APPLICATION OF SMALL-SIZED VACUUM ACCELERATING TUBES FOR NEUTRON CONTROL OF INCREASING DEBIT OF OIL WELLS BY ACOUSTIC INFLUENCE OF THE FORMATION*

A. E. Shikanov, B.Yu. Bogdanovich, A.V Ilyinsky, D. R. Khasaya[#], A. Nesterovich,
D.D. Ponomarev, E. Shikanov, MEPhI, Moscow, Russia

Abstract

The report presents experimental studies results of the possibility using the technique of neutron "labeled" reagent (NaCl) for monitoring of the acoustic effect (AE) results in the oil reservoir to increase oil production debits. These obtained data allow us to estimate the effectiveness of acoustic influence the method on managed oil reservoirs in conjunction with the equipment which pulsed neutron-neutron ray logging based on vacuum accelerator tubes that implements the method of neutron "labeled" reagent. The proposed instrumental set ensures reliable process control stimulation of oil from the reservoir and the allocation of layers to abnormal filtration and capacitive properties and their subsequent development.

MANUSCRIPT

One of the most effective methods of cleaning fluid productive zone recovery in oil well is AE at her longitudinal ultrasonic pressure wave. In the pores of the reservoir fluid-filled productive, there are transient oscillatory micro streams. With sufficient intensity ultrasonic wave cleaning these areas contribute microstreams productive fluid extraction from the above contaminants. [1]

The effectiveness of the AE direction in oil reservoirs can be improved by controlling the parameters of the processes occurring before and after AE in oil reservoirs and selecting intervals stimulation oil. Measurements of changes in the formation of these processes are made remotely through a metal pipe casing, which requires the use of transparent methods of control.

The most effective is the pulsed neutron-reagent method. It allows the monitoring of changes in the formations chlorine containing fluid during its displacement pumped reagent containing solution. The specified control is pulsed neutron method based on the measurement of the lifetime of thermal neutrons in the formation, depending on the composition of the substance contained in the pores. This structure defines the process of formation in the reservoir and the well resulting deceleration,thermalization and diffusion of the field of thermal neutrons, falling in time exponentially.

The time variation of the decrement recession thermal neutron density characterizes the content of chlorine in the reservoir due to its abnormally high radiative capture cross section. This solves the problem of determining water contact due to shortage of chlorine in the oil-rich part of the formation and the presence of excess reagent

in a solution in water due to its mineralization. Lack of formation water or hydrocarbons in the reservoir also affects the damping rate of the neutron density decline, which is proportional to the total cross section of neutron absorption.

In implementing the method of pulsed neutron-neutron logging (PNNL) with the reagent before and after AE in the reservoir in the study area creates a pulsed periodic field of fast neutrons emitted by the accelerating tube (AT), the result of passing on its target nuclear reaction T(d, n) ^{4}He. After slowing down neutrons to thermal velocities begins the process of decay of the neutron density. In this case, the decline of the spatial density of neutrons occurs exponentially with a decrement proportional to the total neutron absorption cross-section [2]. Measuring the density of a neutron decay detector is filled with 3He, which proceeds in the amount of nuclear reaction ^{3}He (n, p) T, followed by analysis of the time spectrum known methods used in experimental nuclear physics. [3]

The measurements were carried out using hardware methods complex AIOC-43 (development VNIIA named by N.L.Duhov) [4] on the basis of compact pulsed neutron generator [5] and multi-channel time analyzer [3].

Upon command from the ground control unit through the correctional system is launched neutron emitter in a repetitively pulsed mode. As a result of the interaction of fast neutrons generated in the target vacuum accelerating tube, in the study of the geophysical environment shapes the field of thermal neutrons.

The detection system converts this field into analog electrical signals that are in well telemetry system are converted into digital information that is sent in geophysical well logging cable telemetry unit to the ground. In this unit, this information is decoded and formatted as a series of files, coming to a computer. The computer is processing the information on the two-component processing algorithms logging signal [3,6]. The result depends decrement Depreciation thermal neutron density λ of the depth of the test bed.

If the acoustic impact inflow of hydrocarbon fluid, it will be recorded a significant decrease in the decrement recession thermal neutron density, since this reduces the concentration of nuclides detected. In the case of failure of the process of acoustic impact or fill water reservoir effect of changing the decrement will be less significant.

Equipment complex consists of ground control unit (geophysical station), which controls the change of geophysical instruments (instrument pulsed neutron
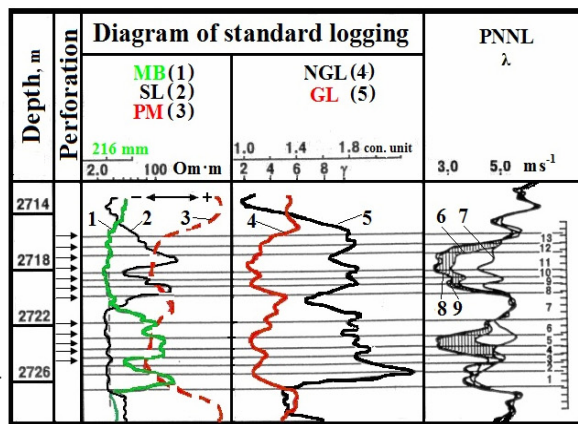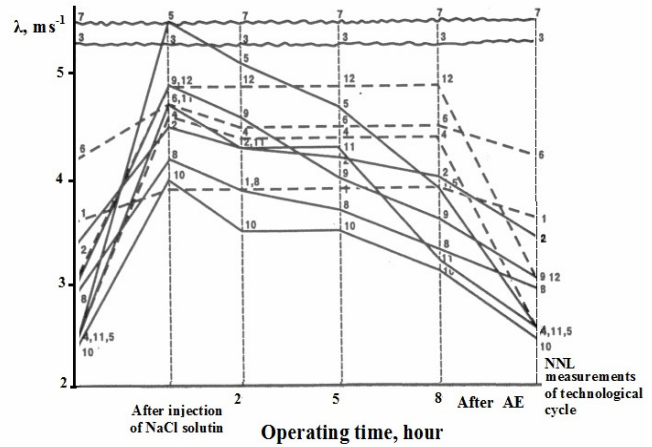
Figure 1: a) Diagram of experiment results in the well by the method of neutron-"labeled" substance and directional acoustic stimulation (right vertical scale numbers are seams); b) Temporary change of decrement λ in layers in the process of technological cycle measurements on well PNNL.

generator and the device acoustic action), depending on the work performed. Replacement geophysical instruments lowered into the well through the valve by tubing to the oil reservoir. Geophysical studies were conducted at the perforations seams.

Measurements were carried out by the method of PNNL after the first injection of the labeled solution, then after 8 hours of recovery (recovery of productive hydrocarbons) and finally after AE in the monitoring section of the reservoir interval. Recording was performed with PNNL lifting speed of 40 m / h The main interpretive the-damping constant λ the thermal neutron density calculated from the measurements of PNNL with a special program of processing two-logging signal. The working solution was used standard technical NaCl solution with density 1180 kg/m3.

During the experiment in a well on the above method were performed as follows:

a) Background recording PNNL, followed by treatment in the test signal logging intervals;

b) injection into the well of the solution, the subsequent recording and signal processing PNNL;

c) a record PNNL after an 8-hour work strata;

d) issued by AE in layers and subsequent recording and processing of PNNL

Fig.1-a. shows the resulting experimental logs. In the first two fragments are standard geophysical logging chart:

MB - measurement of borehole diameter (caliper), SL-side logging (logging type of resistivity recovery wells), PM-potential measurement spontaneous polarization, depending on the lithology of the borehole that is logged on the potential difference between two spaced electrodes (probes) NGL - neutron-gamma logging (measurement of the intensity of the secondary γ-radiation produced by irradiation of rock neutron source rocks in the well-GC γ-

ray logging (recording the intensity of natural γ-radioactivity of rocks in the well).

In the third figure shows a fragment PNNL diagram illustrating the change control of the damping decrements the density of thermal neutrons in the process of the work in the well to intensify the flow of oil and the breakdown of oil reservoir (1 ÷ 13) in the depth of their location, different filtration properties collectors.

Layers are divided by differences of λ, the decrement values obtained by comparing the results of the correlation of background measurements with measurements after: a) push into the layers of the labeled solution, and b) an eight-hour working out of the directional acoustic stimulation. Dedicated strata characterized by different dynamics, the degree of absorption and impact of the labeled solution. When comparing the background diagrams and control charts in separate cycles of measurement established that error definitions are usually random and can be up to 2% to a thickness of 1m. When comparing the results of measurements in different cycles observed small (up to 5%) differences of values of the damping decrement of thermal neutrons due to various backfilling. This distortion is additive and can be easily removed by comparing diagrams to support layers - noncollector, with obviously unchanging properties on the damping decrement of thermal neutrons. The data obtained were evaluated λ changes of reservoir properties of the layers:

- No change in λ push NaCl solution into the formation and development of the eight layers indicates the absence of the connectivity in the well
- In layers 4, 6, 12, minor changes compared to the decrement using NaCl solution in the formation and development of a marker of poor reservoir properties of these layers.

- In layers 5 and 8, with a mean change in the decrement using NaCl solution in the formation and development of their shows low filtration properties of reservoirs.

The data obtained by the interpretation of the definition of reservoir formation properties marked layers 4, 5, 6, 8, 9,11,12. There has been directed acoustic impact on these layers and then measuring PNNL control effectiveness to develop recovery after AE

Fig.1-b. shows changes in reservoir mapping λ decrement in the time interval of work on the well. The ordinate values are laid decrement recession thermal neutron density λ for various spans and technological cycles of pulsed neutron-reagent method (x-axis). In this case, layers with different numbering have different reservoir properties.

The results of correlation comparing the measured values of λ before and after the directional acoustic effects using a solution of the reagent NaCl suggest cleaning processes reservoirs of oil reservoirs. This is a group with a lower reservoir properties - layers 4, 5, 8, and to the development of reservoirs 9,10,11.

The data obtained with the use of reagent AE indicate the intensification of treatment reservoirs containing oil. This is a group with lower reservoir properties (zones 4, 5, 6, 9, 10, 12), which were not used 8 hours working out well.

Factor increasing the adaptability of this technique is the possibility of its combination with traditional events in the wells, requiring the use of chlorine-containing substances. For example, the killing of a well solution NaCl, CaCl during repair works, hydrochloric acid treatment beds, etc.

For solving complex problems stimulation and detail inhomogeneous cut oil layer on the dynamics of processes of filtration displacement and the involvement of the oil reservoir (thickness h> 0,2 m) with different reservoir properties.

REFERENCES

[1] Kuznetsov O.,L., Efimova S.,A, "The use of ultrasound in the oil industry," Moscow, "Nedra", 1983

[2] Shimelevich Y.,S, Cantor S.,A.,Shkolnikov A.,S., Popov N.,V., Ivankin V.,P., Cedars A.,I., Miller V.,V.,Polyachenko A.,L., Physical basis of pulsed neutron techniques for wells. , Nedra, 1976, p.122-130.

[3] Bogdanovich B.,Y., Nesterovich A.,E.,Shikanov A.,E.,Vorogushin M.,F.,Svistunov Y.,A., Remote radiation control with linear accelerators. V.2. Radiation monitoring systems. M., Mechanical Engineering, 2012, p. 284.

[4] Amur A.,G.,Kurdyumov I.,G., Titov I.,A., Hassan T.,S., Shipunov M.,V., Apparatus pulsed neutron-neutron logging for use in modern technology for wells. Sat Materials of the International Scientific Conference "Portable neutron generators and technologies based on them," Moscow, VNIIA them. NL Spirit, 2005, p. 253 - 255.

[5] Bessarabian J.,G., Bogolyubov E.,P., Kurdyumov I.,G.,Simagin B.,I.,Shikanov A.,E.,Downhole neutron emitter. Instruments and Experimental Techniques, № 5, 1994

[6] Startsev A.A., Fedyna E.A., Shikanov A.E. Appl. Radiat. Isot.Vol.48, No.10-12, 1997, p.1329-1330.