Increasing oil recovery and reducing well water content by electric impact

Regional public organization *Institute of Electric and Physical Problems*, Moscow 2019

Electric impact – an innovative approach to increasing oil recovery

Today the majority of major global developed oil fields are at the late production stage and their residual reserves are classified as hard-to-recover. This makes the task of increasing oil recovery the priority. There is a need for new, environmentally friendly and more cost efficient methods. Electric impact meets these requirements perfectly.

Electric impact method: application areas

- Cleaning and clay cake removal from the bottom-hole area of producing wells
- Reducing water content of producing wells
- Increasing oil recovery
- Recovering wells located at fields at a very late production stage
- Isolating premature water breakthroughs

Method application effects

Electric impact

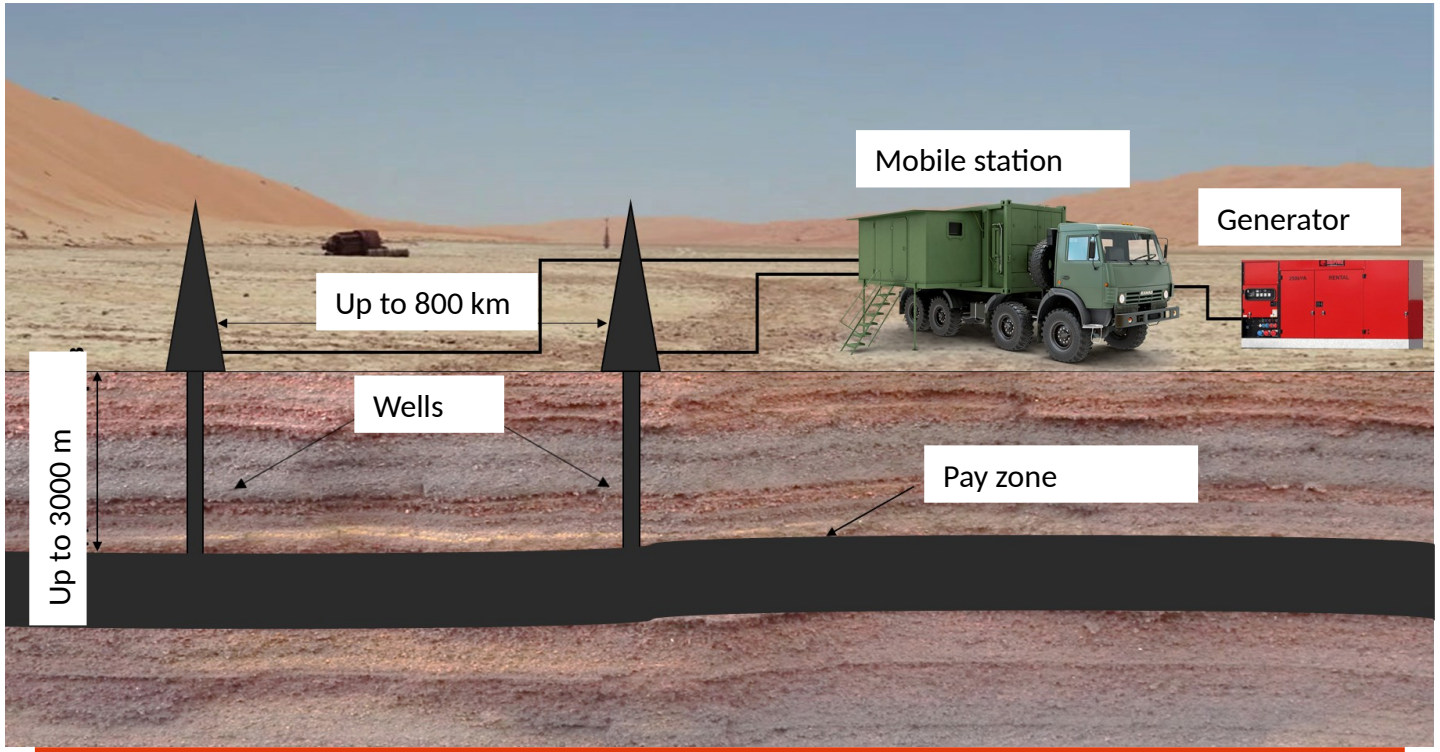
Improving permeability of the bottom-hole area, which increases liquid production rate. This is a lasting effect since it is caused by improved permeability of the bottom-hole area.

Reducing the well water content. This effect is caused by changed phase flows in the pay zone. It lasts from 6 months to 5 years. The affected radius can reach 100 m and more.

Electric impact technology principles

The technology aims at changing the structure of the porous space in micro-heterogeneous environment and spatial structures of filtration flows by sending heteropolar electric current impulses through the pay zone. Localization of the current density in thin capillaries limiting environment filtration speed allows to enhance the cross section of capillaries and, thus, improve the permeability in the bottom-hole area.

Well treatment scheme



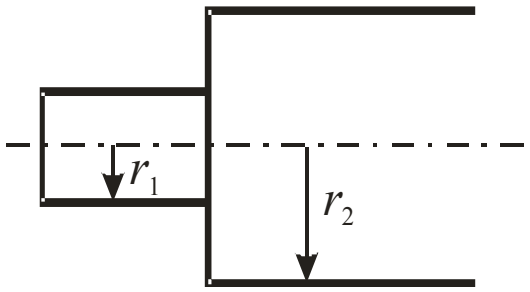
Two wells are simultaneously subject to electric impact. Maximum treatment time is 30 hours

As the power source you can use:
- 6-10 kV high voltage three-phase line (overhead),
- 200 KW 380 V transformer substation,
- Portable 800 kW diesel generator.

Heteropolar electric current impulses are applied directly to well casing strings through a copper wire connected to a mobile station.

Improving environment permeability

The scheme of contact of capillaries of various radii



$$j_1/j_2 \sim (r_2/r_1)^2$$

$$\varepsilon_1/\varepsilon_2 \sim (r_2/r_1)^4$$

$$(r_2/r_1)_{max} \sim 10^3 \div 10^4$$

Electric impact results in restructuring the porous space of the environment in a way that improves the permeability

The electric current flows through two subsequently connected capillaries with r_1 and r_2 radii, current density ratio (j_1/j_2) is proportional to their squared ratio (~ $(r_2/r_1)^2$), and power density ratio (E_1/E_2) is proportional to their ratio to the power of four (~ $(r_2/r_1)^4$). In the real environment r_2/r_1 ratio can amount to or exceed 10^3, for this reason power density in the smallest conductors is so high that it destroys them. Therefore, the number of small radius capillaries in the environment is decreasing and the number of larger radius capillaries – increasing and the total permeability is improving.

Reducing well water content Electrocapillarity effect

In case of electric field impact on the micro-heterogeneous environment the phase equilibrium is changing towards oil – electrocapillarity effect

Electric current changes the surface tension factor and oil starts getting into microcapillaries that were previously filled with water. As a result new capillary chains filled with oil emerge in the environment and part of chains filled with water intersect with capillaries filled with oil, which reduces water relative permeability. Thus, oil relative permeability increases and water relative permeability decreases. Since the electric potential in the pay zone follows the logarithmic law, the impact zone may reach hundreds of meters.

Method history

Regional public organization *Institute of Electric and Physical Problems (IEFP)* was founded in 1997 upon the recommendation of the Committee of the Ministry of Science of the Russian Federation, Ministry of Fuel and Energy of the Russian Federation and Russian Academy of Science on the basis of the Department of Theoretical Problems of RAS and Geon Regional Centre for Geophysical and Geoecological Studies. The founder of IEFP, V.I. Selyakov, is the author of a number of unique technologies related to the impact of powerful electric impulses on micro-heterogeneous environments. First, the electric impact technology was intended for underground uranium desalination. It was successfully used to treat over 2000 uranium wells. Then the technology was adjusted to recover production rates of hydro-geological wells. In early 1990s the industrial application of the electric impact technology started. Since then over 3000 oil wells have been treated. The method became especially popular in Kazakhstan. Moreover, the electric impact method is successfully applied to recover production rate of water wells.

Electric treatment of oil wells was used in various regions of Russia: Krasnodar, Tatarstan, West Siberia; and abroad: in Azerbaidzhan, Kazakhstan, Turkmenistan, the USA, Italy, Venezuela, Libya.

Method ownership

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2208146

Российским агентством по патентам и товарным знакам на основании Патентного закона Российской Федерации, введенного в действие 14 октября 1992 года, выдан настоящий патент на изобретение

СПОСОБ ПОВЫШЕНИЯ ПРОНИЦАЕМОСТИ ПРИЗАБОЙНОЙ ЗОНЫ НЕФТЕНОСНОГО ПЛАСТА

Патентообладатель(ли):

Васнева Галина Ивановна

по заявке № 2002116154, дата поступления: 21.06.2002

Приоритет от 21.06.2002

Автор(ы) изобретения:

Кадет Валерий Владимирович

Патент действует на всей территории Российской Федерации в течение 20 лет с **21 июня 2002 г.** при условии своевременной уплаты пошлины за поддержание патента в силе

Зарегистрирован в Государственном реестре изобретений Российской Федерации

г. Москва, ***10 июля 2003 г.***

Генеральный директор

А.Д. Корчагин

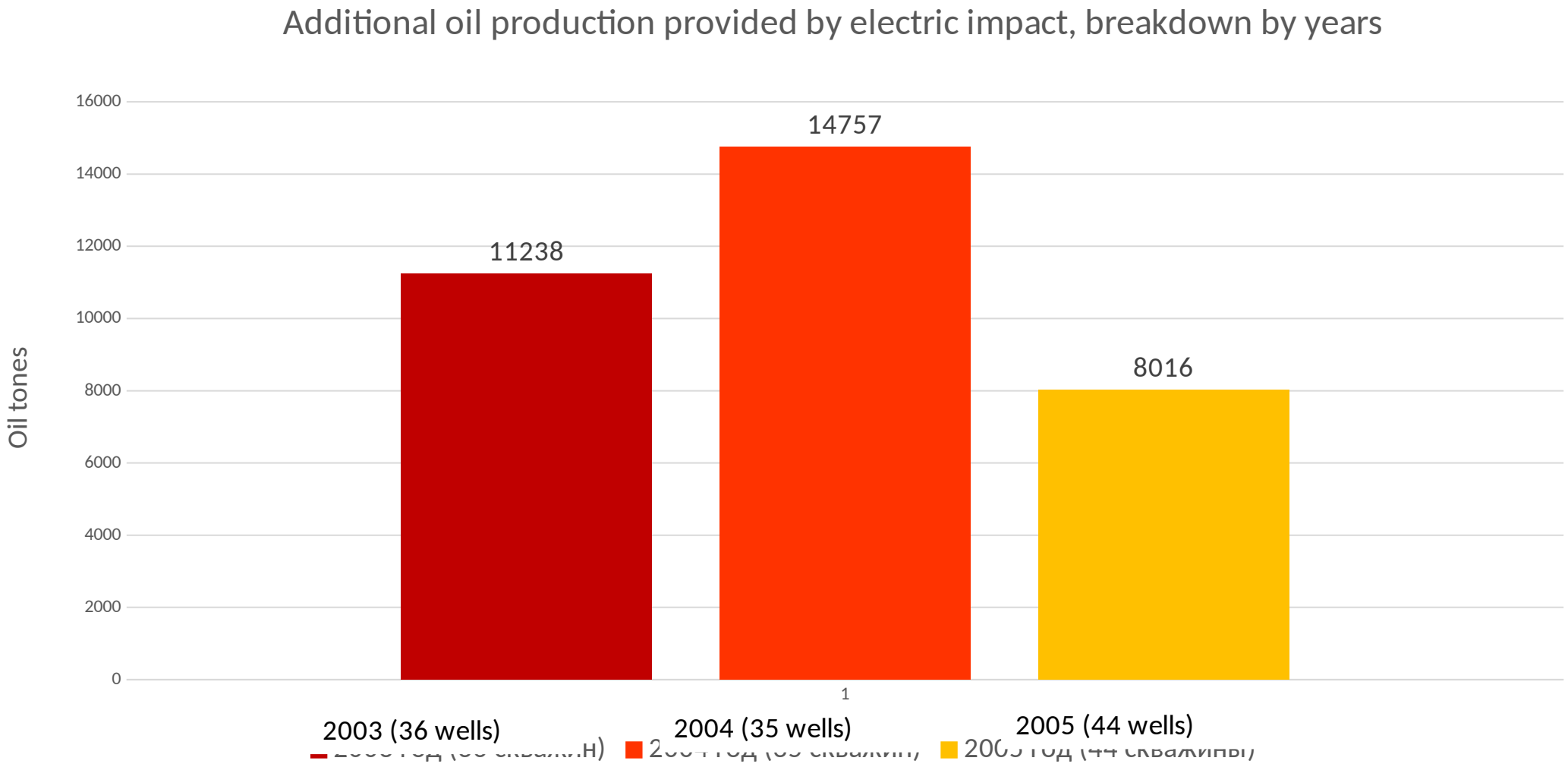
The Institute of Electric and Physical Problems represented by its President G.I. Vasneva owns a number of patents for inventions in the area of electric impact

Future is behind environmentally friendly technologies

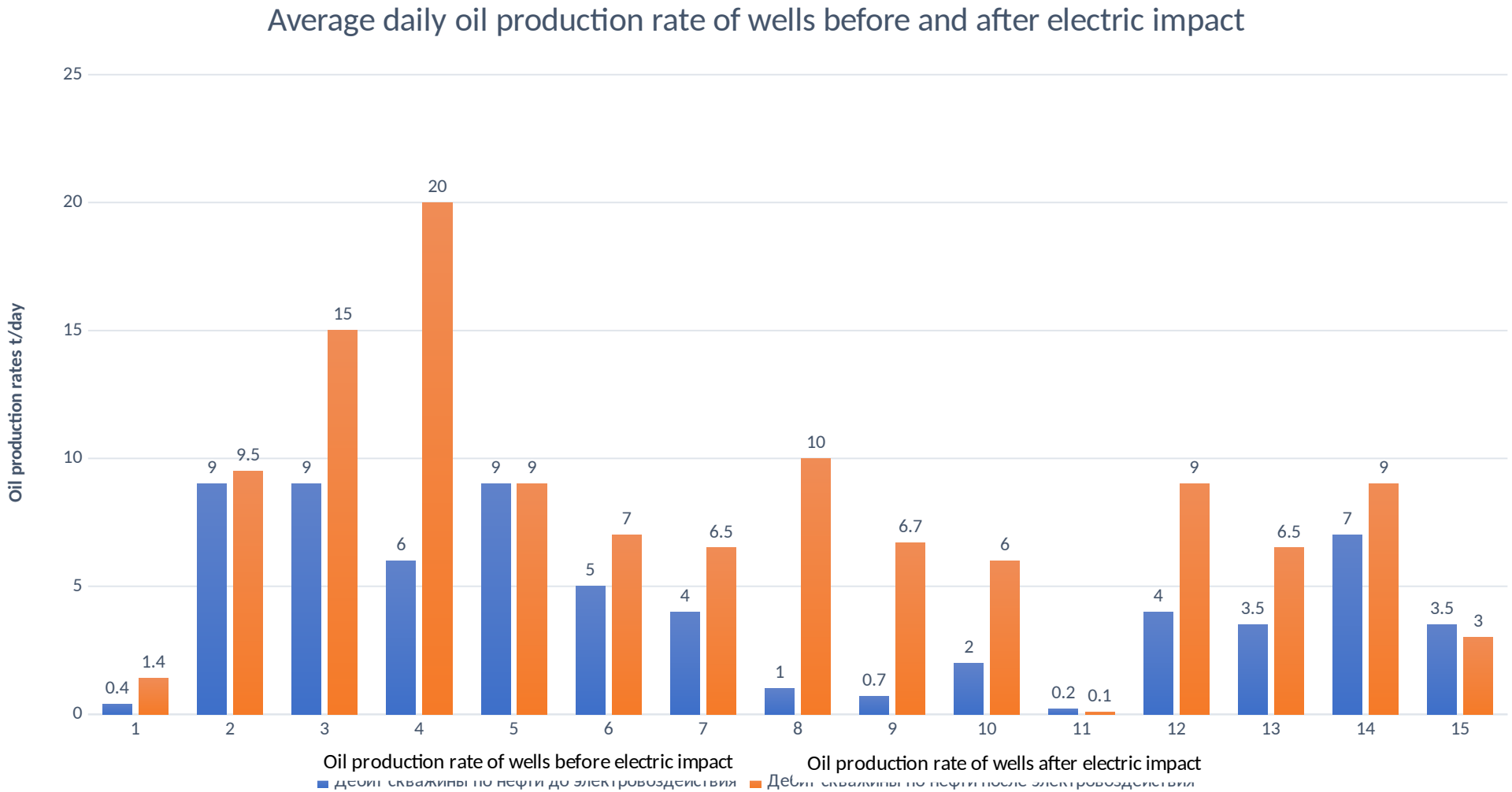
Care for the environment is a key global trend. For leading oil producing companies worldwide ecology has long become not merely a word, but one of the main priorities in developing new fields, oil production and refining. Methods for increasing oil recovery are increasingly required to meet environment standards.

Electric impact – 100% environmentally friendly method for increasing oil recovery.

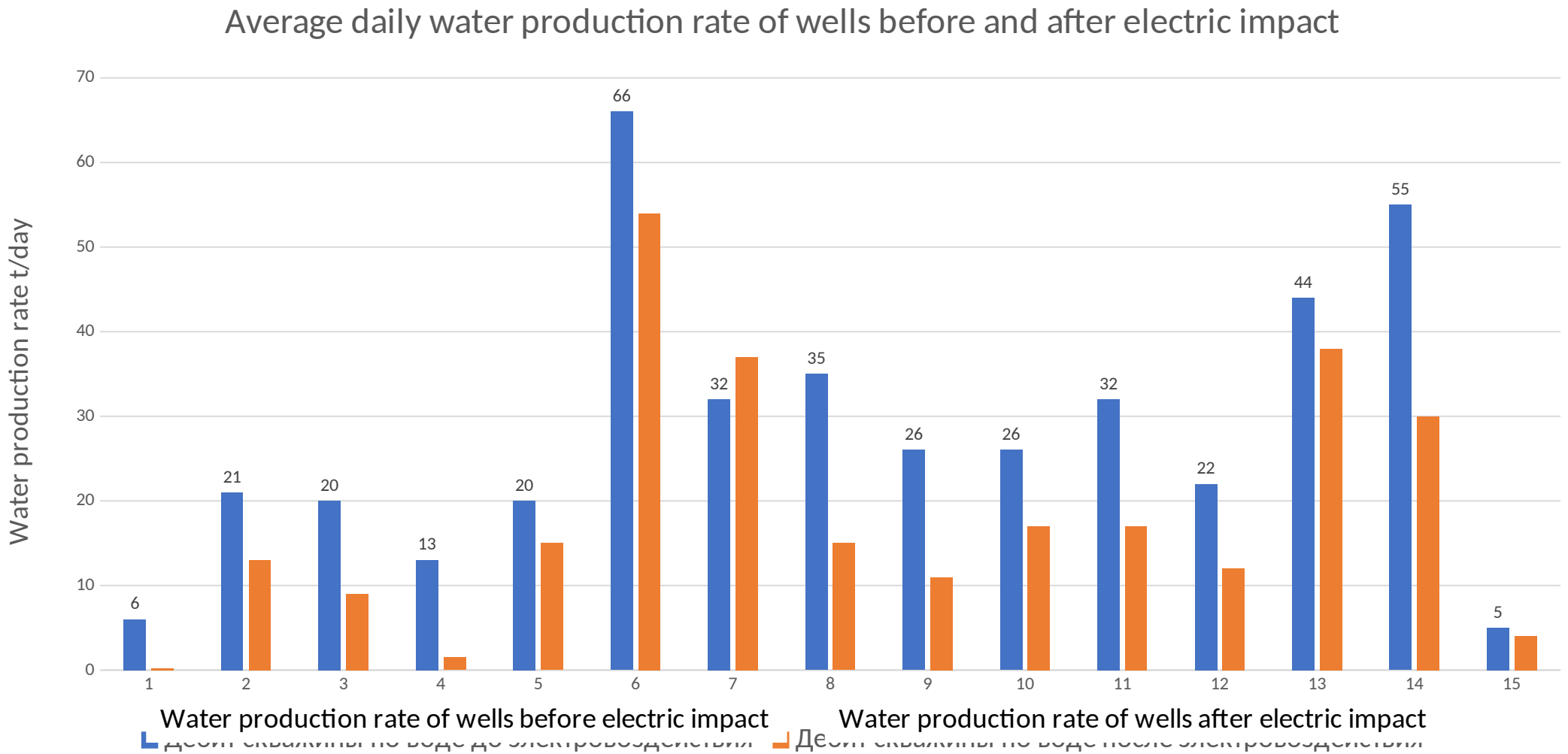
Application experience: Uzen field (Kazakhstan)



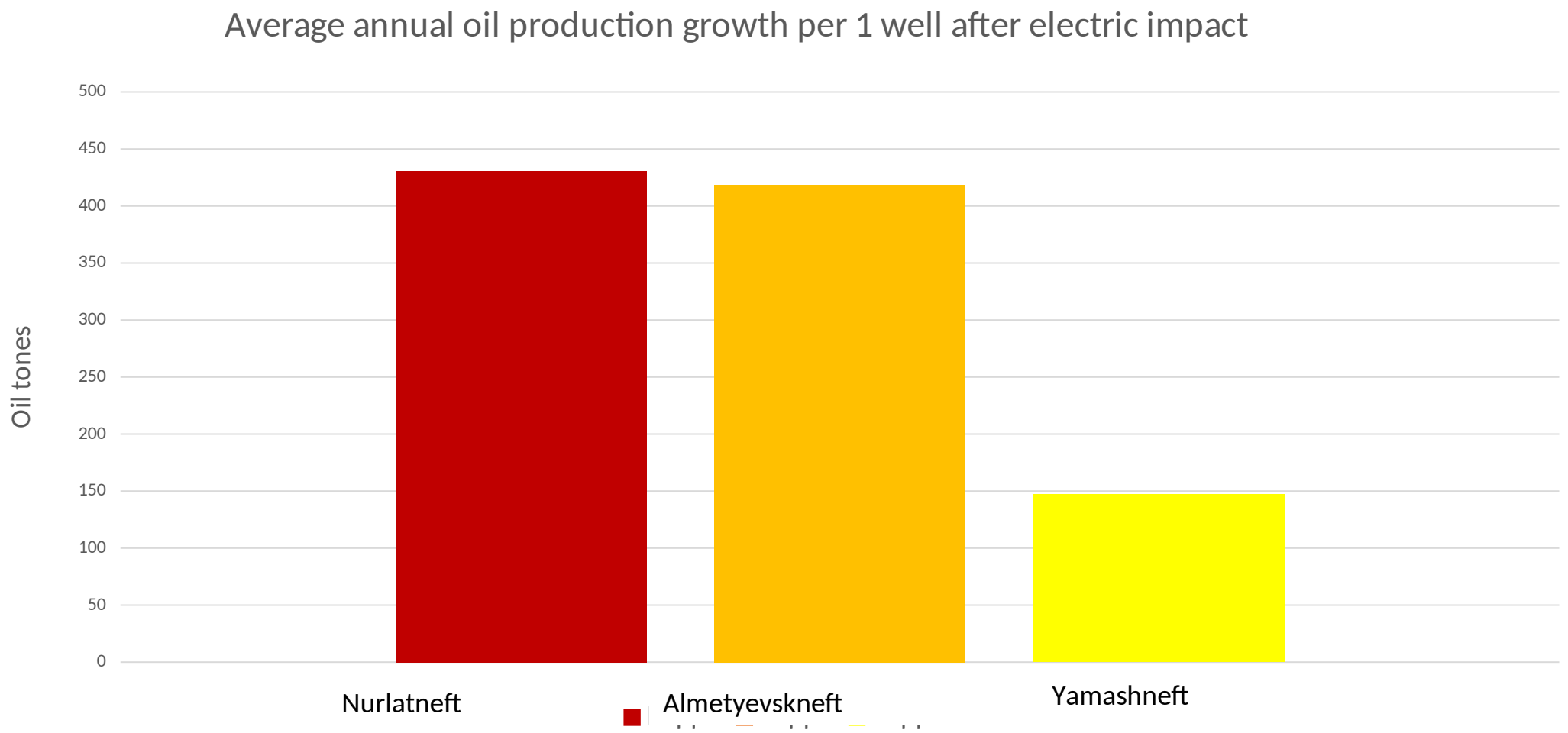
Application experience: South-Western Kamyshit field (Kazakhstan)



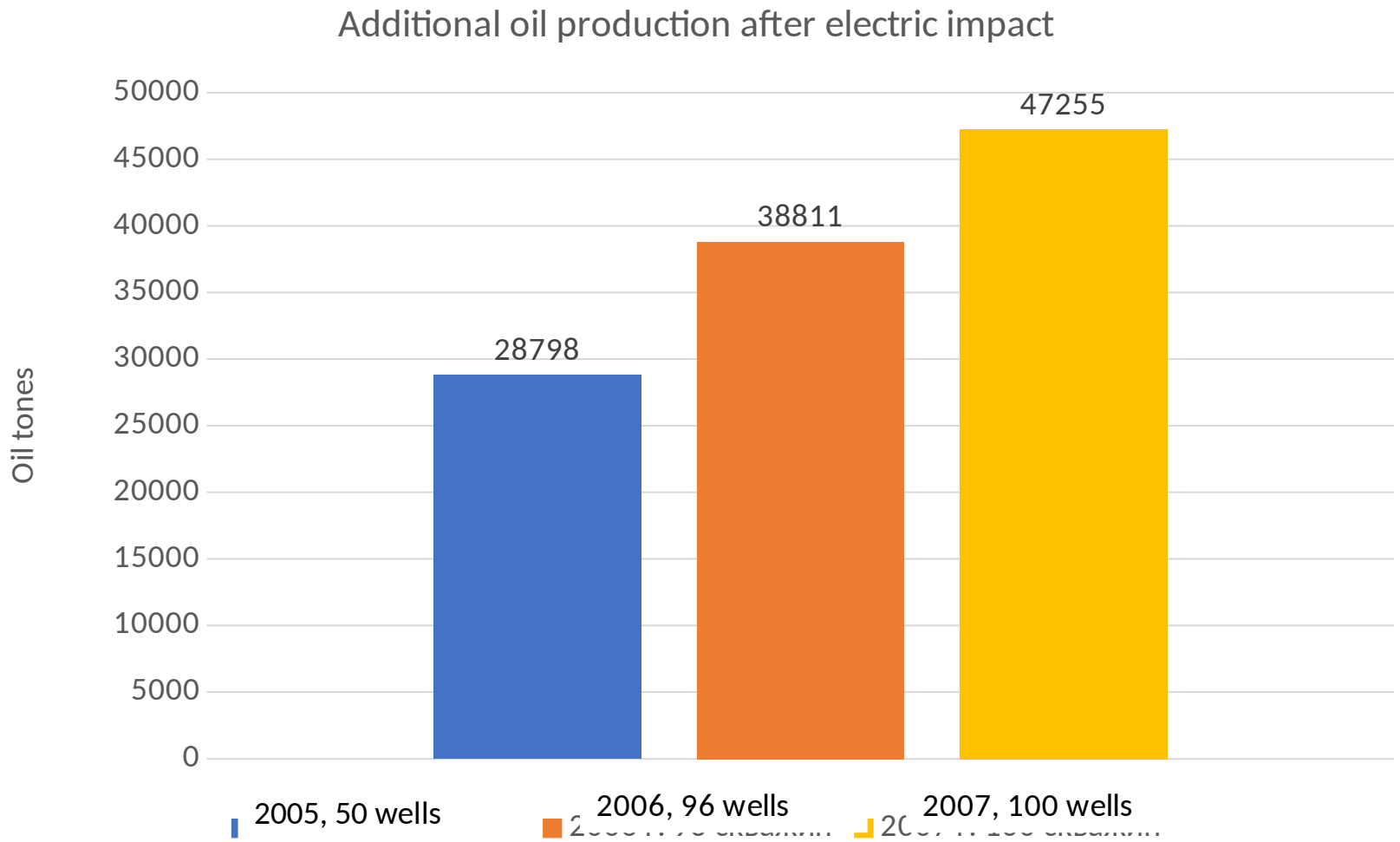
Application experience: South-Western Kamyshit field (Kazakhstan)



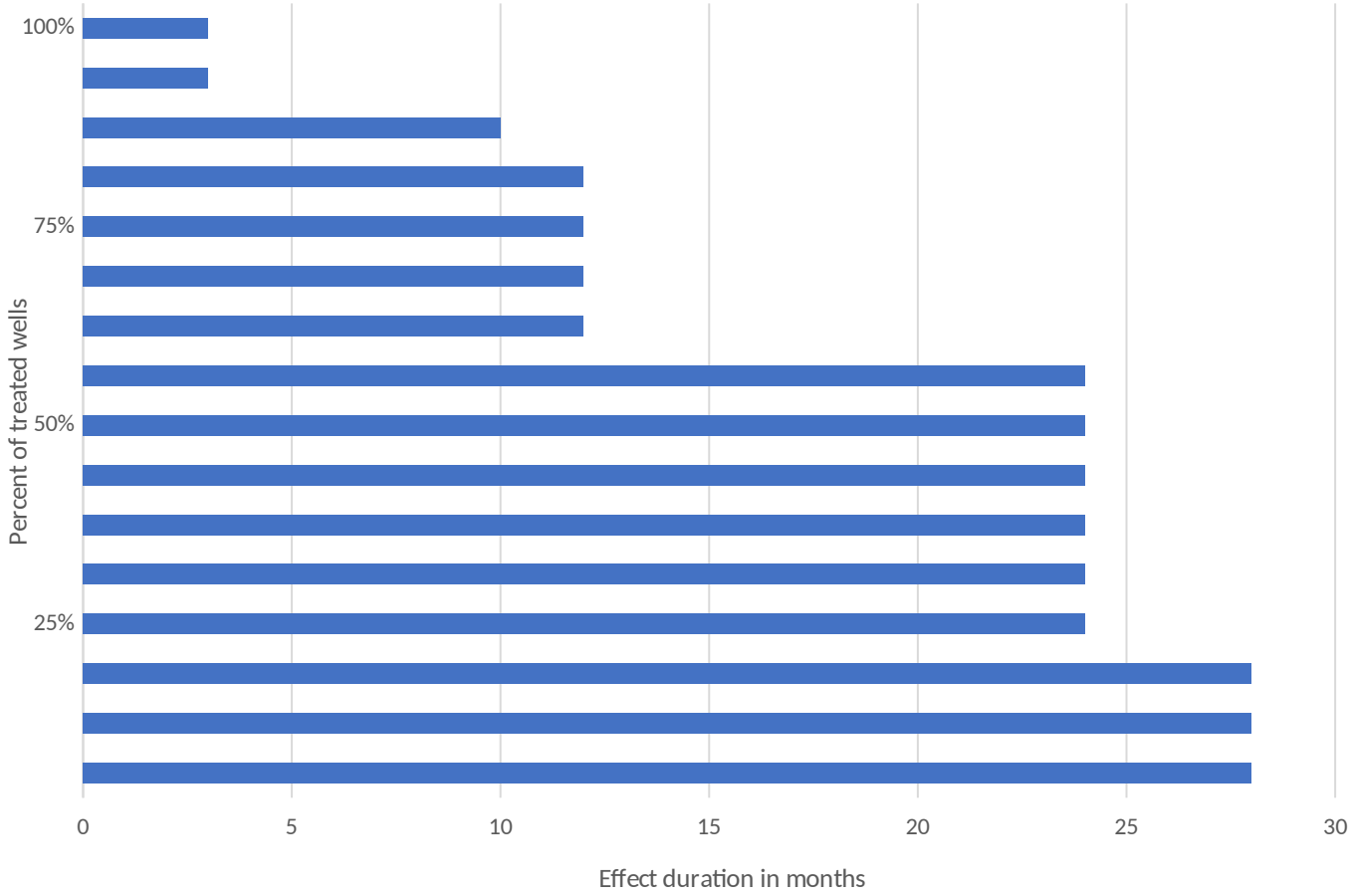
Application experience: Tatneft



Application experience: Uzen field



Application experience: electric impact effect duration



Histogram of the electric impact effect duration at Kazakhoylemb JSC wells

Average electric impact effect duration at Kazakhoylemb JSC wells amounted to 17 months

Advantages and strong points of the method

High cost efficiency	• Usually payback period is maximum 3 months for wells with low production rate and 1-2 months for wells with mean and high production rate.
Absolute environmental friendliness	• Only electric current is used to impact the formation.
Safe for well equipment	• No harmful impact on the cement stone, casing strings, filters and other well equipment.
High performance and efficiency	• One unit treats two wells simultaneously, maximum treatment time is 30 hours.
Low cost	• No need for round-trip operations (formation is treated directly through casing strings) and the only consumable is electric current.
Quick effect	• Usually the effect is visible already in 1-2 days after electric impact
Simple technology	• The formation is treated directly through casing strings, preparation takes only several hours.
Mobile and independent unit	• All the equipment and the living quarters are located in a truck with a box van and a trailer
Lasting effect	• The effect lasts up to 3-5 years. If necessary second treatment is possible.

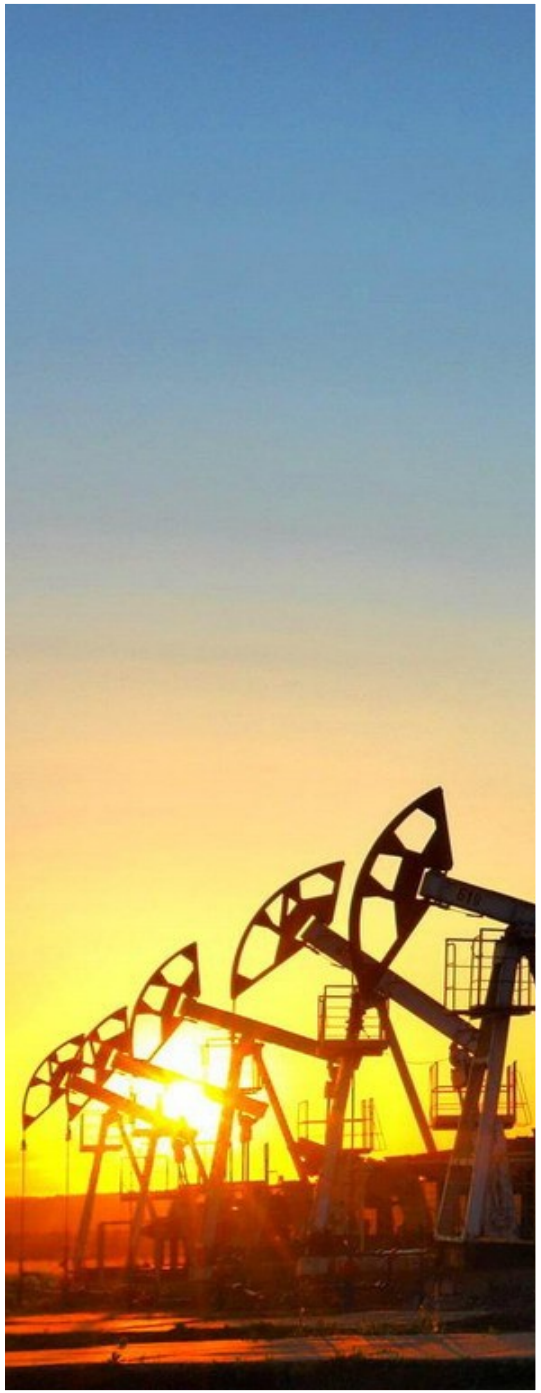
Method development prospects

Specialists of the Institute of Electric and Physical Problems are constantly working on improving and developing the electric impact method, as well as increasing its efficiency.

Apart from the development of the technology itself, we see great potential in the comprehensive approach to increasing oil recovery and expect the synergy effect from simultaneous application of electric impact and other methods.

Applying electric impact together with acid formation fracturing can prove to be most efficient. Using our method together with injection of surfactants also looks interesting and promising.

According to the International Energy Agency, the projects involving cutting-edge methods for increasing oil recovery will bring 300 mln. t of oil annually by 2030.



We are open to cooperation!

Contacts:

www.iefp.pro

iefp@mail.ru