THE INFLUENCE OF HORIZONTAL WELLS' DRILLING COURSE ON PRODUCTIVITY: THE CASE STUDY OF FIELD X IN WEST SIBERIA

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Horizontal sidetracked wells at field X have been put into production since 1992. For the present, in total 6 horizontal wells (HW) and 29 horizontal sidetrackings (HST) have been drilled and put into production at field X. Since the commercial development of field X has began, 6 horizontal wells, 5 of them are recovery wells, and one more is disposal well have been drilled and put into production. For information, in 1992-1993 3 wells with the horizontal shaft length ranging from 200 to 300 m were drilled. As for 2015, 3 wells (one of them is a disposal well) with the horizontal shaft length ranging already from 600 to 700 m were drilled. 29 horizontal sidetrackings have been drilled and put into production. It should be noted that drilling of HST began only in 2008. Altogether, since the commercial development has began, 5 HST with horizontal length 200-300 m and 24 HST with horizontal length 300-400 m have been drilled and put into production, 1 of them worked both as recovery and disposal well at different times.

In the course of well performance analysis, graphs with main production indexes, distributed along the directional attitude of the horizontal shaft have been plotted. For convenience and clarity the wells are divided into groups according to their borehole directions. Average indexes of oil production rate, liquid rate and number of wells over the first 3 months are taken.

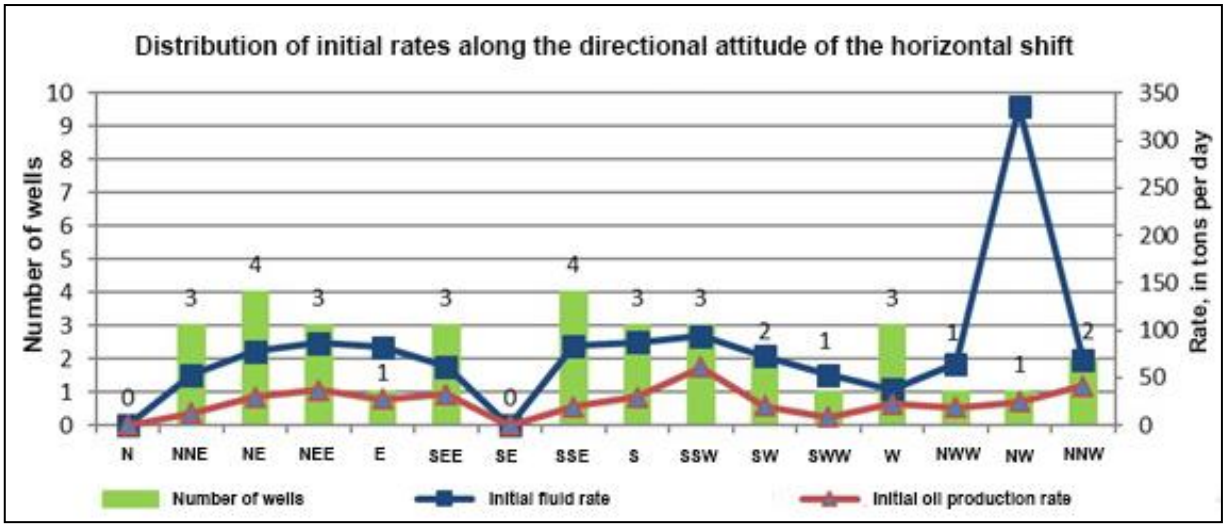

Fig.1 Distribution of initial horizontal well rates and horizontal sidetracking rates at reservoir X along the directional attitude of the horizontal shaft

Figure 1 shows that the highest initial liquid rate was achieved when the horizontal shaft was arranged along the north-west direction. Nevertheless, it also shows that only one horizontal well was drilled in this direction; this data is not enough for identifying any relationships. The highest initial oil production rates and liquid rates were achieved when horizontal wells were drilled along north-east-east and south-south-west directions. The number of wells in this direction comprises 16.

There were investigations on identifying the directions of regional stress of well 15 at field X in 2015. Rock anisotropy was calculated by fast and slow shear waves' speed difference after normalization according to the fast wave in percentage form (Figure 2). The turn of factual measurement is referred to the true travelling direction of fast and slow shear waves (S) (the direction of speed anisotropy). Fast and slow directions have to be checked with azimuth position of the receiver. If a fast/slow azimuth position follows the azimuth of the rotating receiver, the measured anisotropy might be a false phenomenon which is the result of recording peculiarities [1,4]. According to the research results, the lateral pressure direction of rocks at reservoir X comprises ~130-145 degrees.

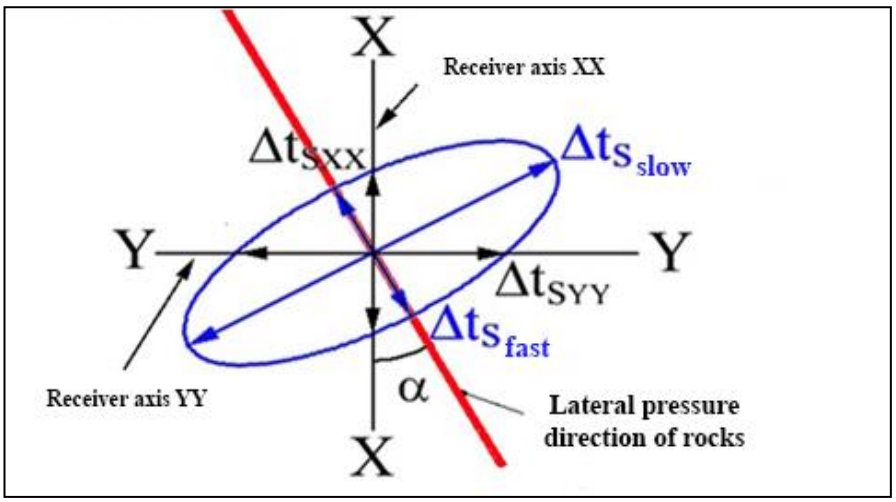

Fig. 2 Results of the research conducted at field X by means of full-waveform logging apparatus, where: α – speed anisotropy angle referred to the direction of receiver XX, SF – fast shear wave, SS – slow shear wave, SXX – recorded shear wave in XX direction, SYY – recorded shear wave in YY direction.

This horizontal wells selection at reservoir X included the wells, where after the start (in the first 3 months) the hydraulic fracturing treatment has been conducted. Hence we may conclude that the best drilling direction for horizontal wells or horizontal sidetrackings at field X are north-east-east and south-south-west directions. When drilling in this direction, i.e. perpendicular to the regional stress direction (according to the conducted research), it is assumed that due to the rock stress difference the fractures resulted from the hydraulic fracturing treatment develop in the best way along the direction of rock stress (~130-145 degrees). Therefore, the highest fracture length can be achieved, and consequently, the bigger formation coverage and the higher well productivity can be obtained [3,2].

In the future it is necessary to conduct additional research at reservoir X and to consider the possibility of drilling new wells in north-west direction, as the only well drilled in this direction has shown the highest productivity.

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REPEATED HYDRAULIC FRACTURING IN HORIZONTAL WELLS WITH UNCEMENTED LINER

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The oil and gas industry has recently faced the problem of reducing the productivity in horizontal wells which are equipped with assemblies for multi-stage hydraulic fracturing in uncemented liner condition. The quantity of such wells is growing every year. In 2013, LLC «Gazpromneft-Vostok» conducted first multi-stage hydraulic fracturing and by today 15 of such wells have actually been put into operation, 2 of which are carrying out acid multi-stage hydraulic fracturing. As a result, the actual problem is to find solutions for performing effective repeated stimulations on a given formation employing existing assemblies.

The proposed solutions are simplified to the following options:

1) Small-sized liner technology;
2) Technology with a chemical deflector (blocking existing cracks by insulating compound);
3) Cup-to-Packer technology;
4) Spot Frac technology (clipping of zones by a two-packer assembly);
5) "Blind" multi-stage hydraulic fracturing.

The aim of this work is to analyze existing, potential possible methods of repeated stimulations of wells with multi-stage hydraulic fracturing, selection of suitable methods for approbation, selection of candidate wells in the company