ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 1 , January 2022

Issues of Microwave Impact on Dipole Water Molecules in the Reservoir to Eliminate the Water Barrier

Saydalimov Azizkhuja Saydiagzam ugli

Head of the group geological and hydrodynamic modeling in JSC «O'ZLITINEFTGAZ», Tashkent, Uzbekistan

ABSTRACT: When developing oil and gas fields, there is always such a negative manifestation as the formation of a cone of water near wells. With the movement of formation water into the drainage zone and its adhesion to the rock, water saturation increases and, accordingly, the phase permeability to water. An alternative effect of microwaves (microwave) on the water barrier in the bottomhole zone of the well is proposed in order to destroy it and restore gas production. The effectiveness of the action of microwave waves is determined by the frequency of the field and the dielectric constant of the emulsion. With the resonant interaction of waves with the medium, an intense destruction of the structure of the rocks adsorbed on the surface occurs.

KEYWORDS: Oil, gas, water, microwave, electromagnetic, well, bottomhole, frequency, experiment.

I. INTRODUCTION

When developing oil and gas fields, there is always such a negative manifestation as the formation of a cone of water near wells. With the movement of formation water into the drainage zone and its adhesion to the rock, water saturation increases and, accordingly, the phase permeability to water. At the same time, there is a decrease in the gas saturation of the formation and the phase permeability of the gas, and the gas stops moving to the bottom of the well. The pressure of the formation gas in the confined volume becomes insufficient for its movement through the formed water barrier and the well stops producing useful production.

Usually, in such cases, sidetracks are cut in wells or special screens are created to prevent the flow of formation water or other technologies are used, after which they cause inflow by replacing the fluid with a lighter fluid (liquid column relief method) or with pumping (liquid level reduction method), which lead to a decrease in pressure at the bottom of the wells and a depression is created. All these operations are time consuming and costly.

An alternative effect of microwaves (microwave) on the water barrier in the bottomhole zone of the well is proposed in order to destroy it and restore gas production.

In this case, the electromagnetic field acts on the dipole water molecules and straightens them. As a result of polarity reversal, water molecules are inverted, hitting each other, and for this reason, their vibration speed or temperature increases. At the same time, water molecules begin to vibrate and detach from the rock surface, thereby reducing capillary forces, which makes their further removal possible.

In 1942, the American physicist Percy Spencer reported the electromagnetic effect of microwave waves (UHF) on dipole water molecules. Since that time, this technology has been widely used in everyday life in microwave ovens. The electromagnetic field acts on the dipole water molecules and straightens them. As a result of polarity reversibility, water molecules turn over, hitting each other, and for this reason the speed of their oscillations increases, i.e. temperature.
The flooded zone of the formation is in an adsorbed state. Due to the complete adhesion of water to the rock, the gas stops moving through the channels in the rock. The formation pressure is not sufficient to move gas through the barrier zone and the well is crushed. As a result, such wells are abandoned.

Recently, the above technology has begun to be applied in the oil and gas industry, for the evaporation of water from oil emulsions (Patents: US No. 2757738 E21B 43/00; RF 2454532; RF 1824983). Technologies such as SAGD, hot steam

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 1 , January 2022

injection and thermochemical methods of reservoir stimulation are used to stimulate the production of high-viscosity oil. In order to increase the intensity of the impact of hot steam injection or with the SAGD technology, in Canada, it was recommended to use microwave for additional heating of water directly in the reservoir [1], which will increase the efficiency of fluid displacement.

The proposed technology is unique in that the microwave will be used for the first time in solving the problem of eliminating the water barrier in the near-wellbore zone, which will quickly restore gas production wells.

II. CALCULATION RESULTS

A number of experiments on bituminous deposits, in order to determine the effectiveness of the microwave effect [2], on the intensification of the extraction of bitumen from the rock, showed a noticeable temperature (up to 240 ° C) and the depth of exposure to microwave microwave waves up to 40 m (Table 1).

Table 1. Results of experiments on bituminous rocks.

Exposure time, min	Heating temperature, ^{0}C	% rock water content	Wave radius, м
before processing	140	1,5	-
15	145	0,5	40
30	230	0,4	36
60	360	0,1	25,5

The effectiveness of the action of microwave waves is determined by the frequency of the field and the dielectric constant of the emulsion. With the resonant interaction of waves with the medium, an intense destruction of the structure of the rocks adsorbed on the surface occurs. Experimental and theoretical studies have shown that the main difference from other thermal methods of exposure is the emergence of destructive forces that manifest themselves at the micro- and nanoscale [2].

Experimental and theoretical studies have shown that the main difference between microwave and other thermal methods of exposure is the emergence of destructive forces that manifest themselves at the micro- and nanolevel [3].

The principle of operation of this technology lies in the fact that dipole water molecules, which create a barrier, at the initial stage lead to a significant decrease in well productivity. With a further increase in the volume of barrier water, the gas-dynamic connection of the reservoir-bottomhole system is disrupted (Figure 1).

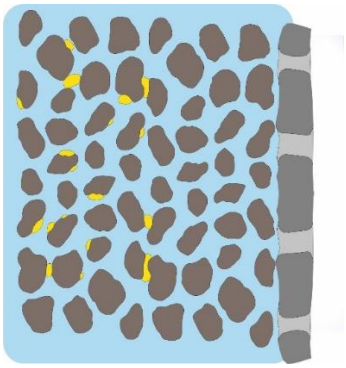

Figure 1 - Disruption of the gas-dynamic connection due to the water barrier

The task of the technology described above is to destroy the resulting water barrier, which causes a decrease in the productivity of gas production wells. With an increase in the size of the water barrier, a part of the volume of the gas

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 1 , January 2022

reservoir is pinched and the gas-dynamic connection of the well bottom with the pinched volume of gas ceases (Figure 2).

Usually, in such cases, sidetracks are slaughtered or special screens are created in the zones of formation water inflow with subsequent pumping of water from the well, or modern technologies are used such as VDI or others.

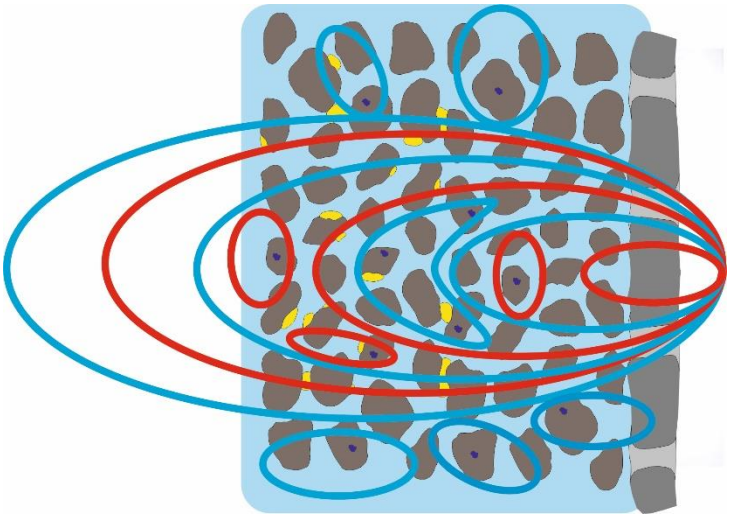

Figure 2 - Electromagnetic waves when exposed to microwave with the influence of metals in the rock

It is difficult to destroy the above-mentioned connection between water and rock in reservoir conditions. The created drawdown is not sufficient to destroy this connection, the gas flow to the bottomhole stops and the watered well is out of operation.

To resume gas production in such wells, the following is proposed. A special string of small-diameter lift pipes with a special nozzle, where a microwave generator and a gas-lift valve are installed, are lowered into the closed well. An important condition for the operation of a microwave generator in such wells is the presence of an open hole or cased hole - using new polymer technologies in the gas-saturated interval.

After lowering the column of lift pipes, voltage is supplied to the microwave generator via a special cable. Treatment of the formation with microwave waves is carried out in 2 stages:
- waves of low power (up to 5 kW), frequency 2400 MHz, duration 3 - 6 hours;
- high power waves (5 - 50 KW), frequency 2400 - 2500 MHz, lasting up to 1 hour.

At the second stage of treatment, the water present in the reservoir turns into a vapor state, due to which the pressure increases sharply and cracks are formed in the rock.

The metals contained in the rock, during exposure to microwave frequencies, behave as centers of secondary oscillations of electromagnetic waves, which will cover a larger radius of exposure (Figure 2).

Dipole water molecules in the initial state are in a chaotic state in the reservoir. A thin layer of water between the grains of the rock is adsorbed due to electrochemical action with the rock, i.e. polar water molecules are attracted to the rock by electromagnetic forces and the rock becomes hydrophilic and the adhesion process occurs (Figure 3).

It is difficult to break this bond of water between the rock in reservoir conditions. The created drawdown is not sufficient to destroy such a connection, the gas supply stops, the well is closed or transferred to another horizon.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 1 , January 2022

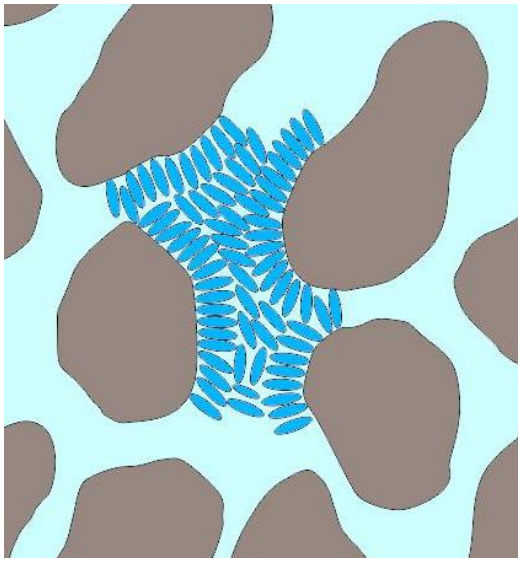

Figure 3 - Interaction of dipole water molecules with rock

A small-diameter pipe string with a special nozzle with a microwave generator and a gas-lift valve is lowered into a closed well (Figure 4). An important feature of the microwave generator is the presence of an open face or cased with new polymer technologies.

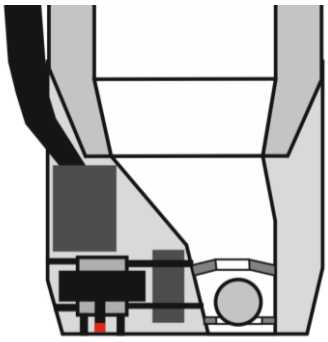

Figure 4 - Special shank with microwave generator and check valve

- After lowering the pipe string, voltage is applied through the armor cables. Formation treatment is divided into 2 main stages:
- • treatment of a seam with low power, up to 5 kW at a frequency of 2400 MHz for a long time (from 3 to 6 hours);
- • treatment of the seam with high power, from 5 to 50 kW at a frequency of 2400 to 2500 MHz for up to 1 hour.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 1 , January 2022

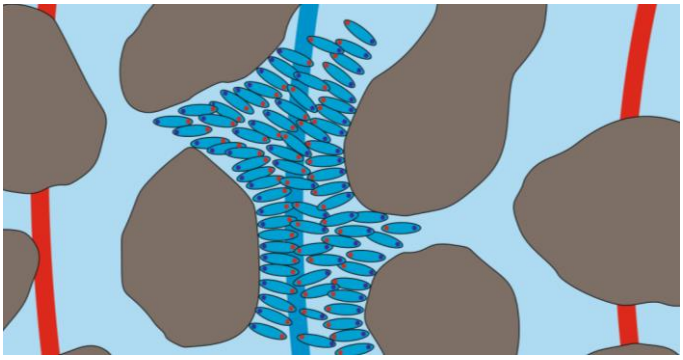

Figure 5 - Straightening of dipole molecules under the influence of microwave.

During the second stage of treatment, the water in the rock turns into a vaporous state, due to which the pressure increases sharply and cracks form inside the formation.

The polarity of electromagnetic waves in 1 second changes 4,900,000 times, therefore, water molecules rotate with the same frequency. As a result of this effect, water molecules collide with each other and release a large amount of heat over a large radius of exposure to microwave waves (Figure 5). As a result of this effect, adsorbed molecules are detached from the surface of rock grains and make it possible to subsequently remove water from the rock with minimal energy consumption (Figure 6).

During the first stage, electromagnetic waves penetrate to a great depth into the formation, which is up to 30-40 m from the source of oscillations, i.e. from the microwave generator.

During the second stage, waves penetrate to a shallow depth, up to 20 m from the source.

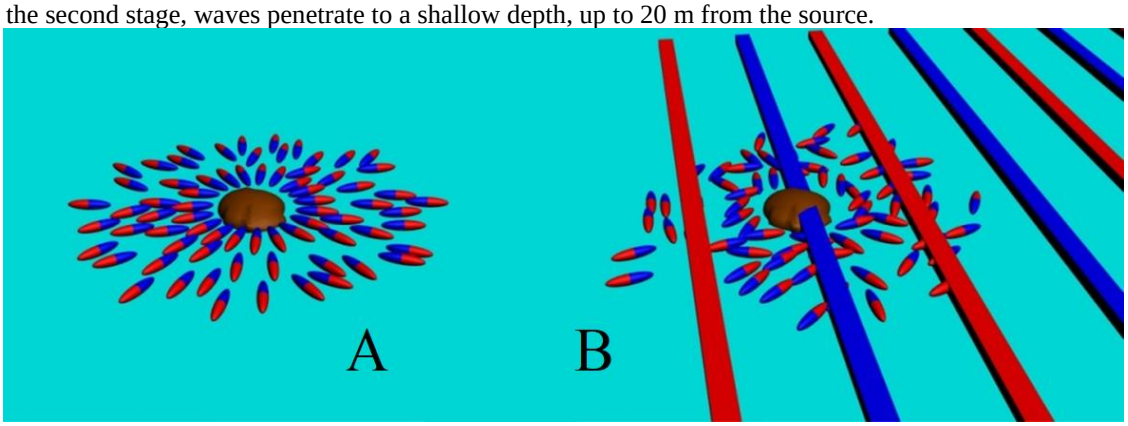

Figure 6 - Impact of electromagnetic waves on dipole molecules, (A) before exposure to microwave, the molecules are in an adsorbed state, (B) under the influence of microwave, molecules are excited.

After the second stage, the source of electromagnetic oscillations is switched to low power. Gas is pumped into the annulus and water in the well, as a result, gasification is facilitated.

III. CONCLUSION

As a result of exposure to microwave waves, adsorbed water in the rock heats up and turns into a vaporous state, which at the initial moment will lead to an increase in water saturation, followed by a decrease and an increase in gas saturation (Figure 7).

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 1 , January 2022

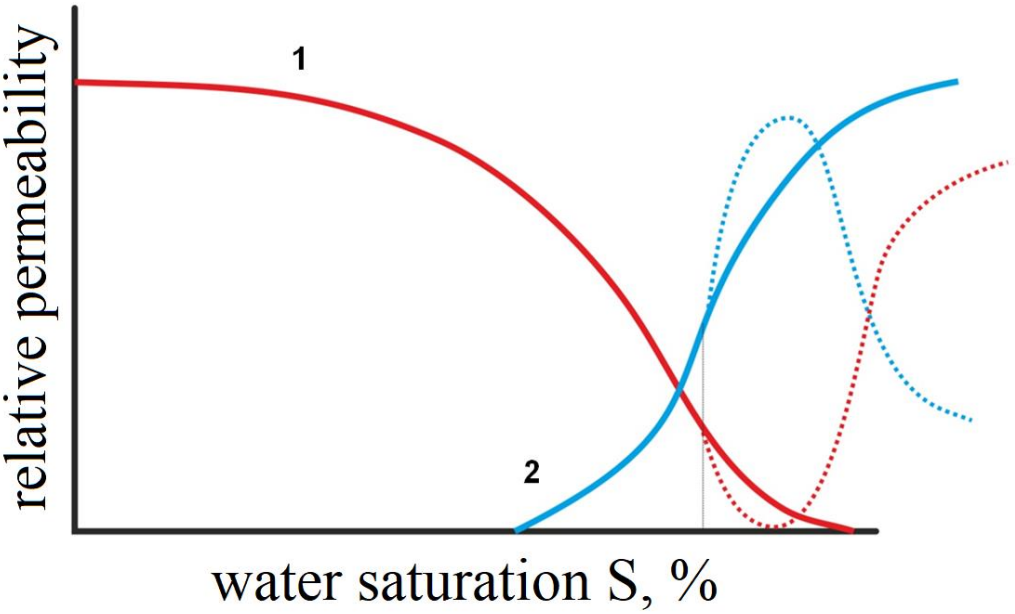

Figure 7 - Water saturation without treatment and with the use of microwave (1 - gas saturation; 2 - water saturation)

The pipe string is raised and the well is turned on at a gentle depression. Also, this technology can be used to destroy the calmations arising from lost circulation.
The main danger of work is the presence of fats and water molecules in the human body, therefore, during the operation, a person should not approach the well closer than 30 m.

The technology described above can also be used to destroy the calmutation zone formed as a result of the penetration of drilling mud into the bottomhole formation zone, as a result of which the hydro- and gas-dynamic components of the formation bottomhole zone are noticeably improved.

REFERENCES

[1] Zakirov S.N. Development of gas, gas condensate and oil and gas condensate fields. Moscow: Nedra, 1981.
[2] Abdrafikova I.M., Kalyukova G.P. et al. Influence of microwave exposure on the extraction and composition of natural bitumen from bituminous rocks and the property of their asphaltenes Trudy BashGU, 2002.
[3] Kovaleva L.A., Zinnatullin R.R. Application of HF and SHF electromagnetic fields in the preparation of oil and processing of oil sludge. Proceedings of BashSU, 2006.

AUTHOR'S BIOGRAPHY

Saydalimov Azizkhuja Saydiagzam ugli – Head of the group geological and hydrodynamic modeling in JSC «O'ZLITINEFTGAZ».
Direction of activity - issues of increasing the efficiency of the development of oil and oil and gas fields, using three-dimensional geological and hydrodynamic models.
Has more than 5 scientific publications in republican and foreign scientific and technical journals and conferences.