LOST CIRCULATION STRATEGY
MATERIAL & TREATMENT
**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 (H₂S)**
- 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
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
- Steady-state test
  - Method of steady-state injections
  - Pressure transient test
  - During drilling by recording the amount of injected and effluent liquid
- Nonsteady test
  - The monitoring of the level decrease
  - The monitoring of the level increase

Core and formation cutting sampling

Geophysical study
- Thermoelectric logging
- Resistivity logging
- Caliper logging
- Hole wall photography
- Bottomhole and hole wall telephotography
- Standard logging
  - Acoustic well logging
  - Radiation logging
  - Flow survey
  - 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

## SEVERE LOSSES
- Static >10.0 m³/h
- Dynamic 60-95%

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump water-swellable polymer suspension</td>
<td></td>
</tr>
<tr>
<td>Pump Bentonite paste or Diesel-Bentonite suspension</td>
<td></td>
</tr>
<tr>
<td>Pump two component composition POLY TGP</td>
<td></td>
</tr>
<tr>
<td>Combination of cement or gypsum plug</td>
<td></td>
</tr>
<tr>
<td>Pump high-speed hardening polyurethane composition</td>
<td></td>
</tr>
</tbody>
</table>

## TOTAL LOSSES
- Dynamic 95-100%

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump water-swellable polymer suspension with cement or gypsum plug</td>
<td></td>
</tr>
<tr>
<td>Pump high-speed hardening polyurethane composition</td>
<td></td>
</tr>
<tr>
<td>Pump two component composition POLY TGP with cement or gypsum plug</td>
<td></td>
</tr>
<tr>
<td>RIH patch liner ULKP-1MAH</td>
<td></td>
</tr>
<tr>
<td>Use water as drilling fluid &amp; pump high-vis pills with LCM</td>
<td></td>
</tr>
<tr>
<td>Run casing &amp; cementing</td>
<td></td>
</tr>
</tbody>
</table>
LOST CIRCULATION MATERIAL

- LCM
  - MR - CaCO3 (fine, medium, coarse)
  - KF, FV и KFC
  - POLYPLUG
  - POLUFIBR
  - Rubber, Sawdust, etc.

- High filtration compositions
  - POLYFILTROL
  - CaCO3 suspension

- High-Vis suspensions
  - Polymer-Bentonite with LCM
  - Bentonite paste

- Polymer compositions
  - POLYKSPAN
  - POLYBLOCK
  - POLYTAN
  - PLASTIZOL
  - POLYGEL

- Backfill compositions
  - POLY TGP
  - ULTRACEMEN
  - POLYCEM GIPS
  - Cement suspensions with LCM

- Patch Liner
  - ULKP-1MAH
  - ULKP-B

NATIONAL DRILLING SERVICE
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
- Barite
- Rice hulls
- Cordage fiber
- Sawdust
- POLYPLUG

- 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/m³. Pump into the well using mud or technical water in an estimated amount.
Filler-colmatant POLYPLUG-B 30 for high intensity lost-circulation control
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
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

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)
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
<table>
<thead>
<tr>
<th>№ well, field</th>
<th>Losses interval, m</th>
<th>Losses rate, m³/h</th>
<th>Type of losses</th>
<th>Pill Volume, m³</th>
<th>Quantity pills</th>
<th>Waiting time</th>
<th>Material take-off, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3 Imbinskoe</td>
<td>2400-2404</td>
<td>&gt; 80</td>
<td>Total + Gas kick</td>
<td>5,0</td>
<td>1</td>
<td>3</td>
<td>Polyekspan - 960</td>
</tr>
<tr>
<td>#I-18-11 Dulisminsko</td>
<td>89-98</td>
<td>60</td>
<td>Total</td>
<td>2,0</td>
<td>1</td>
<td>3</td>
<td>NaCl-120 KF – 80 Polyekspan – 200 kg</td>
</tr>
<tr>
<td>#I-18-07 Dulisminsko</td>
<td>95-120</td>
<td>50</td>
<td>Total</td>
<td>2,5</td>
<td>1</td>
<td>4</td>
<td>NaCl-150 KF – 100 Polyekspan – 200</td>
</tr>
<tr>
<td>#321-74 Chayandinsko</td>
<td>410-425</td>
<td>&gt; 30</td>
<td>Severe</td>
<td>4,0</td>
<td>2</td>
<td>6</td>
<td>NaCl-2250 Polyekspan – 875</td>
</tr>
<tr>
<td>#ПО-98 Yamsoveysko</td>
<td>86-110</td>
<td>&gt;20</td>
<td>Severe</td>
<td>4,0</td>
<td>1</td>
<td>6</td>
<td>NaCl-1000 Polyekspan – 550</td>
</tr>
<tr>
<td>#321-72 Chayandinsko</td>
<td>440-462</td>
<td>25</td>
<td>Severe</td>
<td>4,0</td>
<td>2</td>
<td>6</td>
<td>NaCl-1000 Polyekspan – 500</td>
</tr>
</tbody>
</table>
Dry blend POLY TGP

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.
### Geological and technical conditions in wells while performing the works

<table>
<thead>
<tr>
<th>Geological and technical conditions in wells while performing the works</th>
<th>Well № 9044 Orenburgskoe oil and gas-condensate field</th>
<th>Well № 3 Tsaricanskoe oilfield</th>
<th>Well № 12081 Orenburgskoe oil and gas-condensate field</th>
<th>Well № 998 Kuleshovskoe oil and gas field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current depth, m</td>
<td>550</td>
<td>3310</td>
<td>1491/1922</td>
<td>2508</td>
</tr>
<tr>
<td>Absorption interval, m</td>
<td>541-543</td>
<td>3168-3180</td>
<td>1992</td>
<td>2450-2497</td>
</tr>
<tr>
<td>Static fluid level, m</td>
<td>Not determined</td>
<td>324</td>
<td>350</td>
<td>Gas, oil and water show</td>
</tr>
<tr>
<td>Absorbtion intensity, m³/h</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>The injected volume of PolyTGP, m³</td>
<td>16,0+1,5</td>
<td>30,0+4,8</td>
<td>32,0+5,0</td>
<td>30,0+5,0</td>
</tr>
<tr>
<td>The injected volume of cement plug, m³</td>
<td>2,7+1,5+3,0</td>
<td>6,4</td>
<td>Not placed</td>
<td>8,0</td>
</tr>
<tr>
<td>Circulation after drilling out, %</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Operating result</td>
<td>No absorption</td>
<td>No absorption</td>
<td>No absorption</td>
<td>No absorption</td>
</tr>
</tbody>
</table>
### Cementing slurry Polycem GIPS (gypsum)

**TU 2458-055-97457491-2012**

<table>
<thead>
<tr>
<th>№</th>
<th>Characteristic</th>
<th>Unit of measurement</th>
<th>W/C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Slurry density</td>
<td>kg/m³</td>
<td>0,45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0,50</td>
</tr>
<tr>
<td>2.</td>
<td>Spreadability, not less</td>
<td>mm</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>210</td>
</tr>
<tr>
<td>3.</td>
<td>Thickening time, at a temperature of 4 °C</td>
<td>min</td>
<td>130-140</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>155-160</td>
</tr>
<tr>
<td>4.</td>
<td>Slurry water loss, not above</td>
<td>ml</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>Cement strength at a temperature 4 °C in 24 hours not less transverse strength compression strength</td>
<td>MPa</td>
<td>4,9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4,7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14,2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9,6</td>
</tr>
</tbody>
</table>
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 ASSEMBLY
5. BEFORE RUN IN THE HOLE ULKP MAKE A LOG ANALYS FOR DETERMINING CAVING INTERVAL
6. ASSEMBLING 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 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.

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

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

Ultracement 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.
<table>
<thead>
<tr>
<th>№</th>
<th>Characteristic</th>
<th>Unit of measurement</th>
<th>W/C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0,5*</td>
</tr>
<tr>
<td>1.</td>
<td>Density</td>
<td>kg/m³</td>
<td>1820</td>
</tr>
<tr>
<td>2.</td>
<td>Spreadobility, not less</td>
<td>mm</td>
<td>250-260</td>
</tr>
<tr>
<td>3.</td>
<td>Thickening time, at a temperature of 20 °C</td>
<td>min</td>
<td>240-250</td>
</tr>
<tr>
<td>4.</td>
<td>Slurry water loss, not above</td>
<td>ml</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>Cement strength at a temperature 4 °C in 24 hours not less</td>
<td>MPa</td>
<td>6,9</td>
</tr>
<tr>
<td></td>
<td>transverse strength compression strength</td>
<td></td>
<td>23,7</td>
</tr>
</tbody>
</table>
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 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

<table>
<thead>
<tr>
<th>№</th>
<th>Characteristic</th>
<th>Unit of measurement</th>
<th>Normal range by TU</th>
<th>Measured value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Water solid ratio, in the range</td>
<td></td>
<td>0,5-0,7</td>
<td>0,6</td>
</tr>
<tr>
<td>2.</td>
<td>Slurry density, in the range</td>
<td>kg/m³</td>
<td>1700-1750</td>
<td>1740</td>
</tr>
<tr>
<td>3.</td>
<td>Spreadability, not less</td>
<td>Mm</td>
<td>180</td>
<td>205</td>
</tr>
<tr>
<td>4.</td>
<td>Slurry water loss, not above</td>
<td>ml</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>Thickening time, not less</td>
<td>min</td>
<td>90</td>
<td>95</td>
</tr>
<tr>
<td>6.</td>
<td>Cement strength at a temperature 4 °C in 24 hours not less</td>
<td>MPa</td>
<td>5,0 3,0</td>
<td>7,3 5,1</td>
</tr>
<tr>
<td></td>
<td>transverse strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>compression strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Linear expansion coefficient</td>
<td>%</td>
<td>0,5-5,0</td>
<td>1,5</td>
</tr>
</tbody>
</table>

*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%).*
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 m³ 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

Reagent Poly RR

Well stimulation after drilling and workover

Can be used for stimulated completion

Freeing stuck drilling tools

TU 2458-041-97457491-2010
The results of freeing stuck drilling tools using reagent Poly RR

<table>
<thead>
<tr>
<th>Well №</th>
<th>Field</th>
<th>Sticking interval, m</th>
<th>Injected volume, m³</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>208</td>
<td>Yamburgskoe</td>
<td>3250-3508</td>
<td>2,5</td>
<td>The tool is released after 2.5 h</td>
</tr>
<tr>
<td>109</td>
<td>Yamburgskoe</td>
<td>2849-3080</td>
<td>2,5</td>
<td>The tool is released after 30 min</td>
</tr>
<tr>
<td>10</td>
<td>Vostochno-Pribregnoe</td>
<td>1185-2050</td>
<td>7,0</td>
<td>The tool is released after 6 h</td>
</tr>
</tbody>
</table>
Thank you for your attention!

140180, Russia, Zhukovsky, Moscow region, street Gastello, 1A
140180, Россия, г. Жуковский, Московской обл., ул. Гастелло, д. 1А,
Tel.: (495) 505-51-25, fax: (495) 556-80-49, e-mail: npk@scsbm.ru