

THE VIBROSEISM IMPACTS TECHNOLOGY: LONG-RANGE ACTION AND POTENTIALS FOR APPLICATIONS.

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Introduction: An advanced ecologically correct Vibroseism Impacts (VSI) Technology has been developed and implemented for oil and gas production enhancement as well as to increase the total recovery. It is based on reservoir rock medium properties and physical processes within, and their control. The Technology employs seismic vibrations generated at the surface all across the oilfield, which leads to higher stressed state level of the medium, and, respectively, to higher reservoir pressure and the production rate and recovery therefore increases.

In previous publications we have gradually been submitted the selected academic and practical aspects of the Technology proposed by us and based as we have mentioned before at the discovery of a previously unknown conformity with natural law of the behavior of weak high frequency seismic signals. This work is dedicated to description of the Technology efficiency and prospects for its application in large scale.

Description: The staff of the Scientific Center of Seismology of the Presidium of the Azerbaijan National Academy of Sciences, had successfully implemented the Technology in many different regions among which the most long application has been done on a contract basis from November 1996 until May 2005 in the oil fields of the "Prikamneft" OGPD (Oil-and-Gas Production Department) "Tatneft" PC, Tatarstan, RF. The operations were implemented by the "Seismotech Globe" B. V. Dutch company, which has been handed over the rights for use of Eurasian (№ 001474), European (№ 1266121) and Canadian (№ 2406794) Patents. The idea of the possible impact on the state of the medium from the earth's surface has appeared (back in 1980) in connection with the discovery of the emission preceding the earthquakes specific with its frequency and amplitude parameters in the seismic field. Emission, which at certain stages of its development possessed the energies which were comparable with the energies excited in a medium by vibroseism machine. We assumed that the existence of such kind of effect allows performing vibration impacts on the medium to control and manage its state. Initially, we set ourselves two objectives: the first - to create additional cracks in the medium to increase oil inflow and, the second, - to create the so-called "running wave" in the medium to squeeze the oil along a certain direction, notably, towards the wells.

After the experiments conducted we concluded that the technique of local seismic impacts on any part of the field (or on a separate well) is basically wrong, since it leads only to a redistribution of stress fields in the oil field's medium. And if we can increase it at some part of the oil field, then in other parts the energy of the medium is greatly reduced and, consequently, production is also reduced.

A conclusion that was fully justified in future had been made. Namely, that during seismic impacts the entire field should be regarded as a single non-homogeneity, in order to cover it totally with increase in stress fields, and the drop in stress fields was originated in outside medium.

The principally new features of the Technology are as follows:

1. This methodology of the oilfield study has the purpose of identifying and using of a medium parameter that has not previously been taken for consideration – the stressed state.
2. This methodology of the oilfield study has the purpose of identifying and using another medium parameter that also has not been considered before - the distribution at the territory which 1,5-2,0 times exceeds the dimensions of oilfields of local internal volumes, which are sensitive or insensitive to external impacts.
3. For the first time a physical parameter – vibration field has been taken for consideration. Field tests have documented that the growth (or changes) of its intensity leads to redistribution of tension within the reservoir medium, which has the effect of increasing pore size and reservoir pressure.

The application of the Technology includes the following steps:

1. Geological, geophysical and technological data consideration, and preliminary background observation, including the following: conducting seismic studies, and gravity and topography survey of the oilfields; conducting stratum pressure measurements; study of the production rates of all oilfields wells.
2. Development of the oilfield stressed state model.
3. Development of the model of the effects (impacts) to be introduced by vibroseism machine.
4. Administration of the vibration effect program.

Depending on the reservoir rock medium and fluid properties, as well as the geological and geophysical peculiarities of the formation structures, improved production will continue several months, after which the

whole stimulation procedure must be repeated. As practical research has shown, a 2 – 3 months cycle is the most beneficial and economically profitable. This will allow the maintenance of high stratum pressure and the additional oil production.

Implementation of the Technology lead to increase the level of medium's stress state and level of stratum pressure, protects oilfield from penetrating of underground water from external sources and its subsequent destruction. Furthermore, the Technology does not require an additional pumping of water of other reagents. By this the offered Technology allows to obtain other not less important in economical and ecological meaning results: decrease of water cut of recovered liquid and levels of environmental pollution and the oilfields irrigation.

The vibrational impacts aimed at the certain points in the oilfield cause the redistribution of the stress field within the reservoir rocks along with the production stratum. This causes their partial restructuring, occurring of an intensive seismic emission, and, as a result, the emergence of new filtration channels. In particular, the dilatation occurs in production stratum along with observing the opening of the pores and filtration channels. And as a result of vibro impacts sufficiently reducing viscosity of liquid, speed up filtration processes (particularly in finely disperse medium and weak penetrated volumes of stratum), leading to much more oil production.

The "Prikamneft" OGPD data analysis indicates that before the vibrational treatments started, the desirable result in the oil production enhancement was not achieved through the usage of any other methods of production stimulation (Table 1). As it follows from the data, the best result, that had been accomplished, is the slowing down of the decline in oil production. It is possible to say that there are no methods used by OGPD or other companies in previous years, which had comparable results with the vibrational impacts generated from the earth surface in accordance with the (VSI) Technology developed by us.

Table 1. Oil production improving using various methods (in tons and %) at Pervomayskoye (P) and Bondyujskoye (B) oilfields of the "Prikamneft" OGPD.

Years (P)	1997	1998	1999	2000	2001	Total
VSI Technology	55704 (82%)	61309 (85%)	72818 (85%)	76893 (79%)	90079 (76%)	356803 (81%)
Other methods	12643 (18%)	11287 (15%)	12654 (15%)	20074 (21%)	28827 (24%)	85425 (19%)
Total	68347	72596	85472	96967	118906	442288

Years (B)	1997	1998	1999	2000	2001	Total
VSI Technology	12043 (71%)	47435 (87%)	37131 (91%)	68823 (91%)	102754 (86%)	268186 (87%)
Other methods	4853 (29%)	7094 (13%)	3929 (9%)	6377 (9%)	16368 (14%)	138621 (13%)
Total	16896	54529	41060	74200	119122	306807

At the Pervomayskoye field 15 different methods for increasing production were used and the fraction of extra oil, obtained by means of the VSI, was 81% during the 5 years period, and all other methods taken together represented 19%. And at the Bondyuzhskoye field for the same period of time between 11 different methods used the fraction of extra oil, obtained by means of VSI, was 87% and for all other methods taken together represented 13%.

To show great effectiveness of VSI Technology we present the following data of comparison between VSI and all other methods, used at the "Tatneft" PC: in 2004 in accordance with the monthly reports the overproduction of oil since the commencement of the VSI application increased 9 times.

High efficiency of the VSI Technology is also reflected in the "Tatneft" PC prospects on oil production ("Tatneft" PC Protocol from July 16, 2005, № 325/58-56, signed by the entire company's management). By means of different methods it was assigned to produce additional 47 thousand tons of oil during the first half-year of 2005. Out of this total additional oil production 36 thousand tons were assigned to output by means

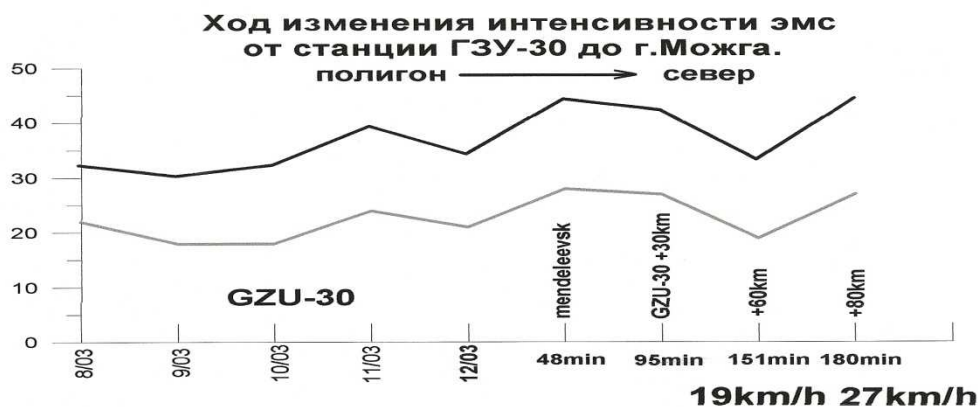
of only VSI and it was just 11 tons planned to be get by the remaining 15 geotechnical methods and means for oil production increase: less than 1 thousand tons for each method (!). Thus the actual value of the Technology in the “Tatneft” PC is 36 times more than by means of any method used in the company.

It should be noted that subsequent analysis of the complex of works and comparison with the results of application of other methods led us to a conclusion about the possibility of a much broader realization of the proposed Technology. It can be used not only for separate fields but for a sufficiently large area of thousands of square kilometers, for impacts on all oil fields located within this region. The results of studies long-range effects of vibration impacts in 35-40 different seismic and aseismic regions have shown that correctly organized vibration impacts followed by occurring of the deformation fields gradually, cycle after cycle, cover the territory with linear dimensions 7-10 times exceeding the area of immediate impact.

As it known, there are numbers of hydrogeological earthquake precursors observed, and among them those which have being reflected in changes in oil production. It is noted in the work (4) as well, dedicated to seismicity and oil production relationship studies. They revealed very important effects, understanding of which along with others led to the Technology development. Firstly, these impacts can affect on fields even at distances up to 200 km., significantly altering layer pressures and production rates long before the main shock of earthquakes. Secondly, about the existing of allowable limits changes of stratum pressures, exceeding of which led to non-linear deformations in medium.

Further research is confirmed by numerous physical measurements showed that the strong changes in the fields caused by vibration exposure were observed not only at oilfields of the “Prikamneft” OGPD (500 sq km) but at distances of 100-150 km or more. Thus, we studied the course of the electromagnetic signals intensity change at different distances from the vibration sources: 20 km, 30 km, 60 km, 80 km, 120 km, 150 km. (Figure 1). The speed and intensity of “seismogravitational” waves are well correlated with those studies on the relationship the seismicity between planet’s different regions and with the data represented in the work (6) as well.

Figure 1. An example of electromagnetic waves intensity changes in North direction from station GZU-30 (at the polygon) to Mojga city.

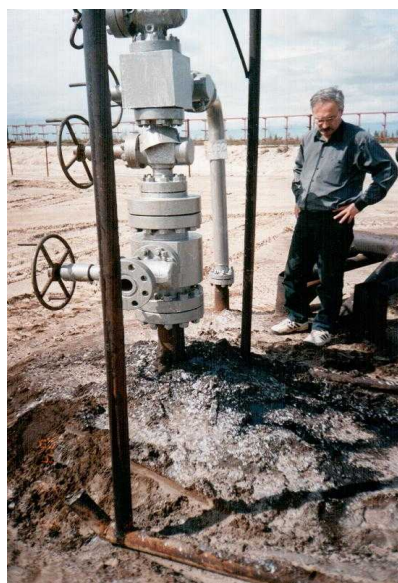


This is also confirmed by data published in articles (7,8), in which it was stated that “in 1996 - 2005 the Company intensively implemented new methods for increasing production” without referring specifically to the VSI. In article (8) it was noted how production in total in “Tatneft” PC was changed from 1990 until 2003. Since 1990-1994 it demonstrated a considerable decline in production. Then for one year production increased due to the new oil field exploration starting. And since 1995 it demonstrated a small decline, but from 1997 it is being characterized by constant and progressive increase in production: by 0.4%, 1.6%, 3.5%, 6.9%, 10.8%, 12.6%, and 14.0% respectively. The total increase in oil production at the fields of “Tatneft” during these years represented 49.8% compared to 1996 (25550.1 thousand tonnes) or 12,724 tonnes. This is 18-20 times greater than the amount of oil produced additionally at “Prikamneft” OGPD during the VSI implementation specified (and paid) in the relevant documents. The data of the article (7) comparatively demonstrate trends in the decrease of oil output in Russia and Tatarstan for the period from 1986 till 2005. For the first 10 year the trends are similar to each other, but from 1996 to 2005 (exactly, in the period of the VSI implementation) Tatarstan showed the reversed trend of oil output increase.

Remote effects are confirmed with quite a series of facts, when wells which did not work for a long time started to flow (fountains) as a result of impacts performed in accordance with our technology. Figure 2 (a,b) shows examples of such a wells located at distances of 30-65 km from impact points: Elabujskoye oilfield, “Tatneft” PC (a), and Novo-Pureyskoye oilfield “Rosneft” PC (b).



(a)



(b)

Conclusions: Summarizing the above, we believe - and this is the essence of our results, obtained during the complex of recent studies that the Technology developed by us nowadays can be used in much large scale, purposefully and simultaneously used in territory with the radius of 100-200 kilometers and more. In contrast with all the currently existing methods for increasing oil production, affecting the bottom hole zone of wells, or some parts of fields. The Technology allows its implementation not only at nearby located separate fields, as we previously used, but for carrying out impacts and control for a positive influence on the stressed state of the medium and increase in oil production and recovery at all fields located in mentioned territory.

Such a large-scale work proposed by us would significantly increase the economic potential of the entire region. This will not only allow to increase oil production by 15-30% and oil recovery up to 60-80% in total for all fields, but no less importantly, to bring the medium into energetically homogeneous state to slow down and prevent further rapid destruction and flooding of fields in today's hazardous environmental situation which touched Mexican Gulf and other regions already. For instance, the results of new analysis show that ecological problems become more pressing for the next big region: the Middle East, which includes Saudi Arabia, Libya, UAE and Qatar. Such work has never and nowhere been conducted previously, but we are absolutely confident in their positive result and the possibility of increasing total production.

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