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WELL KILL OPERATIONS

Well kill operations

The company's technologies include the whole package of works providing well killing of any well categories. The operations are performed by materials and technologies that have passed approbation during workover. Well killing operations are performed on the basis of the following parameters:

- Analysis of geological and technological conditions of the field;
- Killing fluids selection, process design;
- Treatment of water, necessary chemicals and materials;
- Preparation of the necessary equipment;
- Preparation and storage of killing fluids, displacement fluids, perforation fluids;
- Transportation and injection;
- Parameters control of well killing fluid and the well killing technology.

The company offers to use the following well killing technology:

- Well kill operations by salting liquid with density of 1,02-1,60 g/cm3: Na-well killing fluid, K-well killing fluid, Ca-well killing fluid.
- Well killing by invert emulsion mud with density 0,9-1.32 g / cm3.
- Formation damage minimizing well killing using blocking compositions on the basis of our own recipes.
- Well killing fluids based on hydrocarbon with density of 0,8-1,1 g/cm3

Blocking compositions based on silicon sodium salts.
Composition for well killing based on polyacrylamide.
The proposed composition for well killing at temperatures up to 212 F.

HEAVY WELL KILLING FLUIDS KREZOL GROUP

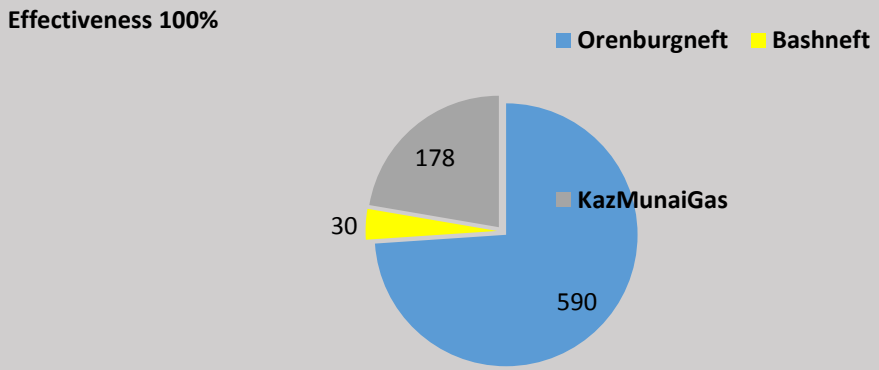
KREZOL Group produces a wide range of saturated liquids for non-destructive killing of injection and production well stock, aimed at reducing the negative impact of highly mineralized solutions on the reservoir, preservation of filtration-capacitive properties of bottomhole formation zone, restoration of permeability after the completion of the well workover, well servicing.

Types of killing fluids:

- **K-well killing fluid – up to 1,52 g/cm3 – potassium salts**
- **Ca-well killing fluid – up to 1,64 g/cm3 – calcium salts**
- **Na-well killing fluid – up to 1,25 g/cm3 – sodium salt**

All killing fluids-series products do not contain solid phase, are technological in preparation, non-toxic, compatible with the blocking compositions of UfaNIPIneft; KR-3G, KR-3E of Krezol Group production.

The results of well-killing procedures by KREZOL Group from 2010 to 2016



Application potential

Killing of injection and production oil and gas well stock with abnormally high formation pressure:

- K-well killing fluid - with clay reservoirs
- Ca-well killing fluid - with carbonized reservoirs
- Na-well killing fluid - with mixed-type reservoirs

Non-damaged well killing

K-1,5- and Ca-1,6- well killing fluids.
Saturation of well killing fluids.

Saturation of well killing fluids -
refinement of working solutions by additives, providing a number of useful fluid properties to reduce the negative impact on the reservoir rock and preservation of filtration-capacitive characteristics of bottomhole formation zone.
Working forms saturation of fluids is carried in steady-state conditions at the "Krezol Group" production facilities or directly at the well before well kill operation.

Saturating additives of "Krezol Group" manufacturing:

-Demulsifiers
-K-surfactants and Ca-surfactants
-Oil wetting agents (water repellents)
-Scale inhibitors
-Corrosion inhibitors
-Bactericides

«KREZOL GROUP» TECHNOLOGIES OF NON-DAMAGED WELL KILLING

Non-damaged killing of production and injection wells

Krezol group produces a wide range of blocking compositions for formation damage minimizing production and injection well killing operations, aimed at reducing the negative impact of highly mineralized solutions on the formation, preservation of filtration-capacitive properties of bottomhole formation zone, permeability restoration after the completion of the well workover.

The product range of blocking compositions includes:

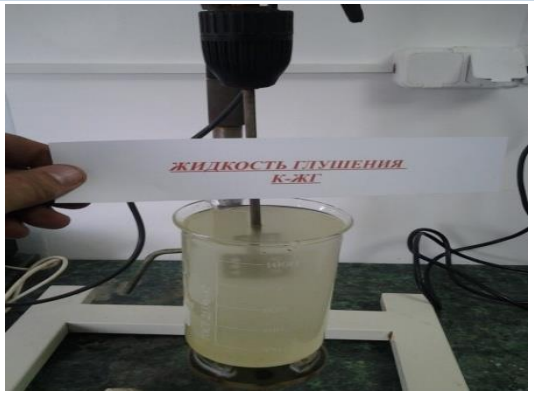
- Blocking composition - stabilized suspension of solid bypass particles
- KR-3G hydrophobic biopolymer gel
- KR-3E high viscosity emulsion based on Devonian oil
- KR-3E low-viscosity emulsions based on diesel fuel or hydrocarbon solvent

Offered blocking compositions special feature is a low toxicity, fire and explosion safety, easy preparation in the field, the ability to control a wide range of physical and chemical characteristics and working properties that allow to adapt the compositions to the specific downhole features.

We suggest to consider the detailed technical characteristics and properties of blocking compositions - KR-3G, KR-3E (Oil), KR-3E (Diesel).

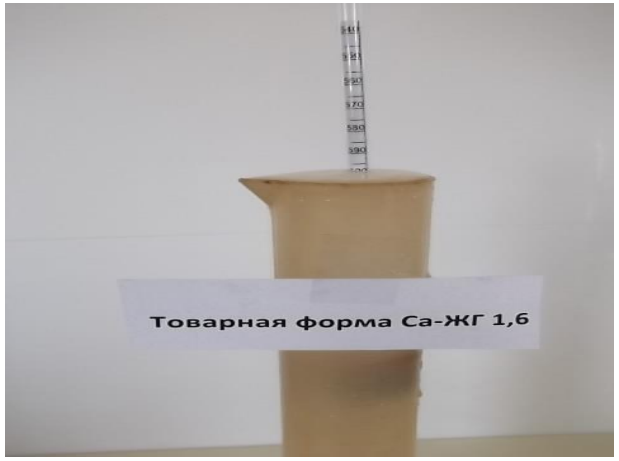
Non-damaged well killing

K-1,5 and Ca-1,6 well killing fluids
Preparation technologies of commodity and active (working) forms



1. The commodity form of K-1,52-well killing fluid
- The commodity form of K-well killing fluid is a mixture of potassium salts - flowing fine powder, packed in 50kg semitransparent bags.

2. The active form – yellowish fluid with the density of 1.5 g / cm3. The preparation is carried out in steady-state conditions at the "Krezol Group" production facilities. Shipping in bulk in railway tanks and boiler trucks.



1. The commodity form of Ca-1,64-well killing fluid
- The commodity form of Ca-well killing fluid is a mixture of calcium salts - flowing coarse-crystalline powder, packed in 50kg semitransparent bags.

2. The active form – slightly gelled yellowish liquid with the density of 1.564 / cm3.The preparation is carried out in steady-state conditions at the "Krezol Group" production facilities. Shipping in bulk in railway tanks and boiler trucks.

Non-damaged well killing

K-1,5- and Ca-1,6- well killing fluids
Saturation of well killing fluids

Saturation of well killing fluids -
refinement of working solutions by additives, providing a number of useful fluid properties to reduce the negative impact on the reservoir rock and preservation of filtration-capacitive characteristics of bottomhole formation zone.
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Saturating additives of "Krezol Group" manufacturing:

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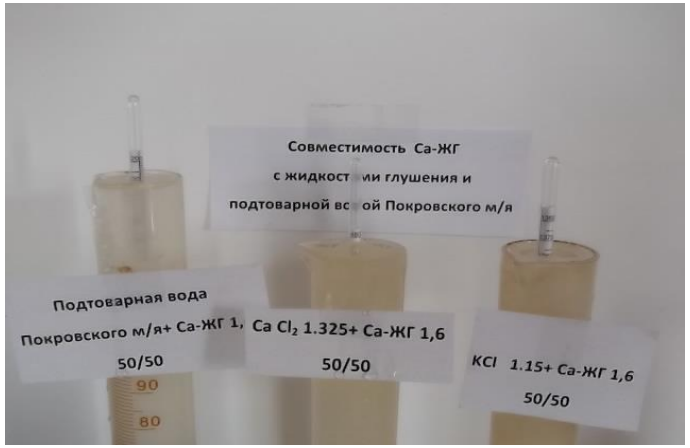
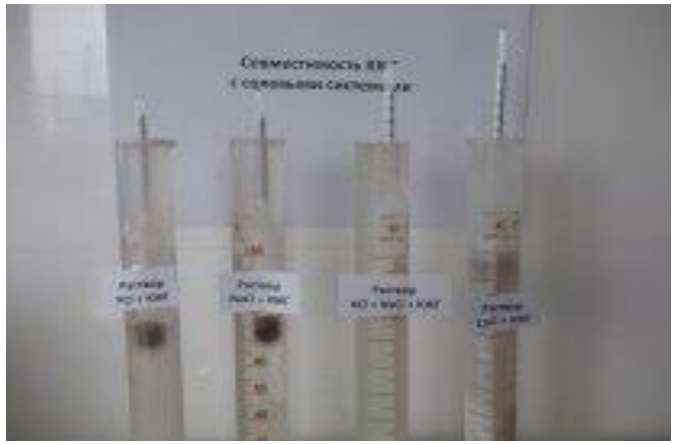
- Bactericides

Non-damaged well killing

Compatibility of K- and Ca-well killing fluids with synthetic brine





<u>K-well killing fluid - 1,5g/cm3:</u>

- Chloro- sodium water - compatible
- Chloro- potassium water - compatible
- Chloro- sodium-potassium water - compatible
- Chloro- sodium-calcium water - compatible in the presence of scale inhibitors
- Chloro- calcium- magnesium water - conditionally compatible
- Commercial calcium chloride 1,32g / cm3 - is not compatible

<u>Ca-well killing fluid-1,64g/cm3:</u>

- Chloro- sodium water - compatible
- Chloro- potassium water – compatible in the presence of scale inhibitors
- Chloro- sodium-potassium water - compatible in the presence of scale inhibitors
- Chloro- sodium-calcium water - compatible
- Chloro- calcium- magnesium water - compatible
- Commercial calcium chloride 1,32g / cm3 - compatible

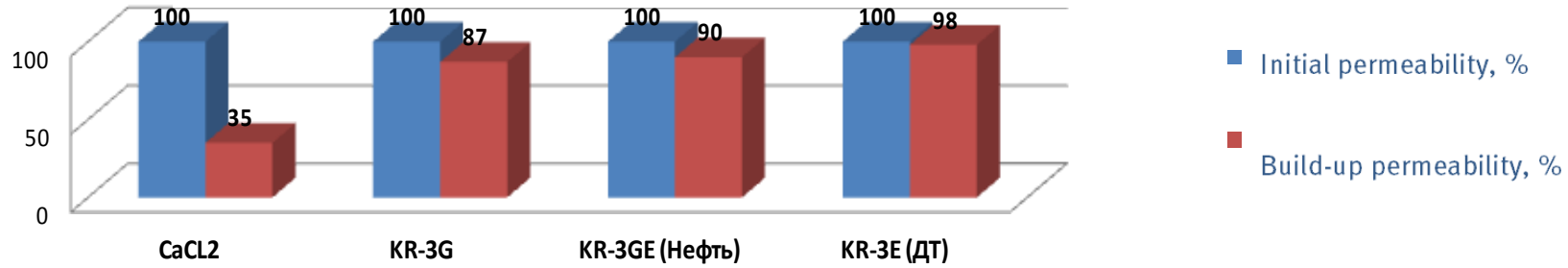
BLOCKING COMPOSITIONS

KR-3G and KR-3E blocking compositions.
Permeability restoring coefficient of bleeding core depending on the blocking composition type.

№	The composition of the active reagent – well killing fluid	Initial permeability as per oil, mD	The permeability after the active reagent influence – well killing fluid, mD	Permeability restoring coefficient, %
1	25% calcium chloride solution	17-18	7-8	35%
2	3% KR-3G	17-18	13-15	87%
3	3% KR-3E (Oil)	17-18	15-17	90%
4	3% KR-3E (Diesel)	17-18	16-18	98%

Permeability restoration of oil-wet core, %

Kern and oil of Bobrowskoe field, formation Б2, Republic of Bashkortostan



KREZOL GROUP TECHNOLOGIES OF NON-DAMAGED WELL KILLING

Non-damaged killing of production and injection wells

Krezol group produces a wide range of blocking compositions for formation damage minimizing production and injection well killing operations, aimed at reducing the negative impact of highly mineralized solutions on the formation, preservation of filtration-capacitive properties of bottomhole formation zone, permeability restoration after the completion of the well workover.

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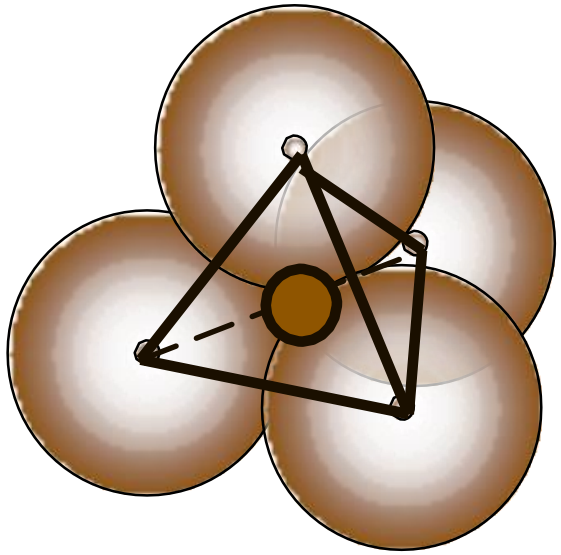
We suggest to consider the detailed technical characteristics and properties of blocking compositions - KR-3G, KR-3E (Oil), KR-3E (Diesel).

The technology of non-damaged well killing with blocking compositions with absorption control

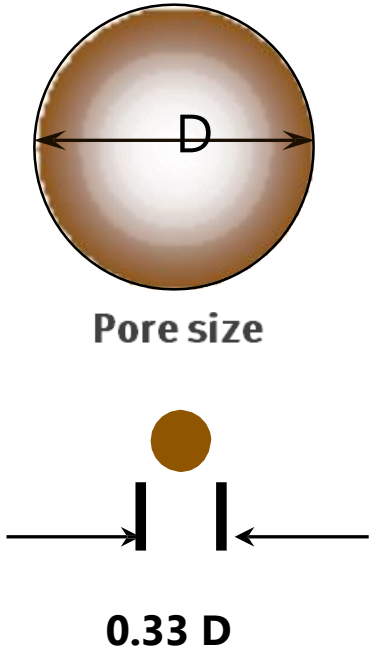
Intended use:

- Wells with abnormally low formation pressure, high absorption;
- Wells after hydraulic fracturing;
- Multilayer wells.

Pore calculation



Tetrahedral dense pack of proppant granules



Pore size

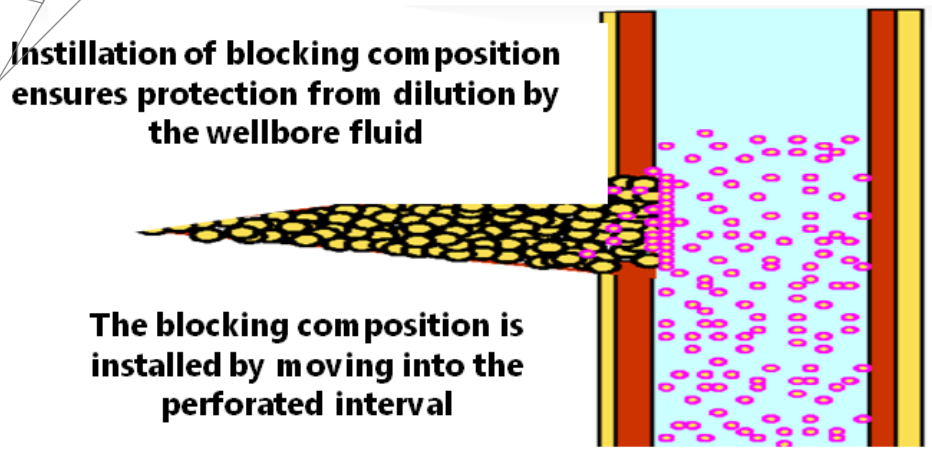
0.33 D

Advantages of halite-stabilized suspensions of solid bypass particles:

- The use of available water-soluble and acid-soluble temporary colmatant;
- An effective scheme of selection and calculation of the fractional composition of a temporary colmatant;
- Thin blocking filter cake formation;
- Low cost;
- High technology of the suspension preparation;
- The lifetime of at least 10 days.

Fractional composition of microcalcite selected by means of iterative calculation to the proppant brand (wells with hydraulic fracturing), or the crack opening (fractured objects).

The technology of non-damaged well killing with blocking compositions with absorption control



The filter cake should:

- be formed immediately at the entrance to the fracture;
- have minimum instantaneous filtration;
- be thin and have low permeability (5 mcd);
- have minimum adhesion to the surface of the proppant

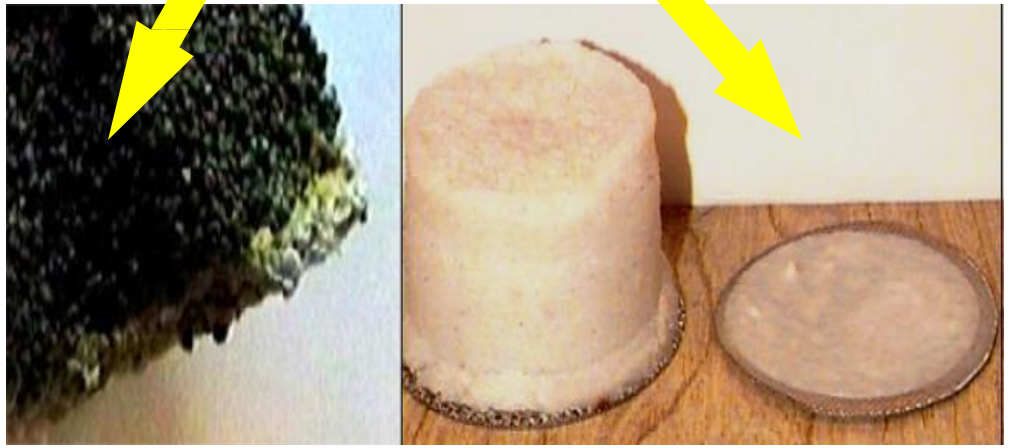
The result of proper selection of the microcalcite fractional composition and technology application is a thin (1-2 mm) low permeability (up to 5 mcd) filter cake.

The idea of technology:

- To obtain thin stable cake on the perforation holes (at the entrance to the fracture), withstanding repression of up to 100 atm.
- To kill the well, and not the formation or the fracture.

The results of the project "Well killing with controlled absorption" (UfaNIPI):

1.Implementation scope in RN-Y2009 - Implementation scope of 324 wells, the success of 93.8%, the average absorption - 7.4 m3/well.,
2.ugansknefteqaz in 2010 - 882 wells, in 2011 - 1750 wells, in 2012 - 1013 wells, in 2013 - 1515 wells.
3.2015 - the execution of a pilot project at the facilities of Orenburgneft - 10 wells.

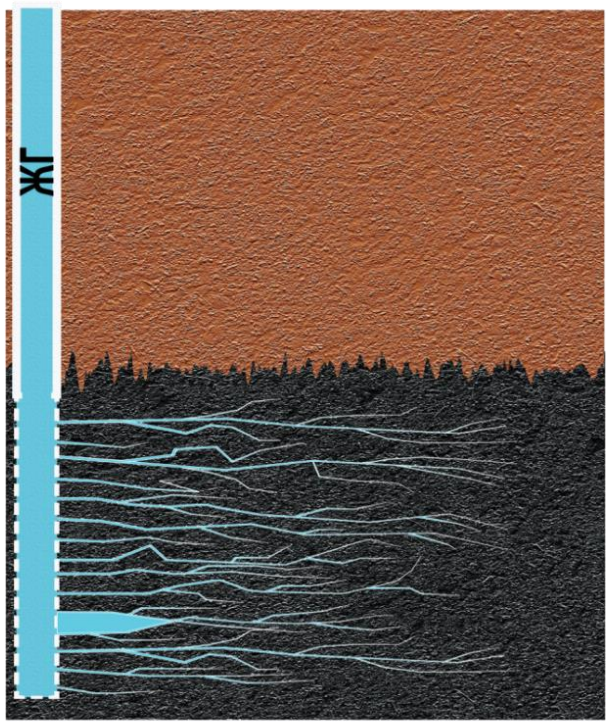


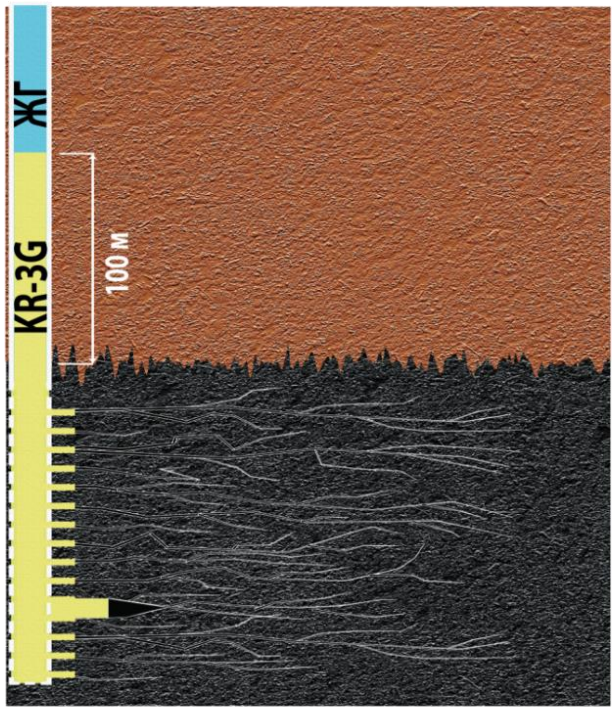
Filter cakes: optimal (right) and nonoptimal (left)

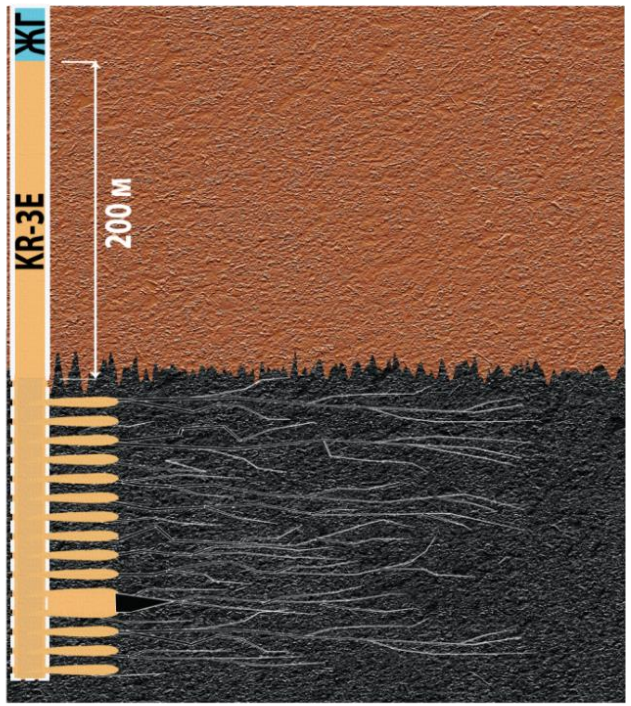
BLOCKING COMPOSITIONS

The intended use of blocking compositions – KR-3E emulsion and KR-3G biopolymer gel
NEW COMPOSITIONS RECIPE FOR WELL KILLING AND BARRIER SETUP:

- Autodecompositioned with controlled decomposition time;
- Damaged by acid compositions manufactured by “Krezol Group”







- Reliable well killing for the entire period of well workover
- Filtration-capacitive properties preservation of the reservoir
- Blocking of well killing fluid loss
- Water flood blocking of oil-saturated reservoir pore by highly-mineralized well killing fluids with a further salting-up and colmatation of the filter cake of bottomhole formation zone
- Reaction products removal during well development with the reservoir permeability restoration as per oil

Non-damaged well killing

Blocking compositions: KR-3G gel and KR-3E emulsions
Preparation technology of commodity and active (working) forms

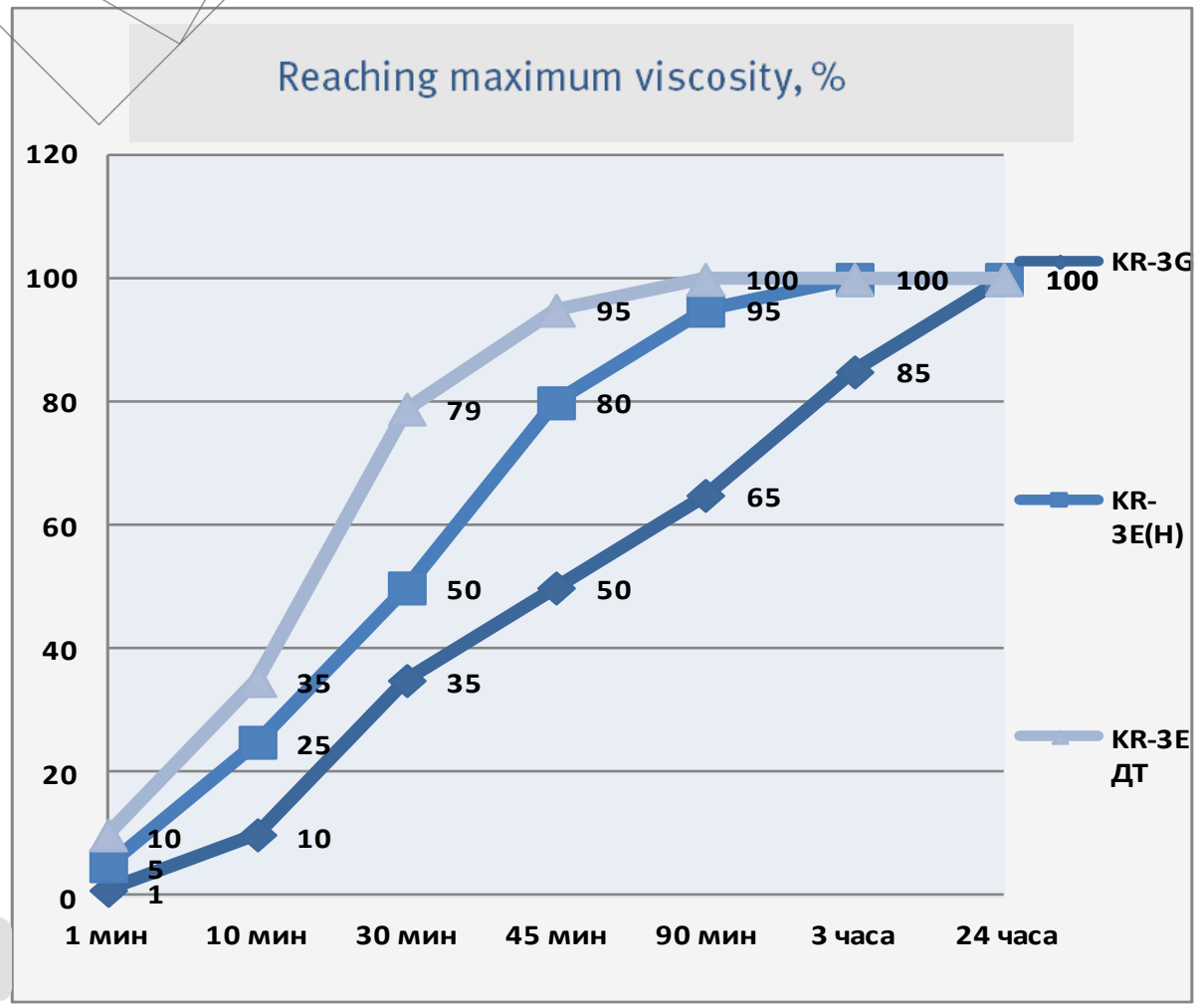
1. The commodity form of KR-3G gel – flowing hydrophobic fine powder, packed in 50kg semitransparent bags and semitransparent soft 1 ton containers.
2. The active form of KR-3G – inert biopolymer gel with a highly hydrophobic nature without color and smell. The preparation of the KR-3G active form is carried out in wellhead conditions by simply mixing the powder with fresh water or mineralized water in the gauge tank.
3. The rate of gel application - 1.5% -5%, depending on specified rheological properties of the gel.

1. **The commodity form of KR-3E emulsifier – dark oily liquid, packed in 216 litres metal drums.**

2. **The active form of KR-3GE– hydrophobic invert emulsion.**
   The preparation of the KR-3E active form is carried out in wellhead conditions by injection of the emulsifier with hydrocarbon mixing and water phase in the gauge tank. The rate of emulsifier application - 1,5%-5% depending on specified rheological properties of the emulsion.

BLOCKING COMPOSITIONS

KR-3G and KR-3E blocking compositions.
Reaching the maximum values of the funnel viscosity in the preparation and sedimentation of biopolymer gel and and invert emulsions in percent at +68 F.



Блок-состав	10 min	30 min	45 min	90 min	3 hours	24 hours
KR-3G	10%	35%	50%	65%	85%	100%
KR-3E Oil	25%	50%	80%	95%	100%	100%
KR-3E (diesel)	35%	79%	95%	100%	100%	100%

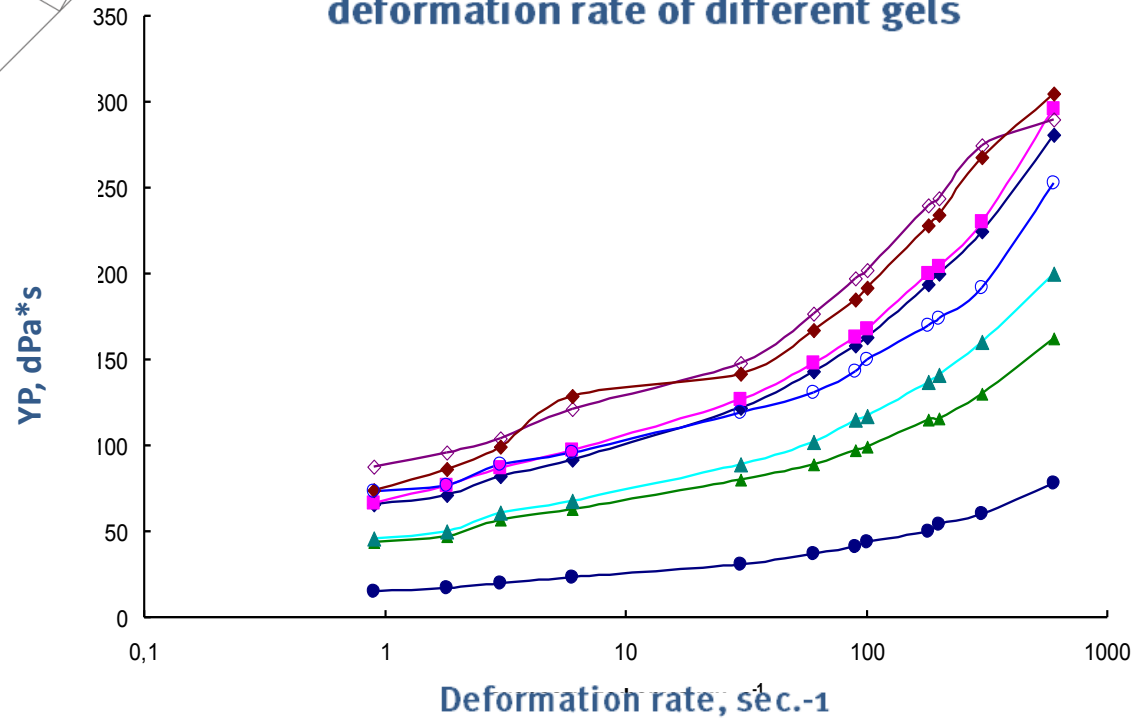
Blocking compositions are ready for operation after sedimentation:
KR-3G – 3 hours
KR-3E (Oil) – 1,5 hours
KR-3E (Diesel) – 1 hour

BLOCKING COMPOSITIONS

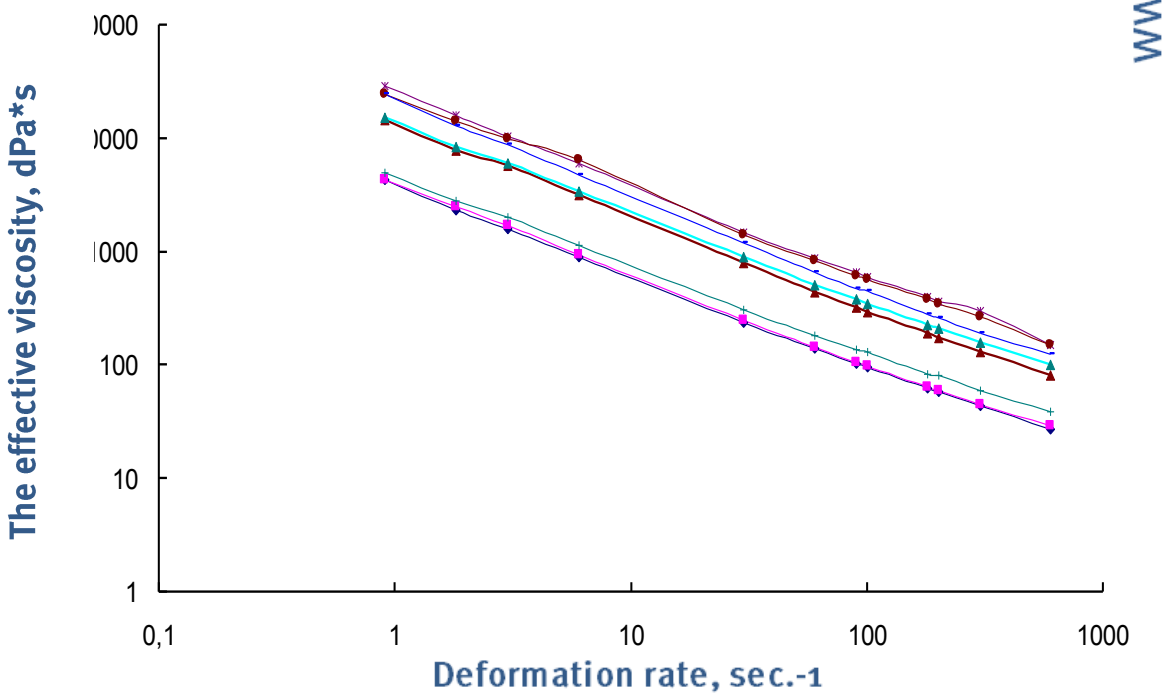
Blocking compositions fluidity

Yield point (YP) and the effective viscosity change depending on the deformation rate of gel

The dependence of YP from deformation rate of different gels



The dependence of the effective viscosity from deformation rate of different gels



Non-damaged well killing

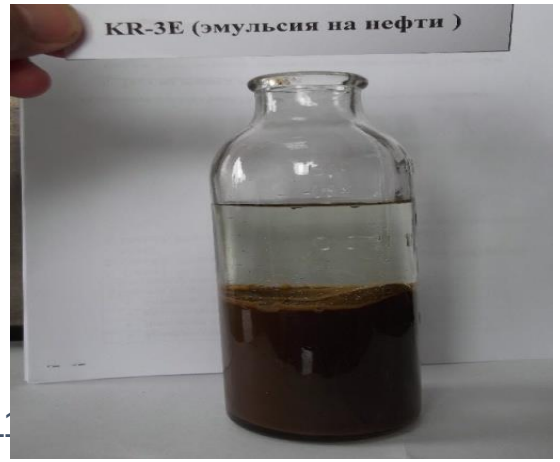
Compatability of blocking compositions with highly mineralized synthetic brine :

<u>The KR-3G hydrophobic gel is inert with respect to all types of highly mineralized water:</u>

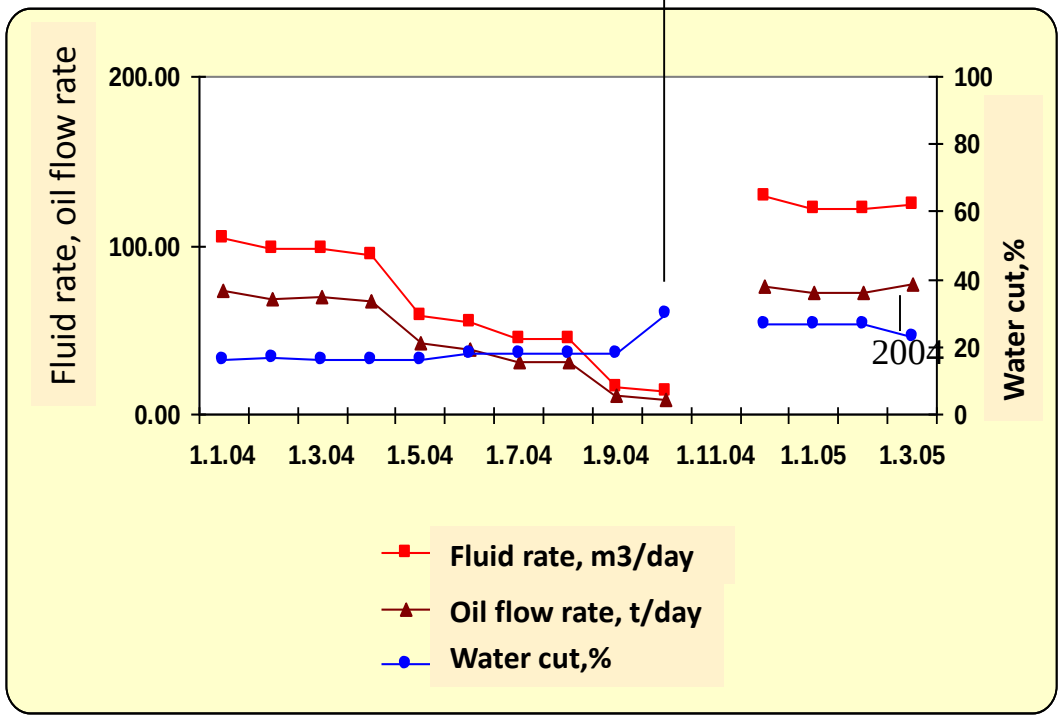
- Chloro- sodium water – compatible
- Chloro- potassium water – compatible
- Chloro- sodium-potassium water - compatible
- Chloro- sodium-calcium water - compatible
- Chloro- calcium- magnesium water - compatible
- **There is neither mixing nor hydrolysis for 10 days in the static position**
- **Without precipitation**

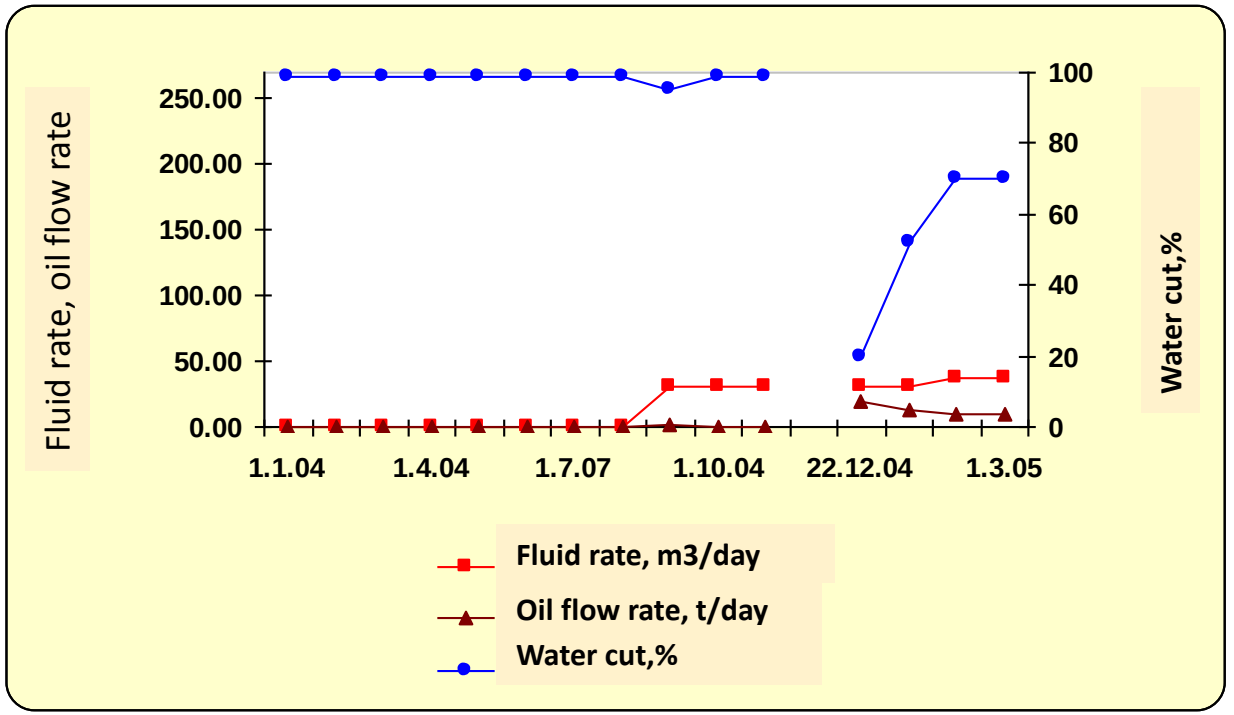
<u>KR-3E hydrophobic emulsions is inert with respect to all types of highly mineralized water:</u>

- Chloro- sodium water – compatible
- Chloro- potassium water – compatible
- Chloro- sodium-potassium water - compatible
- Chloro- sodium-calcium water - compatible
- Chloro- calcium- magnesium water - compatible
- **There is neither mixing nor hydrolysis in the static position for:**
  - **KR-3E (Oil) - for 10 days**
  - **KR-3E (Diesel) – for 5 days**
- **Without precipitation**

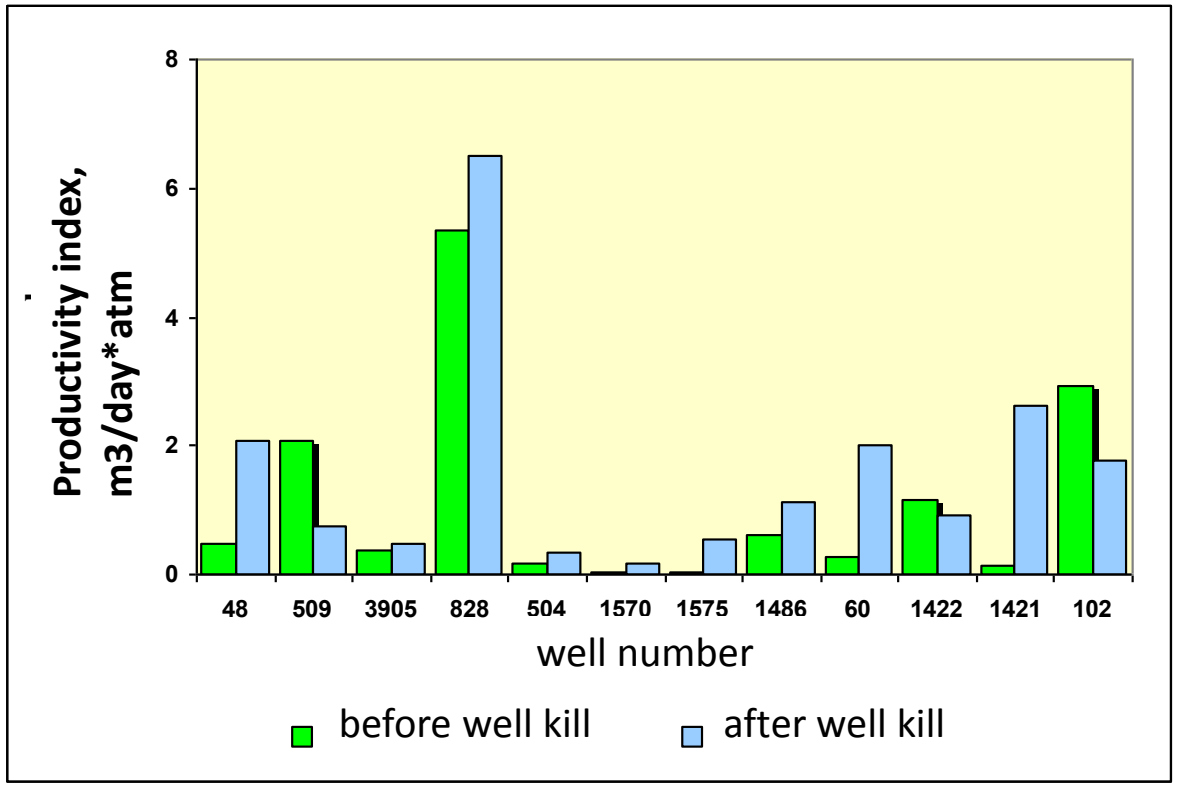


The well performance examples after non-damaged well killing operations





Changing the productivity index after well kill operations



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Thank you for your attention!

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