



**Neftegaztekhnologiya**

## **Blood Vessels technology: innovation project for radial formation penetration**

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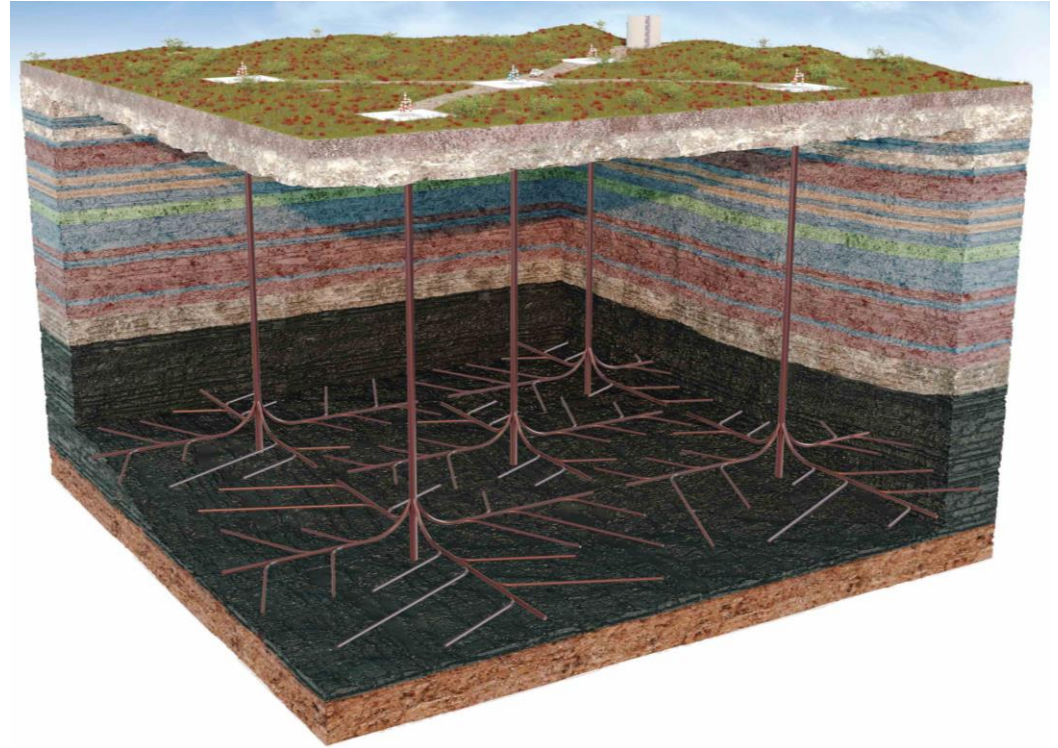


# Blood Vessels (BV) technology of formation penetration

This is technology for enhanced oil recovery and well flow stimulation:

- increases coverage and area of well drainage
- removes skin-factor
- improves conductivity of formation matrix
- maintains initial reservoir permeability

The product of BV technology is water jet creation of multiple long radial TAML2 filtration channels in producing formation with a possibility of their branching by three times in unlimited number of levels of their creation.



Creating network of channels, controlled by power and distribution. BV technology provides for maximum achievable coverage and decrease of formation anisotropy, involvement in development of hydrocarbons reserves which previously could not be recovered.



# Blood Vessels technology characteristics

## Parameters:

- channel diameter – 60-80 mm;
- channel length – up to 300-500m;
- exiting from casing string into formation with 1.5" coiled tubing;
- radius of formation penetration – 7-9 m;
- fluid rate – up to 500 l/min.;
- orientation of channel direction in space;
- geonavigation and control over trajectory and wellbore;
- number of side-tracks at one level – 2-4;
- number of levels is not limited;
- opportunity to perform full cycle of works with underbalance;
- environmentally friendly technology.

Blood Vessels technology is a new tool and complementary service for such technologies as hydraulic fracturing, side-tracking, drilling of horizontal wellbores or multi-lateral wells.



# Experience in implementation of RDS technology in Russia – prototype of Blood Vessels technology

Technology of laterals radial drilling was born in USA and Canada over 30 years ago. In Russia the first jobs associated with water jet creation of radial channels were performed by RDS Company since the beginning of 2000s in the fields of Tatneft, Lukoil, Rosneft, TNK-BP, Gazprom, etc.

LLC Neftegaztekhlogiya jointly with RDS Company developed and performed jobs associated with drilling of radial channels for Gazprom in Bolshoi Urengoi fields in 2007 and 2008.

44 channels were drilled with maximum length of up to 100 m, including 3 radial tracks drilled with underbalance.

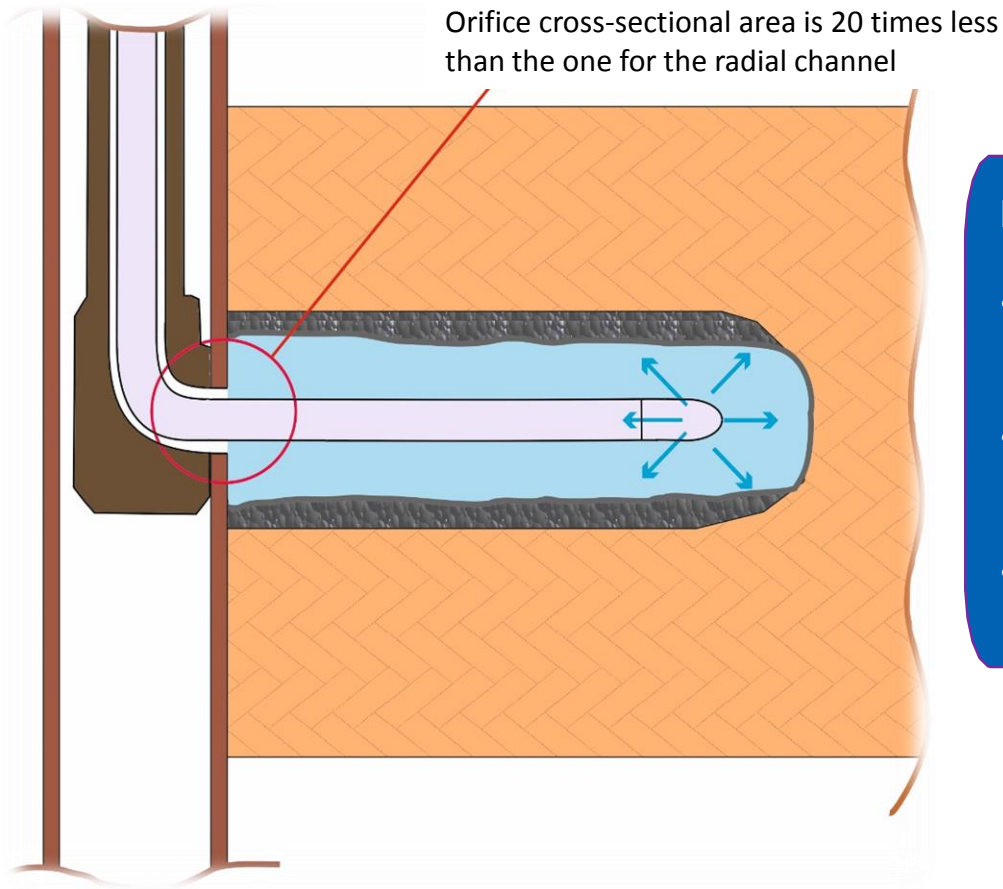


## RDS testing results

Absence of technical effect in terrigenous formations due to colmatation of radial channels walls and the channels filling up by decomposed rock.



# RDS technology deficiencies

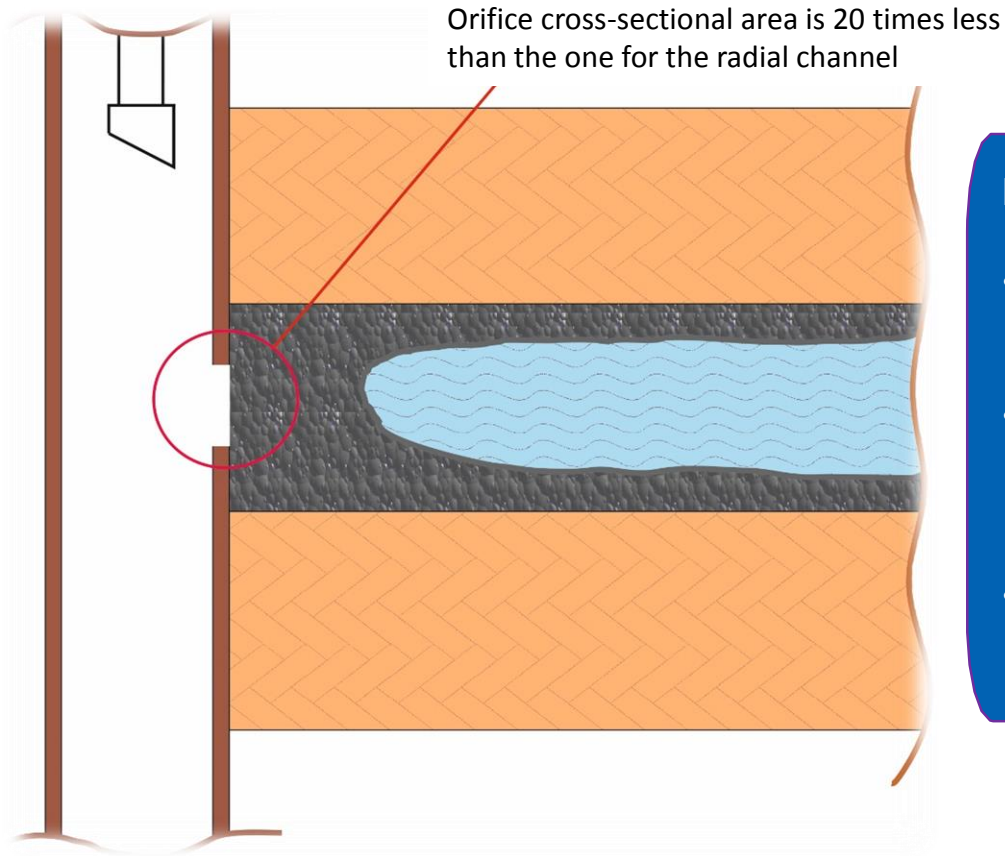


Major deficiencies of the previous technology are:

- Unpredictable geometry of radial channel due to lack of rigidity of bottomhole assembly
- Low fluid rate and absence of pock particles cleanup from the radial channel
- Choke effect for return fluid at the orifice in the casing



# RDS technology deficiencies

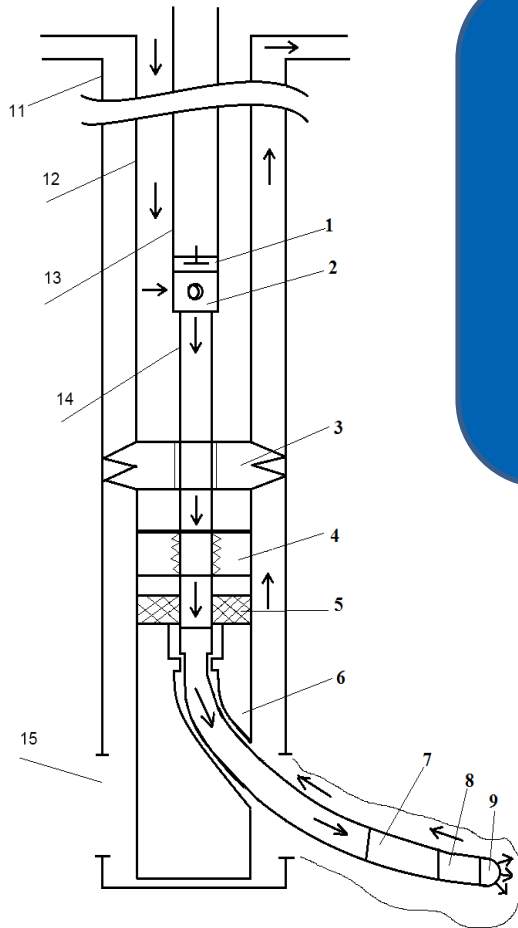


Major deficiencies of the previous technology are:

- Plugging of orifice in the casing by rock particles during the well kick-off
- Absence of possibility to perform radial channel navigation due to small diameter of bottomhole assembly
- No possibility to enhance the technology in terms of fluid rate and channels length increasing



# Technical solutions of BV technology



## Main components:

- |                              |  |
|------------------------------|--|
| 1 – check valves;            | 8 – wellbore trajectory control system;          |
| 2 – flow direction device;   | 9 – water jet nozzle;                            |
| 3 – anchor;                  | 11 – casing;                                     |
| 4 – rotation mechanism;      | 12 – high-strength tubing;                       |
| 5 – sealing device;          | 13 – transporting coiled tubing string;          |
| 6 – coiled tubing whipstock; | 14 – operating coiled tubing string;             |
| 7 – geonavigation system;    | 15 – longitudinal milled side windows in casing. |

1. Significant decrease of hydraulic pressure losses due to flow path through tubing/coiled tubing annulus on the most of the well length. This leads to ability of increasing fluid pump rate up to 700 l/min, including usage of nitrified liquid for underbalance operations with high pump rates as well.
2. Absence of choke effect for return fluid and during well kick-off – area of every milled window is 4 times higher, than cross-sectional area of radial channel.



# Equipment for implementation of BV technology

Well workover rig

Coiled tubing package

Nitrogen unit package

Tubing for high internal pressure

Drill pipes

Tubing for workover operations

Vacuum truck

Mobile water tank

Special BV equipment:

1. Package for casing windows milling
2. Coiled tubing whipstock
3. Rotation mechanism
4. Anchor device
5. Sealing device
6. Flow direction device
7. Water jet nozzles
8. Geonavigation system
9. Wellbore trajectory control system

Return tank with degasser

Fluid tanks

High-pressure pump unit

“CA-320” pump unit

Centrifugal supply pump

Coarse- and fine-mesh filters

Multi-purpose wellhead sealing device

Equipment providing for safety of personnel and protection of equipment.



# BV technology job sequence

## Well preparation

Normalization of well bottom  
Scraping of intervals for anchor setting  
Drift run  
Testing of production casing integrity  
Well logging: inflow profile (optional)  
Anchor and orientating device run in hole  
Well logging: depth correlation  
Milling of windows in production casing  
Running of 3.5" tubing with BV assembly  
Radial channels creation



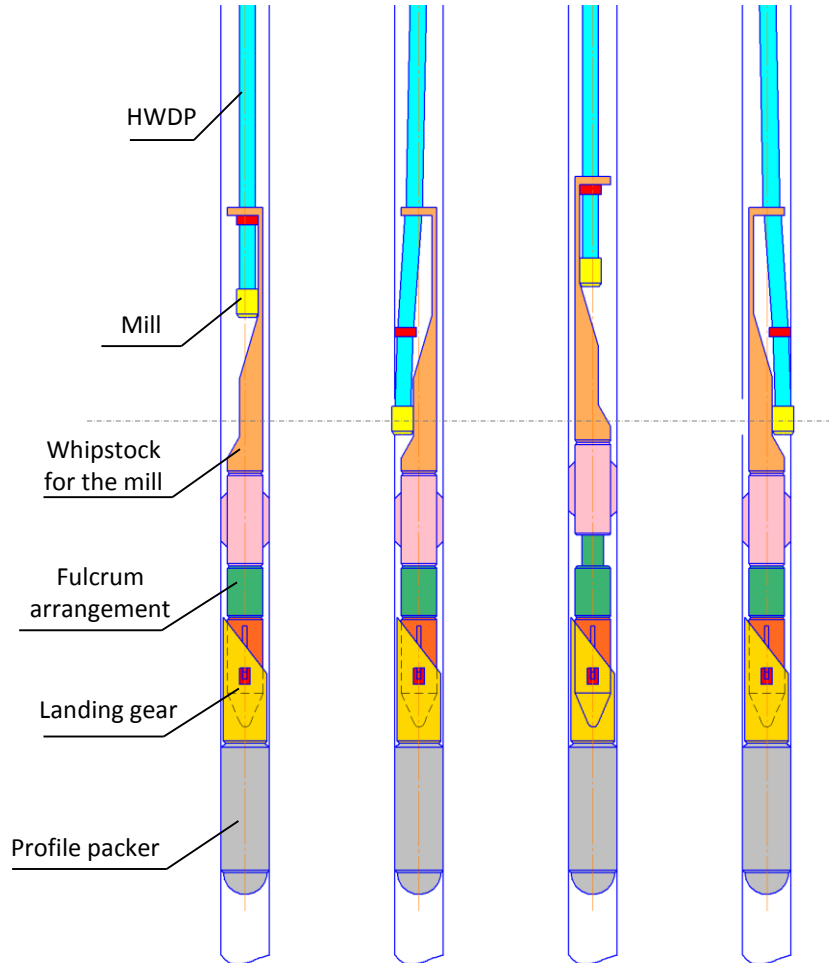
## Job execution

Run in hole 38.1mm coiled tubing with water jet nozzle, systems for control of wellbore trajectory and geonavigation and other elements of downhole assembly. Creation of high pressure jet in the nozzle provides for rock destruction, coiled tubing movement provides for creation of channel in the formation. Upon achievement of channel design length, the working tool is retrieved from the formation, whipstock is turned to the next window, and the process is repeated. For work at the second level it is required to perform mechanical action with tubing or coiled tubing in order to switch over to the next milled windows at 80 cm above. Creation of channels is repeated. For work with underbalance the technology is supplemented with injection of nitrified fluid with control of bottomhole pressure and additional downhole equipment in order to put the well into production without well killing.

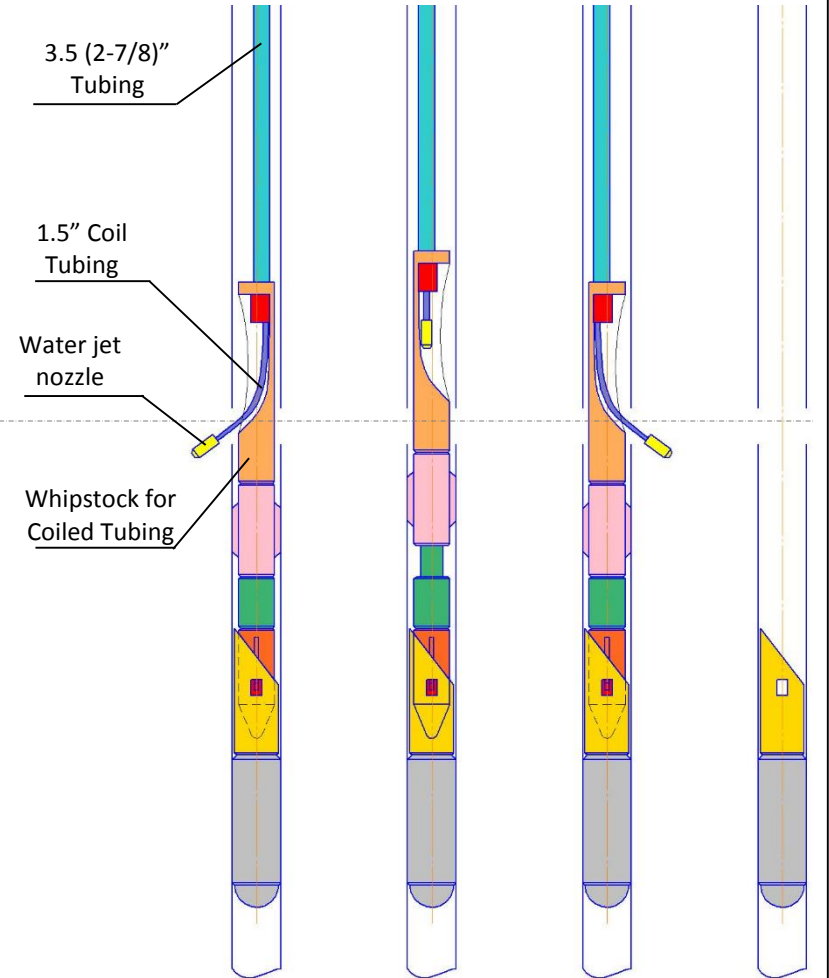


# BV lateral channels creation steps

## Milling process



## Radial channel creation



# General differences of BV technology from known technologies of radial formation penetration

## Differences and unique features

1. Creation of lateral tracks with use of geonavigation and system for control of wellbore trajectory
2. Length of lateral tracks increases up to 300 – 500m with an opportunity of branching by three times with length up to 100m
3. Capacity of BV technology is higher by 30 times
4. Assembly rigidity: working tool – coiled tubing
5. Opportunity to create lateral tracks at underbalance
6. Focused impact on the formation
7. Maximum coverage and increase of drainage area for hydrocarbons reserves.
8. Delicate formation penetration after remedial cementing
9. Big-volume, penetrating to hundreds of meters acid treatment of carbonate reservoirs.
10. Synergy due to combination of BV technology with formation hydraulic fracturing and drilling of horizontal wellbores or multi-lateral wells



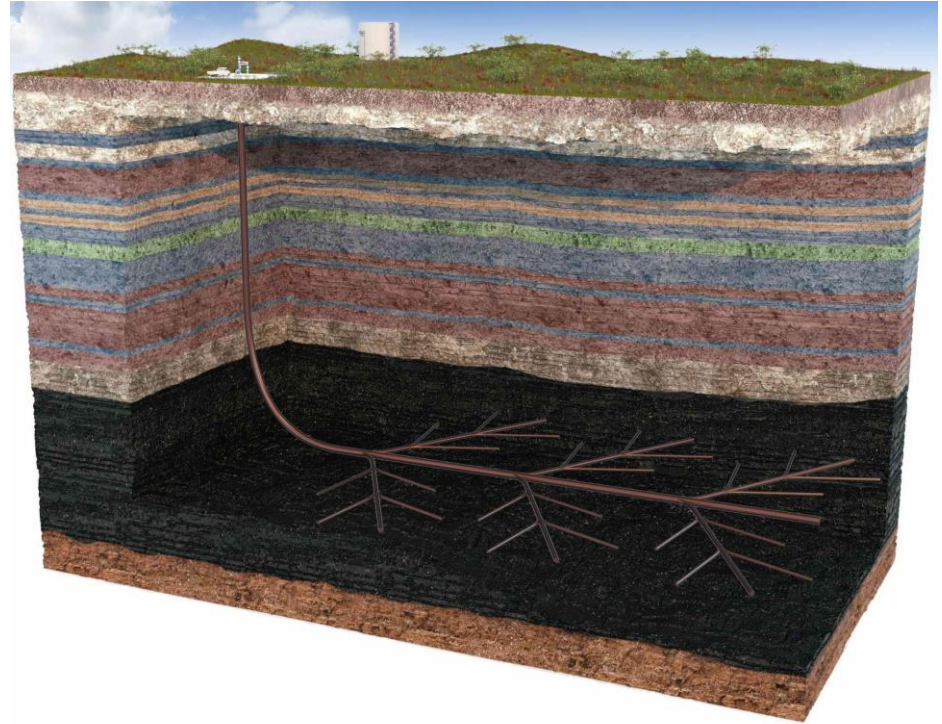
# Blood Vessels technology significance

Blood Vessels technology – a new tool and complementary service for such technologies as hydraulic fracturing, side-tracking, drilling of horizontal wellbores or multi-lateral wells for development:

- low-permeable reservoirs of hydrocarbons
- oil leg reservoirs
- bottom water-drive reservoirs
- multi-zone reservoirs
- wells after water shutoff treatment
- hydrocarbon reservoirs at offshore and

Arctic fields

- gas condensate reservoirs with abnormal low reservoir pressure, developed in depletion regime
- stand-by fund of wells without borehole section in productive formation



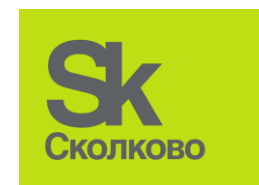
# Patents



Positive marks from experts are received from:



РГУ нефти и газа  
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# Windows milling 146 mm casing. Yard test results

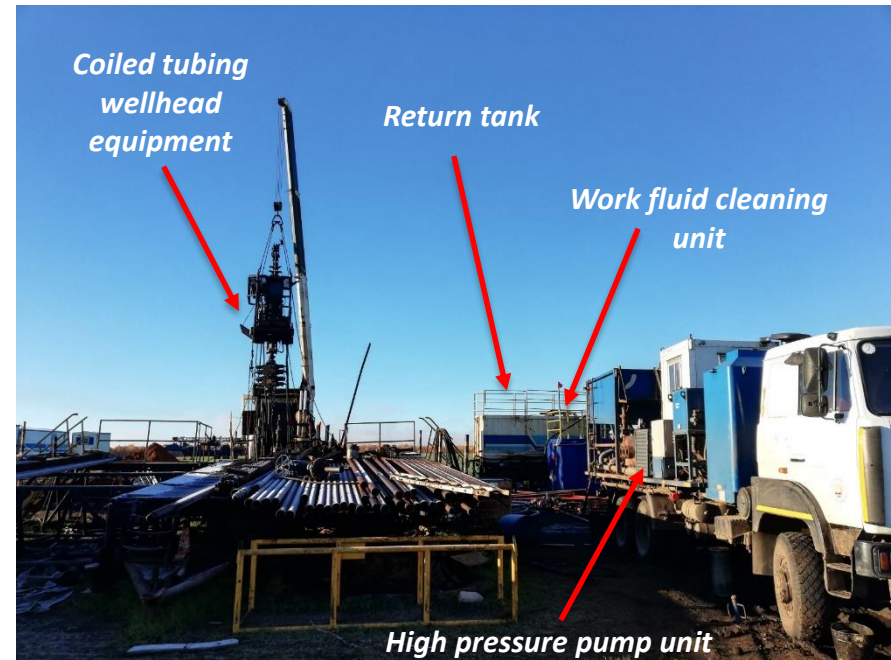


# Water jet nozzle yard tests results



# Blood Vessels results from test well

- Test BV job was performed 23.09.2018 – 16.10.2018 at Tatneft well
- 4 windows were milled in casing 146 x 7.7mm
- 3 lateral channels were drilled in the formation. The channels lengths are from 4.3m to 35m
- Successfully tested technics of running in hole BV assemblies on tubing and coiled tubing, rectangular windows milling regimes, hydraulic regimes for circulation and rock drilling, other technical solutions, performance capabilities and working life for BV equipment, including operating and measurements of autonomy downhole inclinometer





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# Thank you for attention!

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