LLC ENGINEERING-PROMOTIONAL CENTER

“INGEHIM”

TREATMENT OF OIL WELLS BY PULSATIONS FOR INCREASING THE WELL PRODUCTIVITY (INJECTIVITY)

Kazan, Russia

CHARACTERISTICS OF CONVENTIONAL METHODS FOR WELL TREATMENT

The main activities on well maintenance are normally related to a reagent treatment of the bottom-hole zone for increasing permeability, increasing treatment depth, well productivity or injectivity.

The applied reagent treatment technologies are based on using the following scheme:

1. **Static action:** **“injection – static maturation – pumping out”**
2. **Non-stationary action:** **“pulse for action – pulse for relief”**

In pulse technologies, a significantly better result is achieved via the formation of a **"shock" wave of great unit power** and perturbations caused by the wave when applying:

- Mud pulses of extreme pressures (more than 150 atm)
- Explosive agents
- Thermal-gas-chemical reactions
- Downhole generating devices, etc.

CHARACTERISTIC DISADVANTAGES OF CONVENTIONAL TECHNOLOGIES

The applied conventional technologies normally lead to a structure destruction.

In conventional methods, when the impact parameters reach certain extreme values, the following consequences can occur:

- Destruction of the reservoir and decrease in its service life
- Change in the stratum structure and increase in its heterogeneity
- Formation of irreversible processes of decolmatation

In existing reagent technologies:

- The impact is one-time and clearly decaying
- It is required to change the existing downhole arrangement and apply some downhole devices
- Transport of contamination products to the well mouth is impossible during and after repair
- Impossible to control or manage the impact clearly
- Limited opportunities for implementation of integrated or multipurpose treatment methods, which are considered as most efficient.

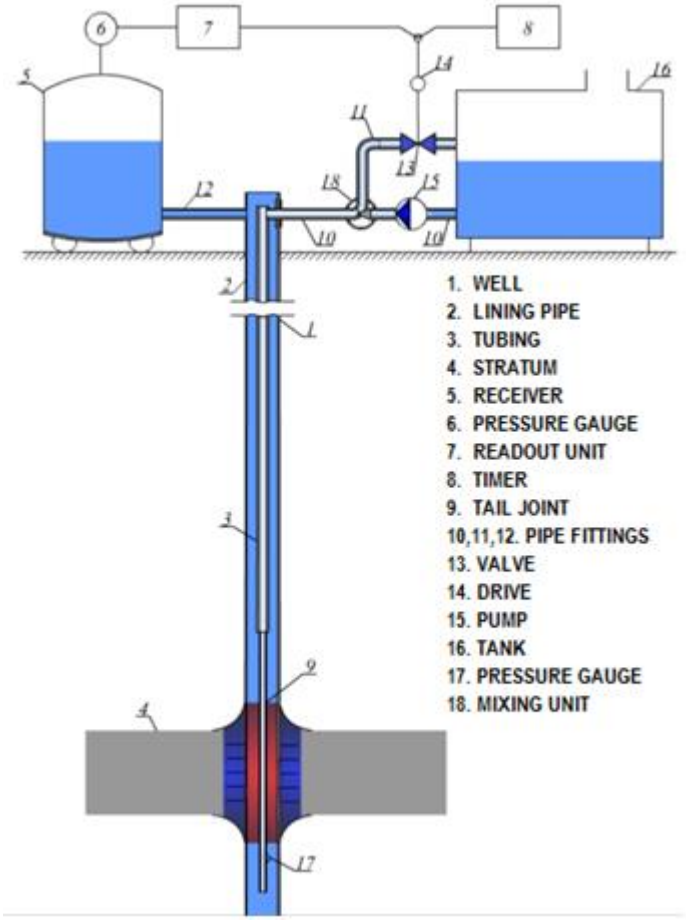
CHARACTERISTICS OF THE PULSATING METHOD

For carrying out well repairs that **would bring no damage to the well structure**, we propose applying the pulsating treatment method based on creation of low frequency pulses (0.001-0.02 Hz) of working liquid pressure (not exceeding 80 atm) at the well mouth combined with an alternating-sign change in the flow direction.

Based on the action's type, treatment by pulsations belongs to the class of **hydropulse methods**, whose application is defined in the Russian normative documents, RD, for carrying out repair works in oil wells (RD 153-39-023-97 of 18.09.97, subsection 4.9.1.1.8).

The hydrodynamic regime of impact on the oil well has the following characteristics:

- Forced and regularly recurring
- Non-stationary and undamped
- Turbulent (Re=30000-50000)



MOBILE PULSATING UNIT (MPU)

For carrying out the treatment of oil wells by pulsations, we propose applying **the mobile pulsating unit (MPU).**

MPU performs water, reagent and integrated treatment of oil wells by pulsations for increasing the well productivity (injectivity).

Objects:

- Operating injection and producing wells
- Stripper wells
- Wells of alternating designation
- Clusters of wells.

Power block

Control block

<u>The available versions of the MPU design include:</u>

- Skid-mounted with an electric or self-propelled drive
- On a chassis of a truck driven by a PTO shaft
- Stationary with an electric or self-propelled drive

MOBILE PULSATING UNIT (MPU)

High efficiency of the pulsating method can be attributed to the following characteristic features of the method:

- Long-term non-stationary action applied to the treated zone that intensifies the heat and mass transfer processes
- Effects of working liquid “ebullition”
- Gas phase separation and near-wall layer destruction
- Formation of steady depression in the bottom-hole zone
- Rehabilitation of filtration properties and stabilization of water permeability

MPU in the oil field

MOBILE PULSATING UNIT (MPU)

Advantages of the proposed method in comparison with the other applied methods for well treatment are following:

- No limit loads; hence, the reservoir structure remains intact
- No need to change the existing downhole arrangement
- No internals
- The pulse is easy to control and manage
- Contamination products can be transported from the borehole bottom to the well mouth during and after repair
- Opportunities for implementation of integrated or multipurpose treatment methods

MPU in the oil field

PILOT TESTING OF MPU

The MPU efficiency was examined under the pilot-test conditions in the oil fields of the Republic of Tatarstan, Russia.

Washing of the well by pulsations (with the use of water, surfactants, and solutions of weak reagents) **provides a primary cleaning and preliminary preparation** of the perforated interval and bottom-hole zones with removal of weakly and medium-colmatating contaminants so that the efficiency of the main reagents is improved.

The working liquid used for pilot testing was stratum water.

Results of pilot testing of the water washing by pulsations:

- At the time of pulsed treatment (washing) conducted after a “routine” washing procedure, transport of “oily sludge” (up to 10 m^3) to the well mouth was recorded.
- In line with well logging data, after the pulsed treatment, complete removal of deposits from the sump was observed, while the downhole arrangement remained unchanged.
- During the pulsed treatment, the well reaction to the pulsating action appeared in the form of an “initial” change in the well injectivity.

Summary of the testing: the washing technique making use of pulsations appears to be more efficient than the current regulatory washing techniques (both direct and reverse washing), and its application in technological operations of the reagent treatment is advisable.

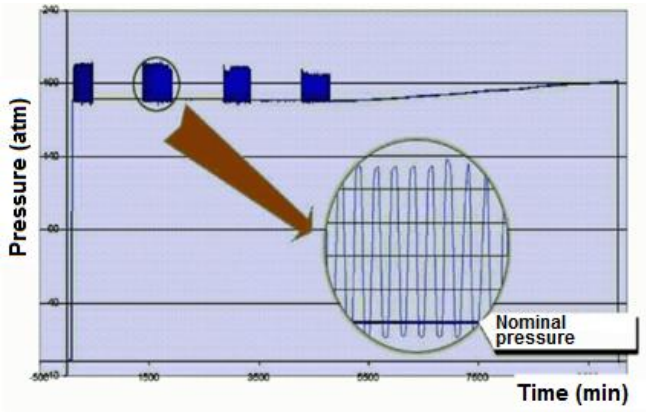
PILOT TESTING OF MPU

Treatment of the bottom-hole zone of injection wells by pulsations.

The working liquid used for pilot testing was stratum water.

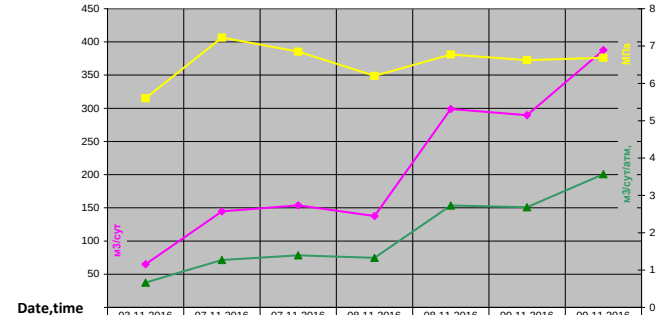
The pilot testing allowed obtaining the following results:

- Positive reaction of the wells to pulsations together with a significant change in operating parameters.
- Confirmation of regimes of pressure change in the well and determination of steady depression with the use of the downhole pressure gauge.
- Rehabilitation of well injectivity to the operating level and its subsequent increase by the factor of 3 to 5.
- Stabilization of injection pressure within 2-3 months after treatment by pulsations.
- Opening of pores in clogged perforated intervals together with a power increase up to 50%, beginning of their operation
- Significant change in chemical composition of the working fluid and reduction of its hardness.



Measurements by downhole pressure gauge

Change in injectivity at the time of pulsating treatment: 07.11.2016 – 09.11.2016



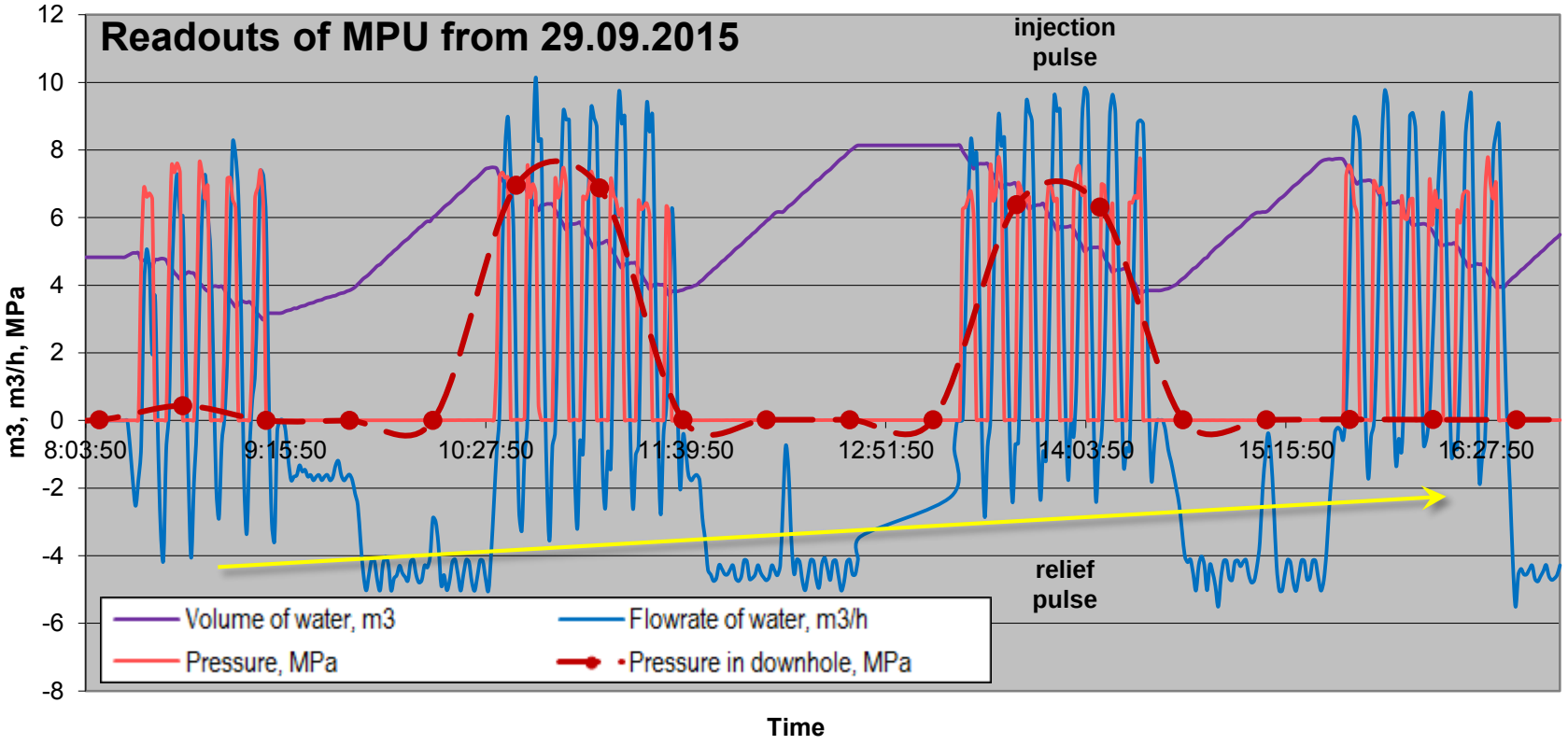
Date,time	03.11.2016 12:23	07.11.2016 11:05	07.11.2016 14:32	08.11.2016 9:02	08.11.2016 15:05	09.11.2016 8:39	09.11.2016 14:05
Расход	65	145	154	138	299	290	388
Давление уст	5.6	7.2	6.8	6.2	6.8	6.6	6.7
Кпр	0.66	1.27	1.39	1.33	2.73	2.68	3.57

Increase in injectivity index from 0.66 to 3.57

Conclusion: results obtained during treatment of the bottom-hole zone by pulsations point to influence of elastic pulsation forces on the stratum productive zone.

DECODING OF CONTROLLER DATA FOR VARIOUS MODES OF MPU TESTING

Treatment of the bottom-hole zone of an injection well by pulsations without channeling in the mode of work “by time” at the treatment pressure value **66-75 atm.**



The figure clearly demonstrates dynamics of an increase in flowrate of the fluid pumped into the well during the injection pulse, and a sharp decrease in total volume of the fluid in MPU.

As a result of treatment of the bottom-hole zone by pulsations, an increase in the well injectivity takes place along with a decrease in the injection pressure.

TYPES OF TREATMENT BY PULSATIONS CARRIED OUT BY MPU

- **Flushing of the well by pulsations**

It is used for flushing intensification and transport of contamination to the well mouth, preliminary preparation of perforated interval and bottom-hole zone before applying reagents.

- **Reagent treatment of the bottom-hole zone by pulsations**

It is used for intensification of all kinds of reagent flushing of the bottom-hole zone by means of applying a regular non-stationary turbulent hydrodynamic action that promotes decolmatation of contaminated zones, unblocking of cross flows and pore openings, rehabilitation of filtration ability and hydroconductivity, increase in productivity or injectivity.

- **Complex treatments of wells as well as of clusters of wells by pulsations**

MPU carries out complex treatment of well (washing out, acid treatment, reagent injection, etc) by itself combined with pulse impacts.

- **Water flooding of injection wells by using pulsations**

Its application leads to rehabilitation of the bottom-hole zone's filtration ability, preservation of its hydroconductivity resulting in enhancement of water flooding parameters.

- **Squeezing of reagents into the stratum by using pulsations**

Its application results in a more uniform distribution of reagents and an increase of depth of their penetration into the stratum.

- **Intensification of conventional technologies of treatment of wells** leading to increase of their efficiency.

PERSPECTIVES OF DEVELOPMENT OF PULSE TECHNOLOGIES

The positive effect is achieved in testing of MPU only due to hydrodynamic action applied to the zone of treatment by stratum water without using any reagents, auxiliary downhole devices or special-purpose equipment.

Dynamics of changes in operational parameters during the pulsating treatment points out the positive influence of elastic forces of the pulsations on the bottomhole zone. To increase efficiency of well maintenance pulsating treatment can be combined with reagent, heat and other treatments.

Application of reagent treatment by pulsations provides:

- Intensive cleaning of the perforated interval as well as of the pore space together with removal of the colmatant from the bottom-hole zone
- Increase in permeability of the stratum productive zone as well as in its productivity
- Increase in productivity of producing wells as well as in injectivity of injection wells
- Increase in depth of reagent treatment with a possibility of squeezing a reagent into the stratum
- Increase in intermaintenance period of the oil well operation

Thanks for your attention