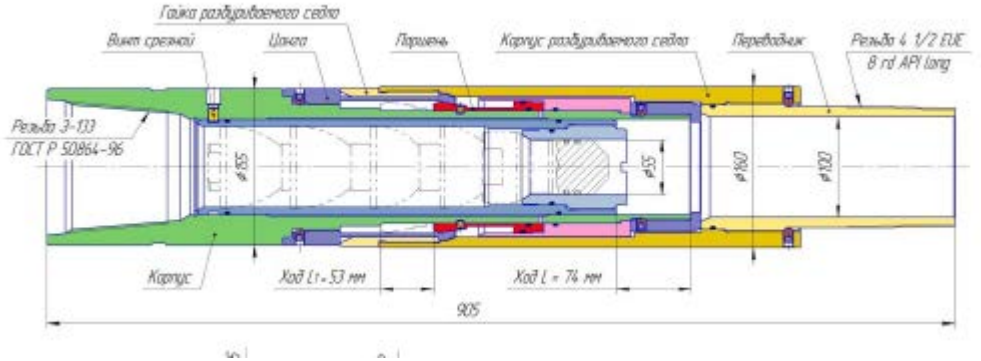


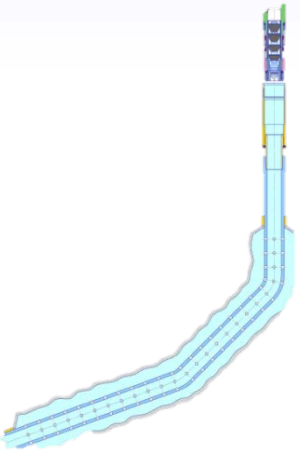

№	Characteristic	Unit of measurment	W/C ratio	
			0,45	0,50
1.	Slurry density	kg/m^3	1780	1750
2.	Spreadobility, not less	mm	175	210
3.	Thickening time, at a temperature of 4 ˚C	min	130-140	155-160
4.	Slurry water loss, not above	ml	0	0
5.	Cement strength at a temperature 4 ˚C in 24 hours not less transverse strength compression strength	MPa	 4,9 14,2	 4,7 9,6

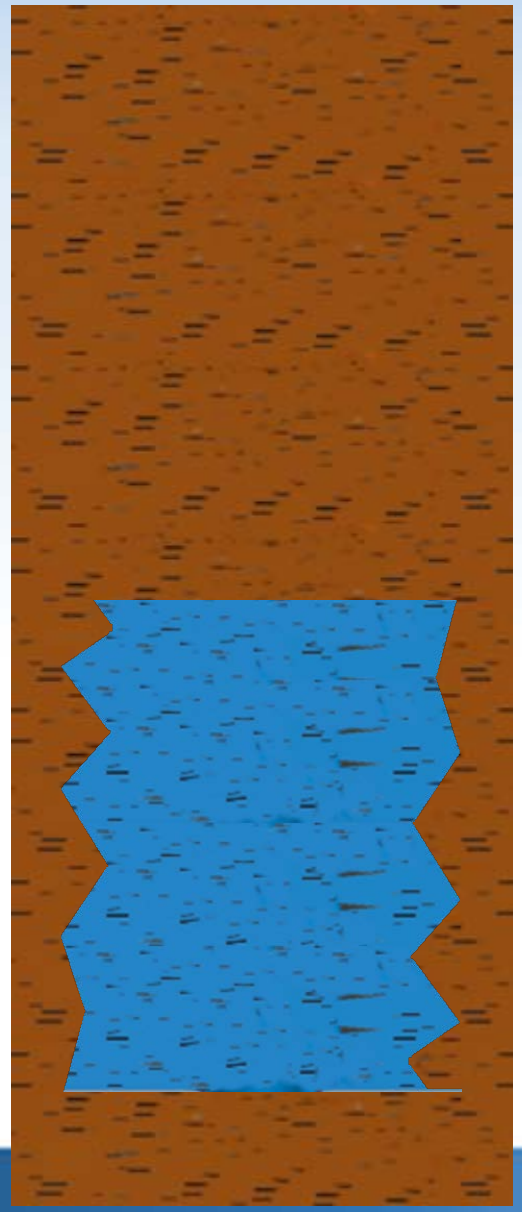
Lost circulation control technology using ULKP-B



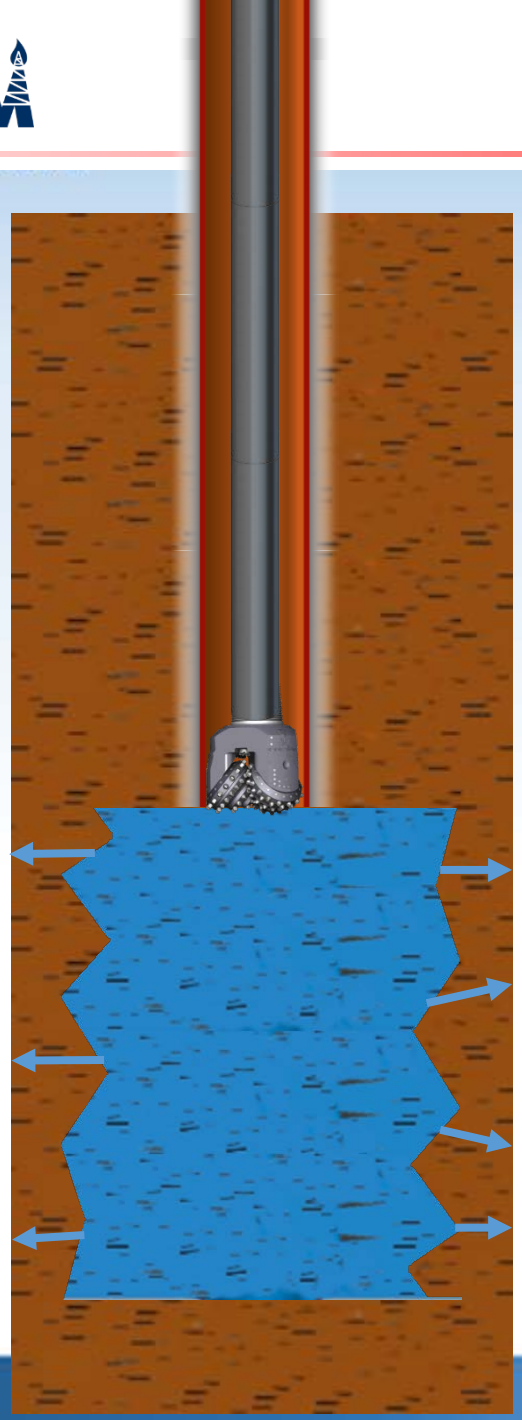




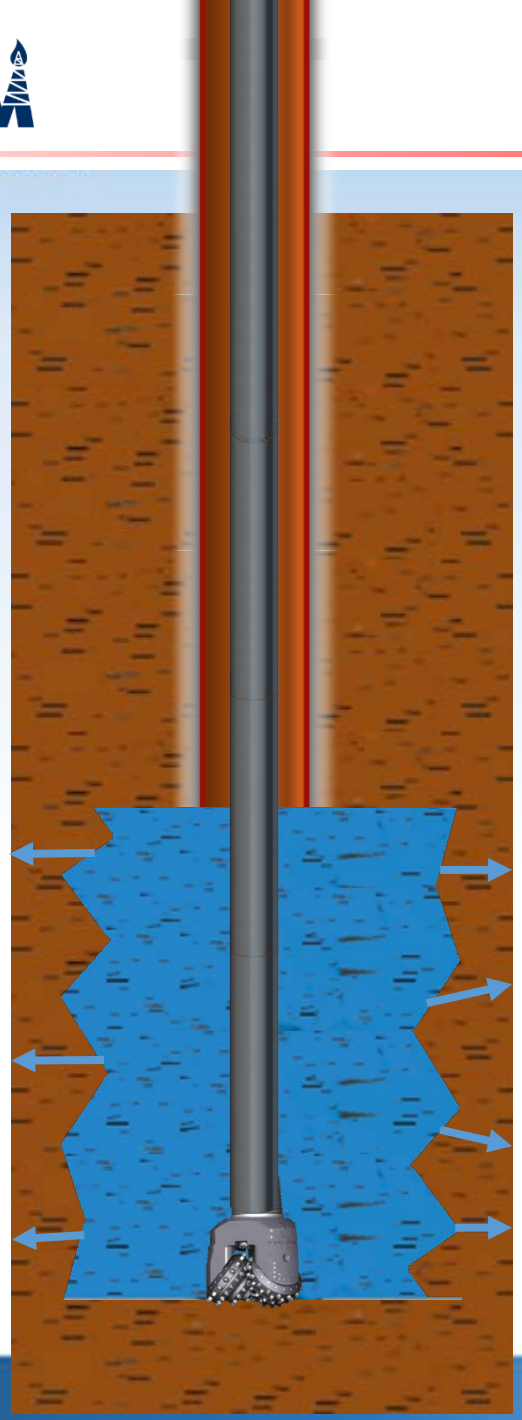




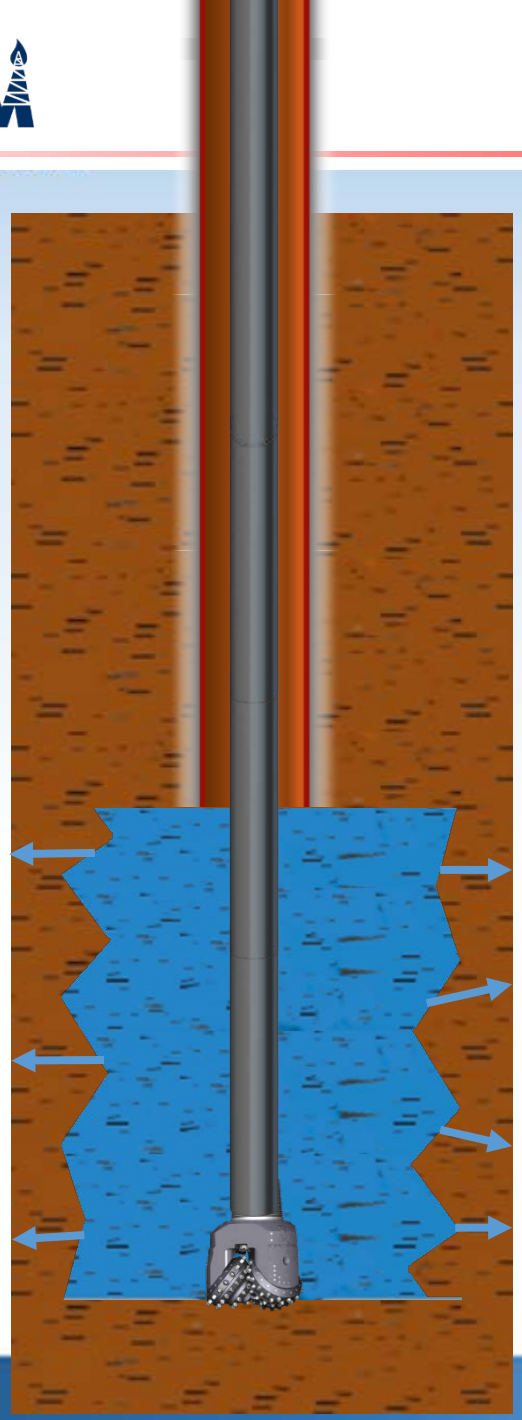
1.NORMAL DRILLING



2. BOTTOM HOLE ASSEMBLY ENTERS INTO THE PROBLEM FORMATION

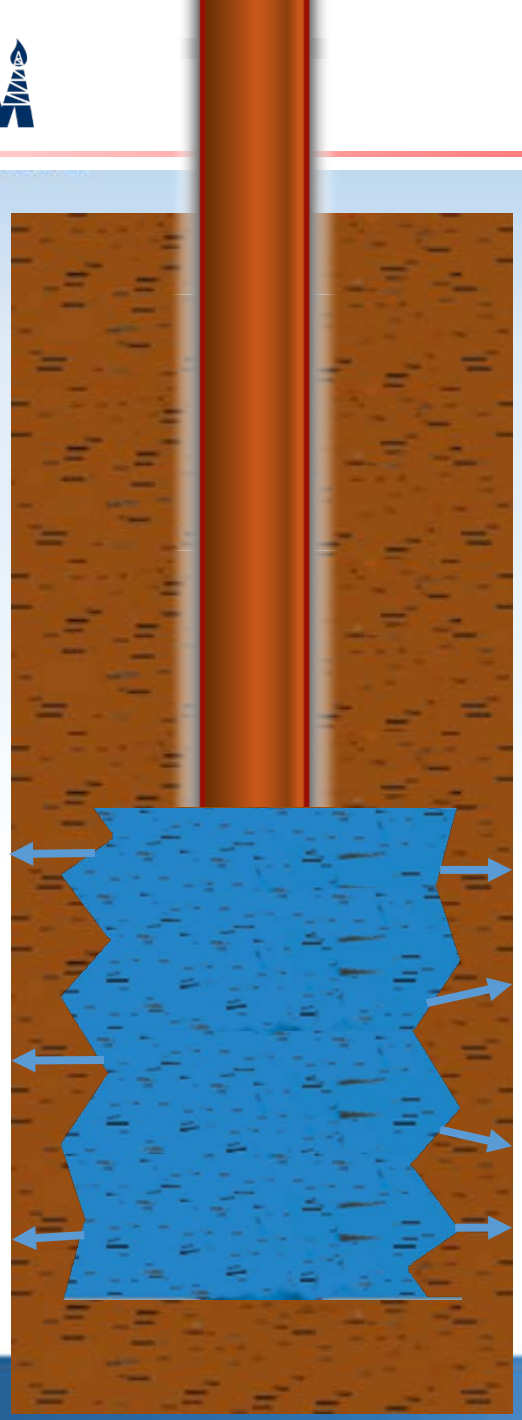


3. DRILLING IMPOSSIBLE DUE TOTAL LOSSES

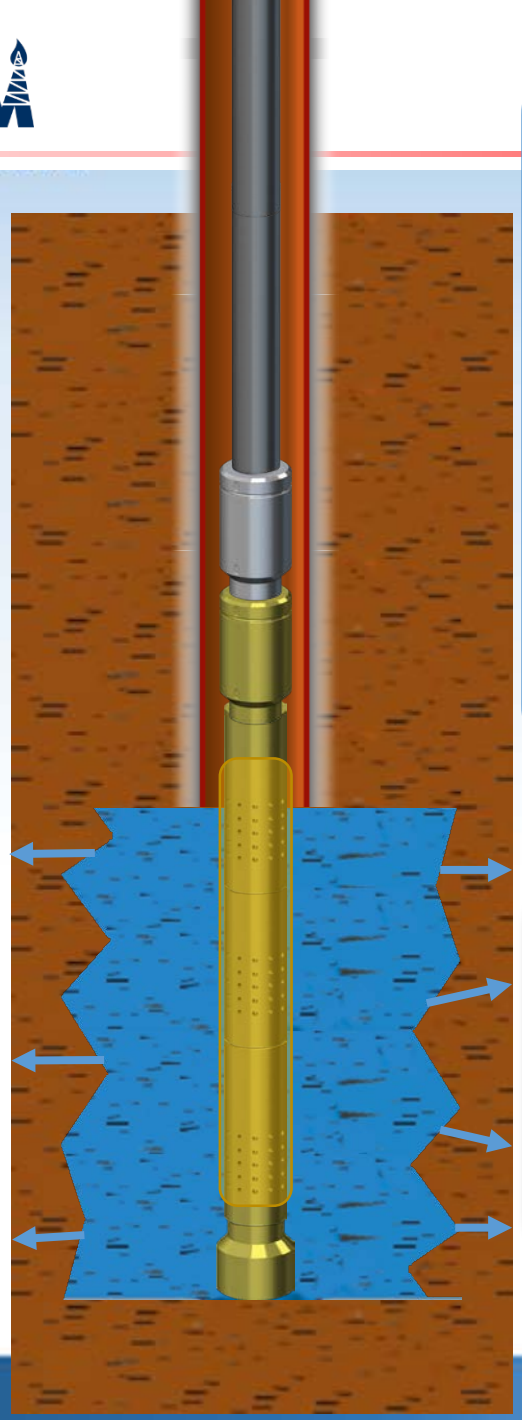


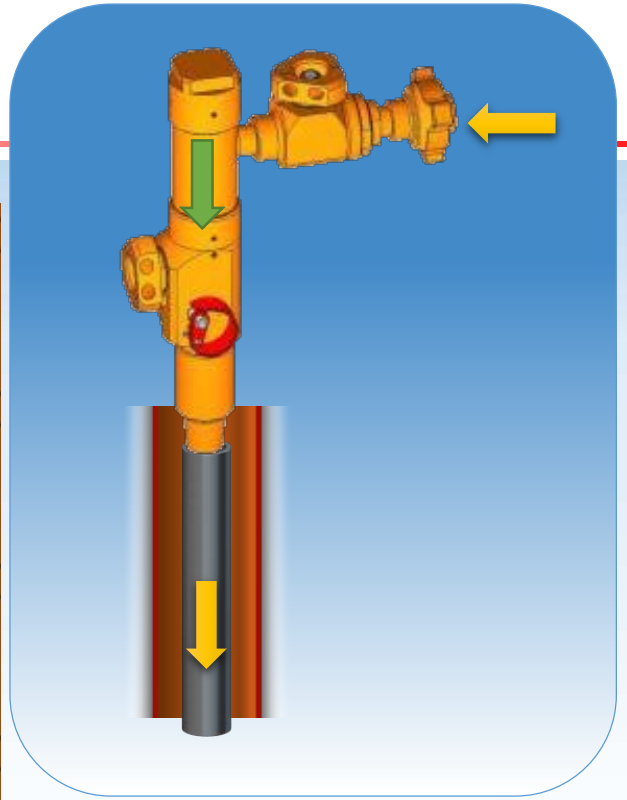
4. POOL OUT OF THE HOLE BOTTOM HOLE ASSEBMLY

5. BEFORE RUN IN THE HOLE ULKP MAKE A LOG ANALYS FOR DETERMINING CAVING INTERVAL

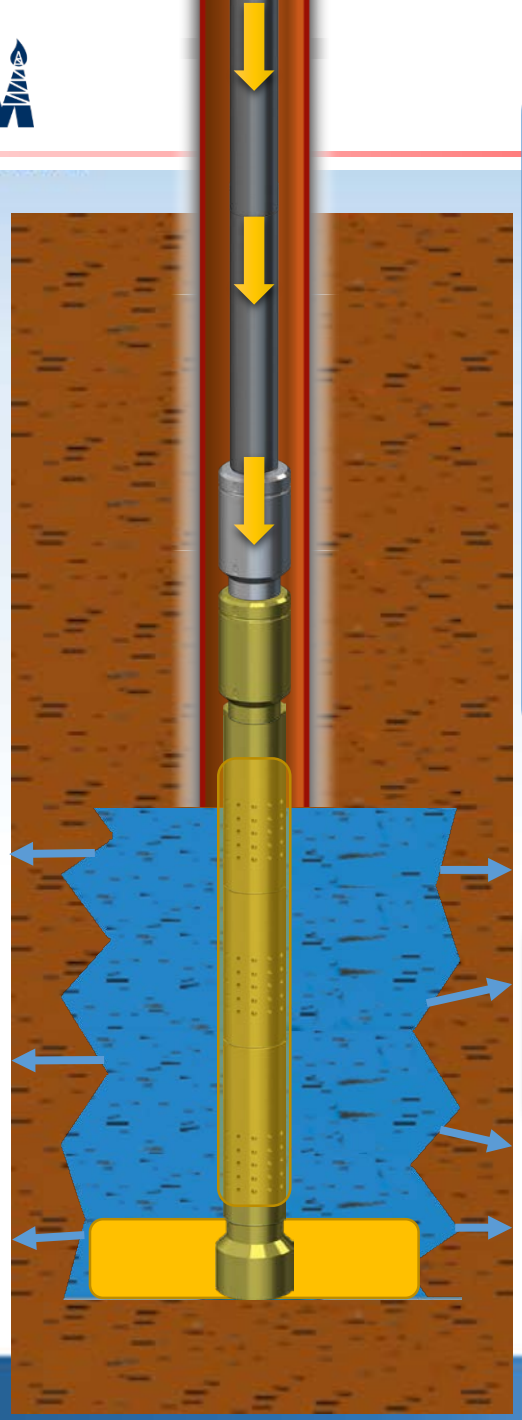


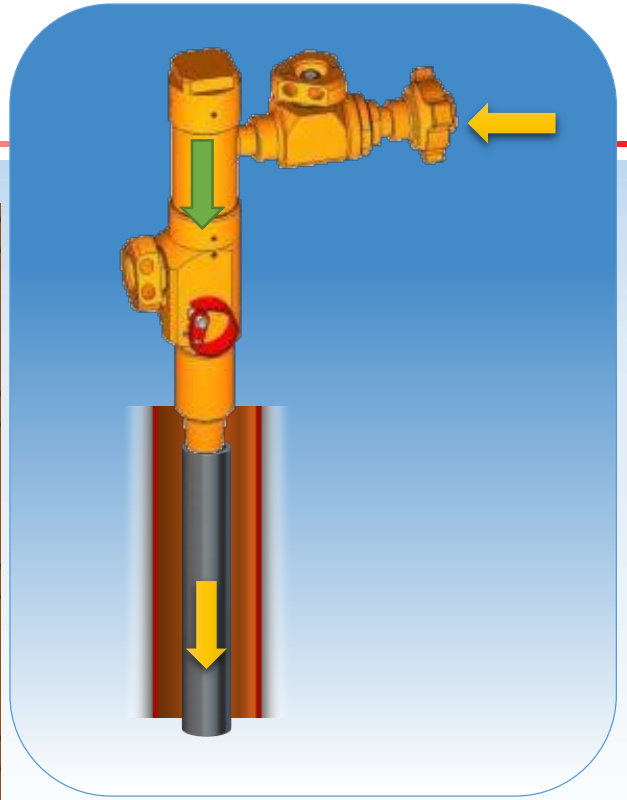
6. ASSAMLBING BOTTOM HOLE ASSEMBLY WITH ULKP AND RUN INTO THE HOLE



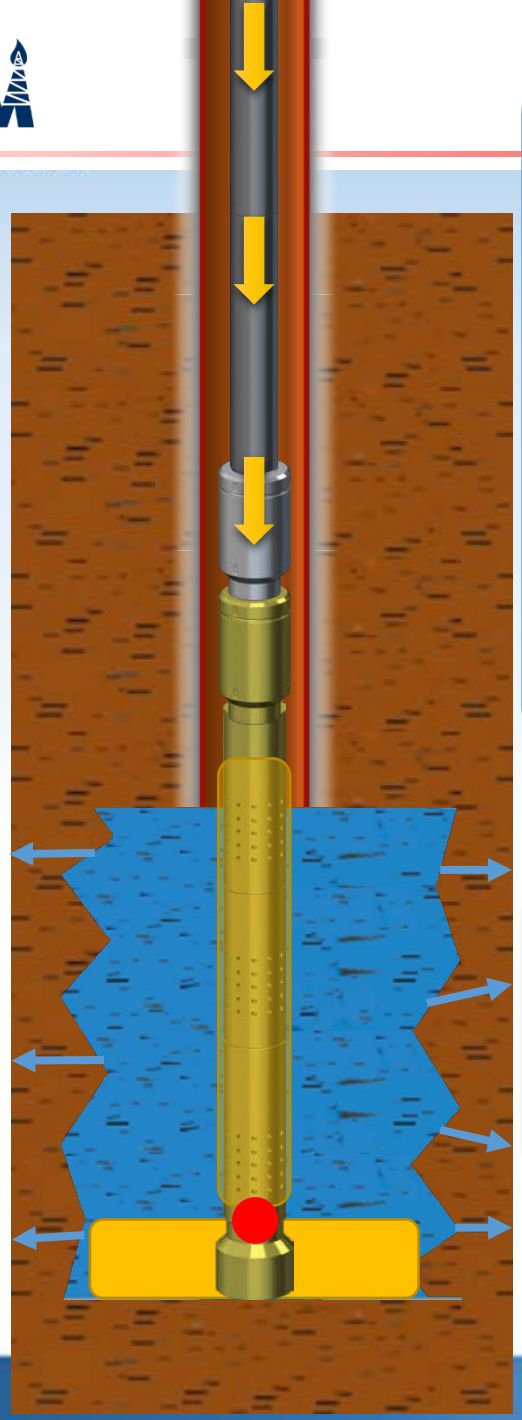


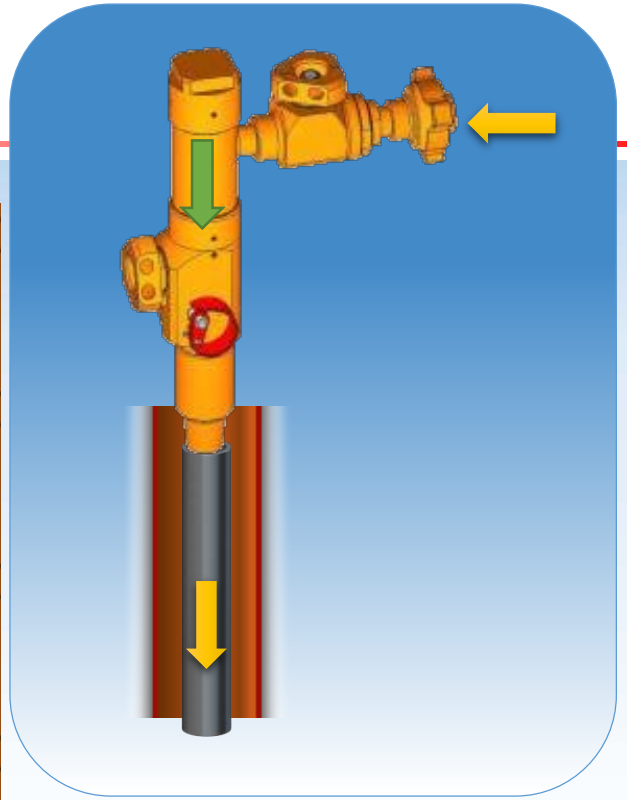
7. CONECTION PUMP WITH CEMENT CASING HEAD



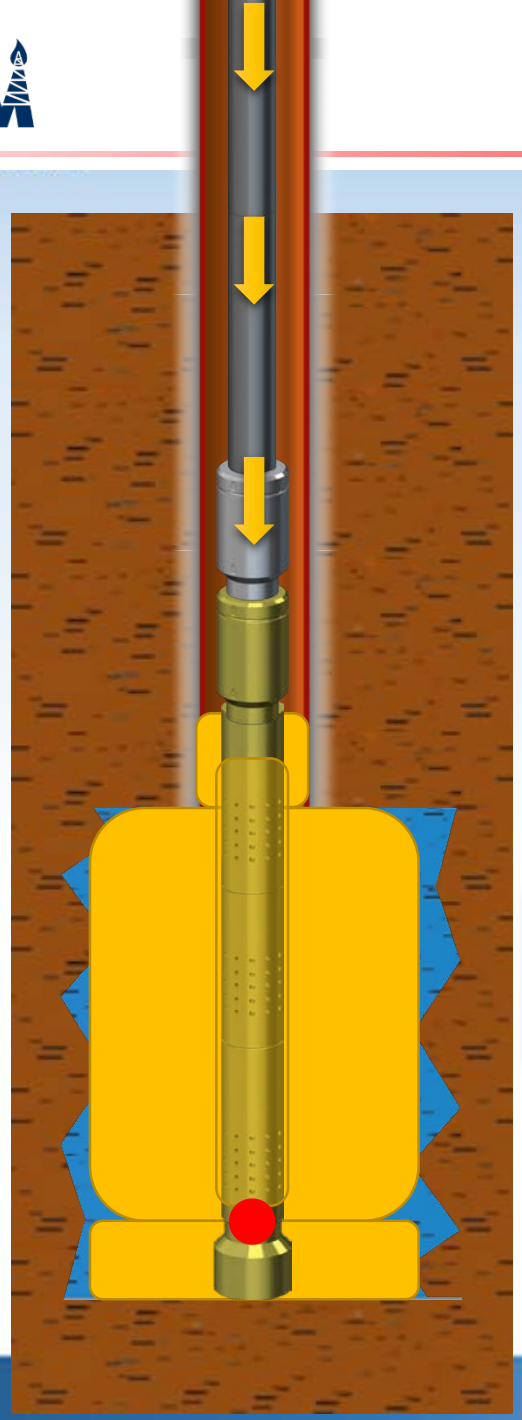


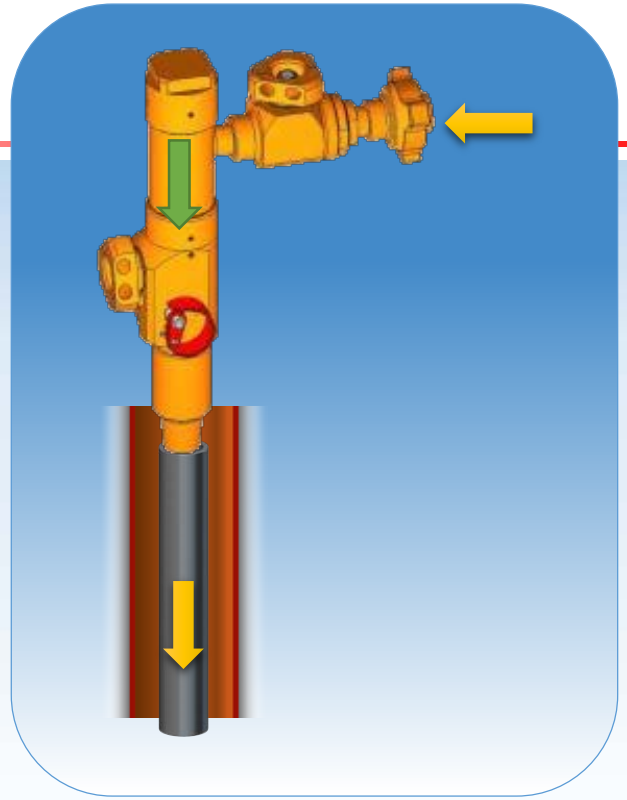
8. PUMPING CEMENT (OR ANOTHER COMPOSITION)



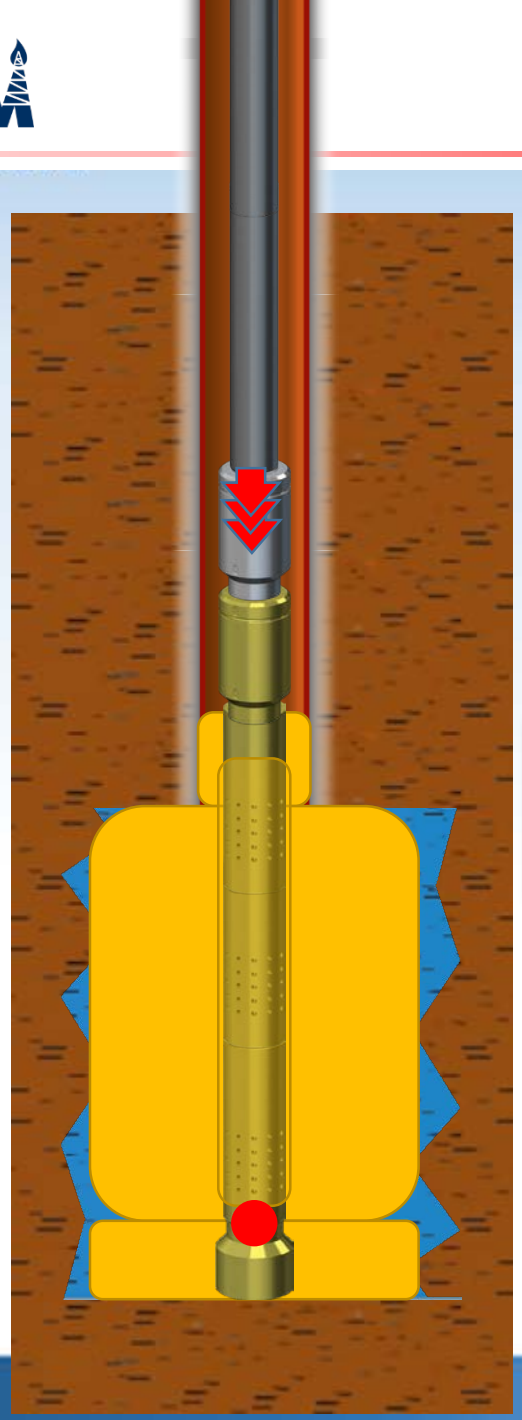


9.DROPPING BY-PASS PLUG, CONTINUED PUMPING CALCULATION VOLUME

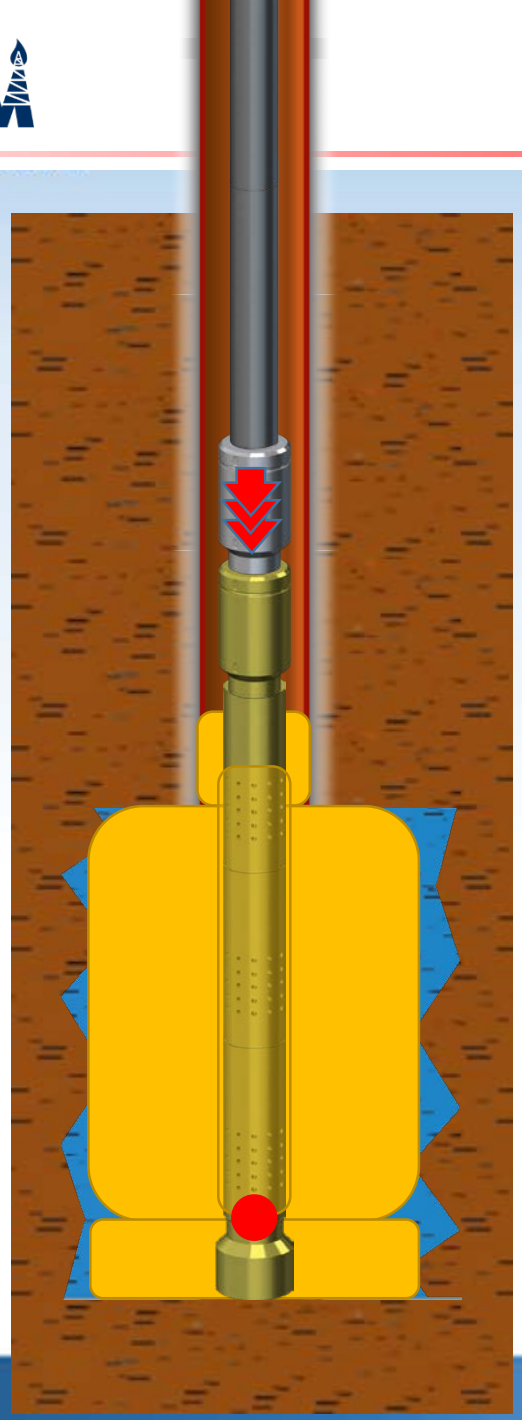




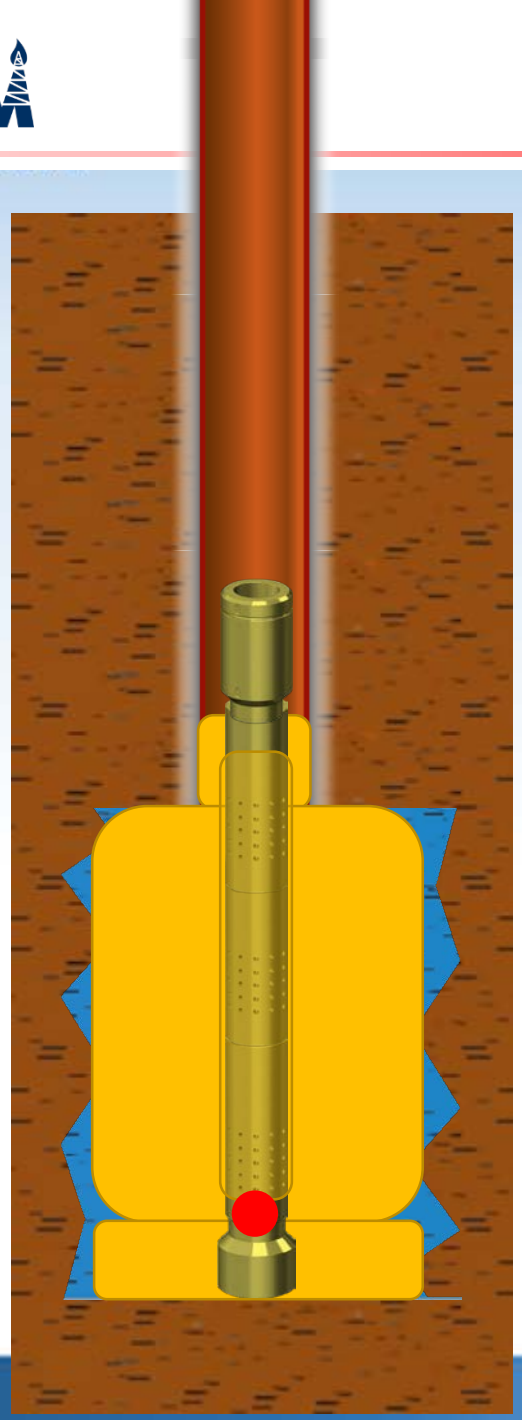
10. OPENING AND FILLING JACKET BY CEMENT



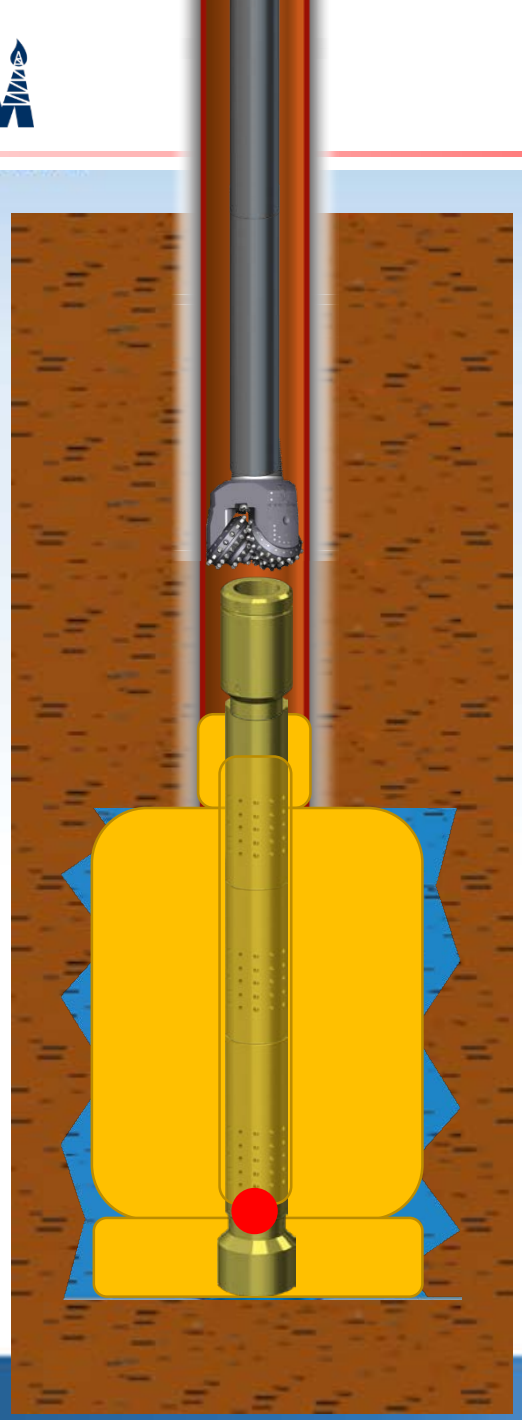
11. CREATING THE NECESSARY PRESSURE AND DISCONNECTION



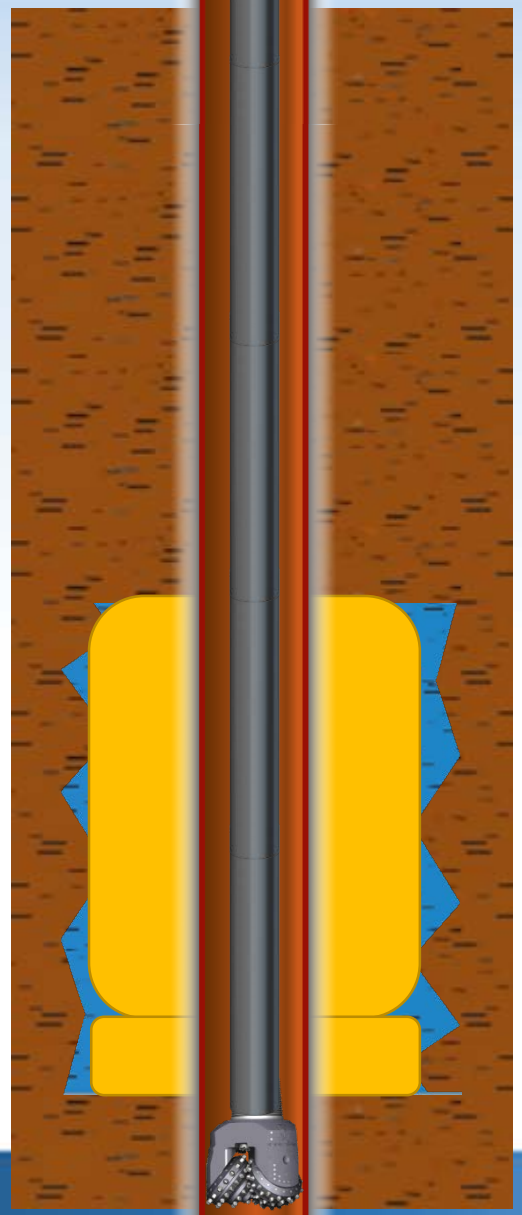
12. POOL OUT OFF THE HOLE BOTTOM HOLE ASSEMBLY



13. RUN IN THE HOLE
ROCKCUTTING TOOL



14. DRILLING OUT OF CEMENT PLUG



DRILLING CONTINUED

Ultracement micronized cement

Ultracement characterictics

TU 2458-064-97457491-2012

Ultracement is a particularly fine mineral binder with guaranteed smooth change in the particle size distribution. It has high strength, low fluid loss, shrink resistance and high sedimentation stability.

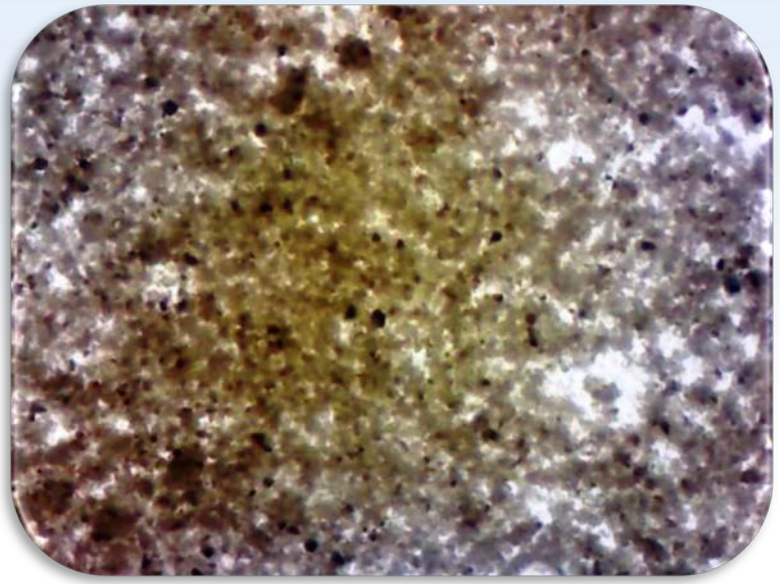
Ultracement is a powder and made by grinding and classifying cement PCTI-G-CC-1 GOST 1581-96 or portland cement PC-500DO GOST 10178-85 with sulphate resistant additives, so it is a hydraulic mineral binder.

Ultratcement slurry has fluidity comparable to fluidity of water even at the minimum Water/Cement ratio, and the penetrating ability of the slurry is comparable with dispersion-free binders (Ultracement can be considered as an alternative to liquid glass and polymer compositions, epoxy, urea, phenol-formaldehyde and others.) This feature is used to create water shutoff screens in squeeze jobs.

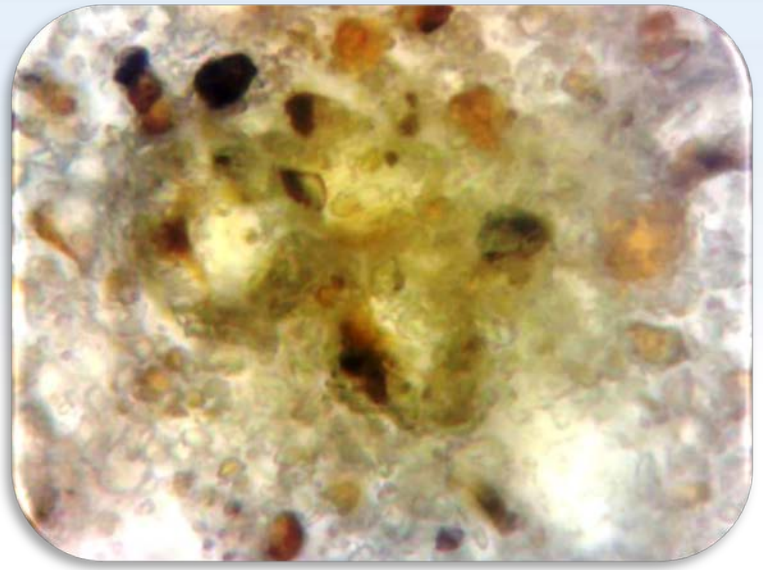
Ultratsement is inert and does not oxidize under normal conditions, does not polymerize, does not decompose. It does not soluble in water; Low hazard substance, non-toxic, fire-flame-proof substance, fibrogenic action. In accordance with GOST 12.1.005-88 and GOST 12.1.007-88 belongs to the 4th class of hazard.

Ultracement under microscope

Ultracement-10



Cement M-500



A visual comparison of the compared cements with a magnification of 160 times

Range of application

The main advantage of the slurries based on Ultracement is high penetrability into the pores and crack which have size less than 20 microns. This advantage is used in restoring the integrity of the casing stone, including the annular pressure elimination.

Ultratcement is recommended for casing leak repears and squeeze jobs in producing wells to create an effective water shutoff screen.

Ultratcement additive in cement slurry can improve strength, adhesion, etc. and other technological properties of the cement stone, among others exclude contraction.

Ultracement additive allows to restore technological properties of the well cement out of date.

Physico-chemical properties of cement slurries based on Ultracement-10

№	Characteristic	Unit of measurment	W/C ratio			
			0,5*	0,6*	0,8*	1,0
1.	Density	kg/m^3	1820	1725	1573	1529
2.	Spreadobility, not less	mm	250-260	260-270	270-280	280
3.	Thickening time, at a temperature of 20 ˚C	min	240-250	300-310	330-360	400-450
4.	Slurry water loss, not above	ml	0	0	0	0,1
5.	Cement strength at a temperature 4 ˚C in 24 hours not less transverse strength compression strength	MPa	 6,9 23,7	 5,3 15,2	 4,2 12,5	 3,64 10,4

Ultracement benefits

- High penetrating ability
- High cement strength (compression strength up to 50 MPa)
- Adjustable setting time and fast strength generation (up to 70% in 48 hours)
- High sedimentation stability
- High adhesion to rock and metal
- A wide range of application
- The price is significantly lower than similar analogs - RHEOCEM (UK) and MICRODUR (Germany)

Cement composition Polycem MC

Cement composition Polycem MC is a magnesia binding material. The main advantage of the magnesium compounds to the standard cements is the ability to place the mission-critical cement bridges and carrying out squeeze jobs in water-bearing horizons or in excessive mineralization of the drilling fluid filling the wellbore. When forming the cement stone, there is a significant linear expansion of up to 5%. Also, this material can be recommended for the lost circulation control with incompatible drilling conditions at intervals as the clastic and carbonate sediments, including cavernous-fractured sections.

The composition consists of a mixture of components and mix with technical water with input retarder thickening and setting time. The thickening time and setting time of the composition can be adjusted in a wide range from 15 minutes to 5 hours (if necessary).

Physico-chemical properties of cement slurries based on Polycem MC

№	Characteristic	Unit of measurment	Normal range by TU	Measured value
1.	Water solid ratio, in the range		0,5-0,7	0,6
2.	Slurry density, in the range	kg/m^3	1700-1750	1740
3.	Spreadobility, not less	Mm	180	205
4.	Slurry water loss, not above	ml	0	0
5.	Thickening time, not less	min	90	95
6.	Cement strength at a temperature 4 ˚C in 24 hours not less transverse strength compression strength	MPa	 5,0 3,0	 7,3 5,1
7.	Linear expansion coefficient	%	0,5-5,0	1,5

Note: To start the reaction of thickening and setting, activator is added into the solution (at least 15 wt. % of dry substance). The additional property of the cement stone is acid solubility (Solution HCl 10-15%).

The technology of preparation and injection into the well cement composition based on Polycem MC

- 1. For preparation and injection into the well cement composition based on Polycem MC used the following equipment and materials:
- Cement mixing unit (type SMH-20) – 1 unit, Pump unit (type CA-320) – 1 unit, mud hopper – 1 unit.;

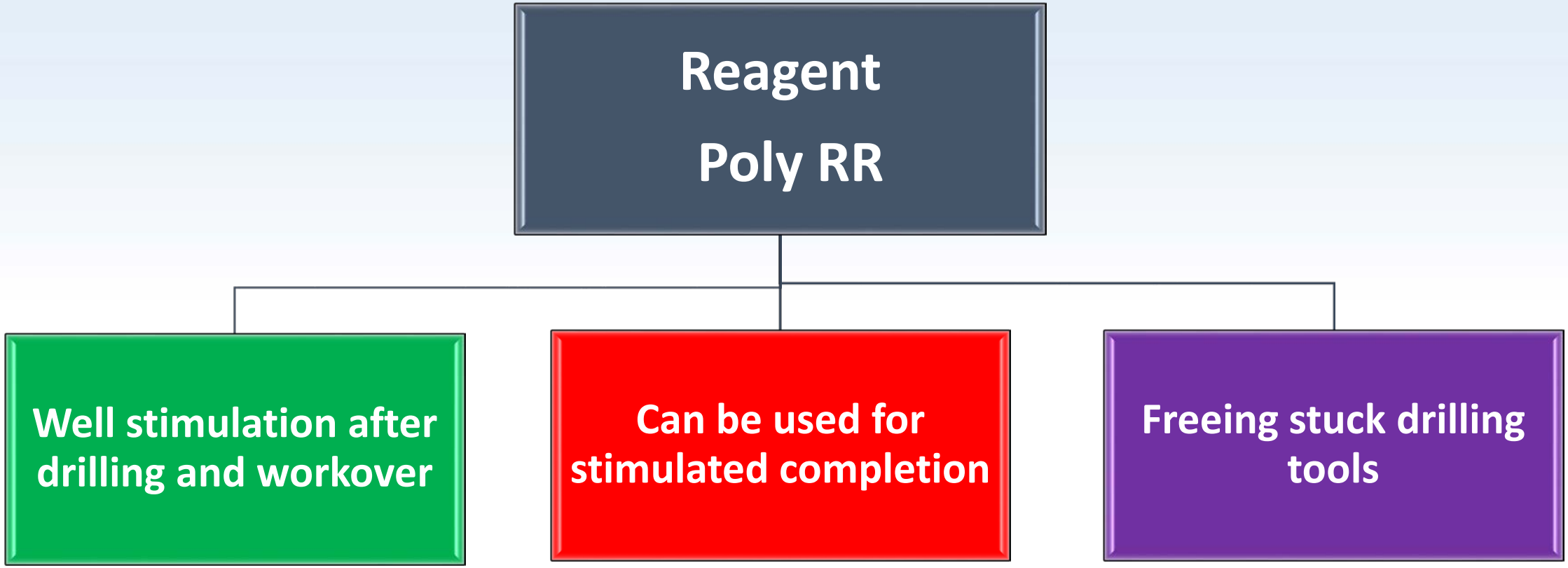
- The preparation of 1 m^3 cement slurry be successively mixing the components: technical water – 460 l, moderator NTF – 8,4 kg, Polycem MC – 927,6 kg, activator– 344 kg (injected into the solution prior to pumping into the well for 20-30 min).

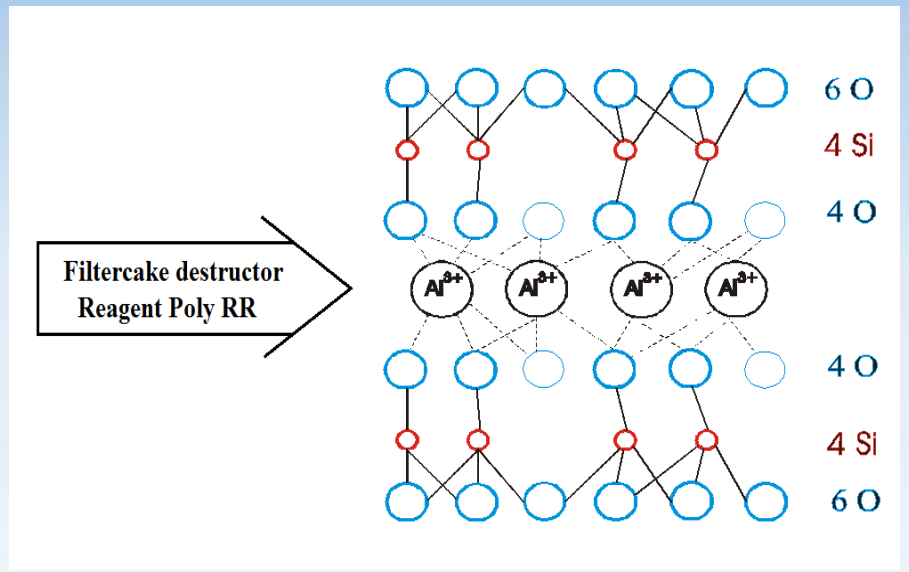
2. Sampled solution to determine the process parameters, thickening time and setting time prior to pumping cement slurry into the well.

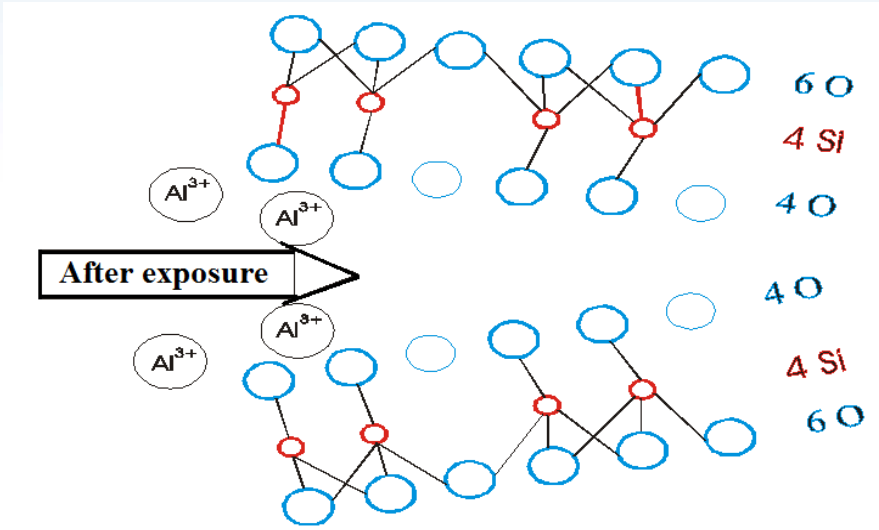
3. Pumping cement slurry based on Polycem MC police carried out the standard way, as well as cement slurries using the pump unit (such as CA-320). Squeeze volume and flush volume are calculated based on the actual depth and the conditions of drilling problems.

Solutions for freeing stuck drilling tools and well stimulation

TU 2458-041-97457491-2010

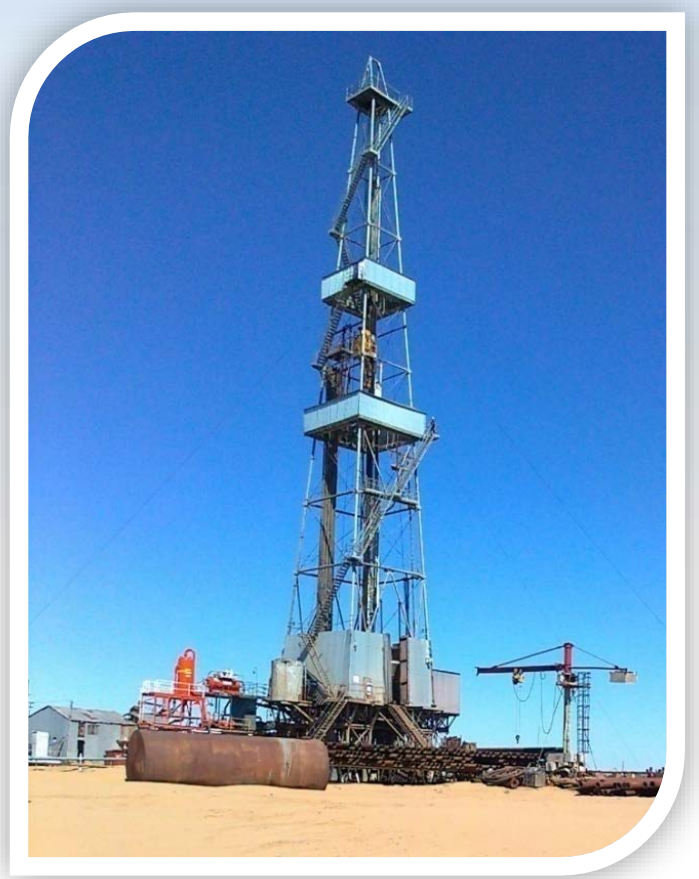



Filtercake destructor
Reagent Poly RR
6 O
4 Si
4 O
4 O
4 Si
6 O


After exposure
6 O
4 Si
4 O
4 O
4 Si
6 O

The results of freeing stuck drilling tools using reagent Poly RR

Well №	Field	Sticking interval, m	Injected volume, $м^3$	Effect
208	Yamburgskoe	3250-3508	2,5	The tool is released after 2.5 h
109	Yamburgskoe	2849-3080	2,5	The tool is released after 30 min
10	Vostochno-Pribregnoe	1185-2050	7,0	The tool is released after 6 h



Thank you for your attention!

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