



Fig. 1 Selection of criteria and selection of weight coefficients

References

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WELL COMPLETION OPTIMIZATION USING THE «FISHBONE» TECHNOLOGY UNDER CONDITIONS OF FACIES HETEROGENEITY OF THE MESSOYAKHA TYPE RESERVOIR

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On the modern stage of oil industry, the part of hard-to-extract reserves is growing every year. Such category of reserves includes reservoirs with transition and continental genesis. These deposits are characterized by the high degree of uncertainty, small sizes of sand bodies and great shale content. The main ways how to produce oil from such complex objects are drilling horizontal wells (which intersect as more sand bodies as possible) with multi-stage fracturing. However, sometimes such methods of enhanced oil recovery are not effective due to geological and technological limitations. For example, hydraulic fracturing (HF) is not recommended in the reservoir where water saturated horizons are close to horizontal wellbore due to the risk of fracture to penetrate them and cause water coning.

Vostochno-Messoyakhskoe field is a complex reservoir which is characterized by a few significant features:

1. High degree of facies heterogeneity.
2. Many faults, different levels of water oil contact (WOC) and gas-oil contact (GOC).
3. Unconsolidated rocks.
4. Gas cap with abnormal properties.
5. 65 % hydrocarbon reserves are in zone with bad poroperm properties (middle and top part of the reservoir).

Drilling a long horizontal wellbore is limited by risk of well collapse and low production build-up. On the other hand, HF is also unrecommended due to presence of gas cap and necessity to keep it unproduced in order to avoid sharp reservoir pressure decline.

Thus, more effective completion decision has to be made which takes into account all features and geological characteristics of the target reservoir – formation PK₁₋₃. The goal of this research is to suggest recommendations for well completion optimization using the «Fishbone» well design under conditions of facies heterogeneity of the Messoyakha type reservoir.

First of all, object of research has to be described. Vostochno-Messoyakhskoe oil gas condensate field is located at Yamal-Nenets Autonomous District and consists of eight petroleum plays. The main object is formation PK₁₋₃ – Pokurskoe suite which is deposited at relatively small depth (around 800 m). This formation is divided into three cyclites [1]. Each of them is characterized by its own sedimentary environment.

- Cyclite C (the deepest): deltaic channels.
- Cyclite B: tidal sandy flat.
- Cyclite A: tidal shaly-sandy flat.

After considering the properties in each cyclite it can be said that trends of characteristics from bottom to top of formation is following:

1. Degree of rock consolidation decreases
2. Reduction of sand content
3. Higher reservoir compartmentalization
4. Worse poroperm properties
5. Transition from deltaic to tidal flat environment
6. Sand bodies orientation: S-W (channels) → S-E (flats)

According to the field development experience optimal length of horizontal section in wells is 1000 m. For production from cyclite C most optimal case is using horizontal and multilateral wells for zones with good properties and shale zones

respectively (Figure 1). In cyclite B the most effective well design is «Fishbone» wells of vertical design (main hole drilled in C-cyclite). flow rate of «Fishbone» is more by 50-80% than flow rate from horizontal well [2].

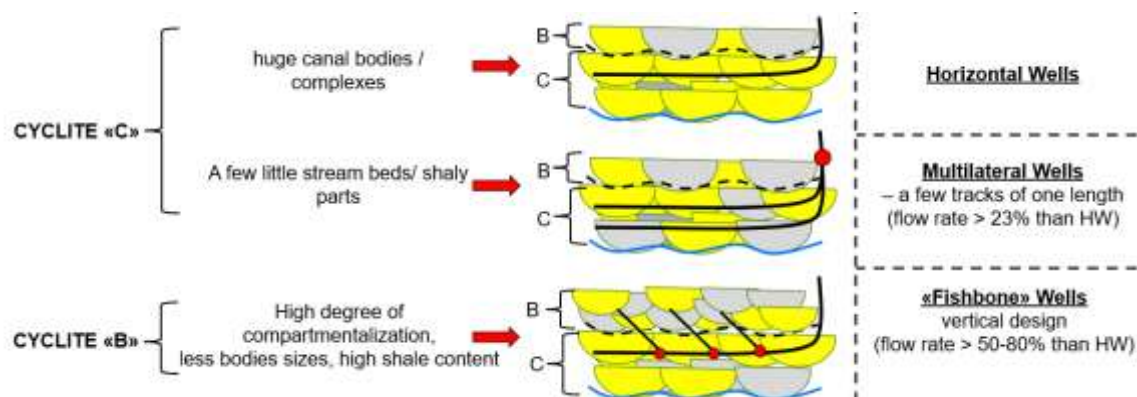


Fig. 1. Experience and key features of formation PK_{1.3} development [2]

In order to estimate «Fishbone» wells performance, simplified geological and hydrodynamic flow models should be built. Parameters of model grid is described in Table 1.

Table 1

Characteristics of the grid

Model characteristics	Cyclite C	Cyclite B	Cyclite A
Bodies orientation in horizontal plane (azimuth), °	225	135	135
Net to Gross, v/v	0.75	0.6	0.45
Sells number (Z-axis)	10	20	20
Grid size	100x100		
Sells orientation, °	45		
Sells number (total)	955500		

In order to fill grid with «net-to-gross» properties, object modeling method was used. The size and orientation of sand bodies was changed in each layer – cyclite (Figure 2).

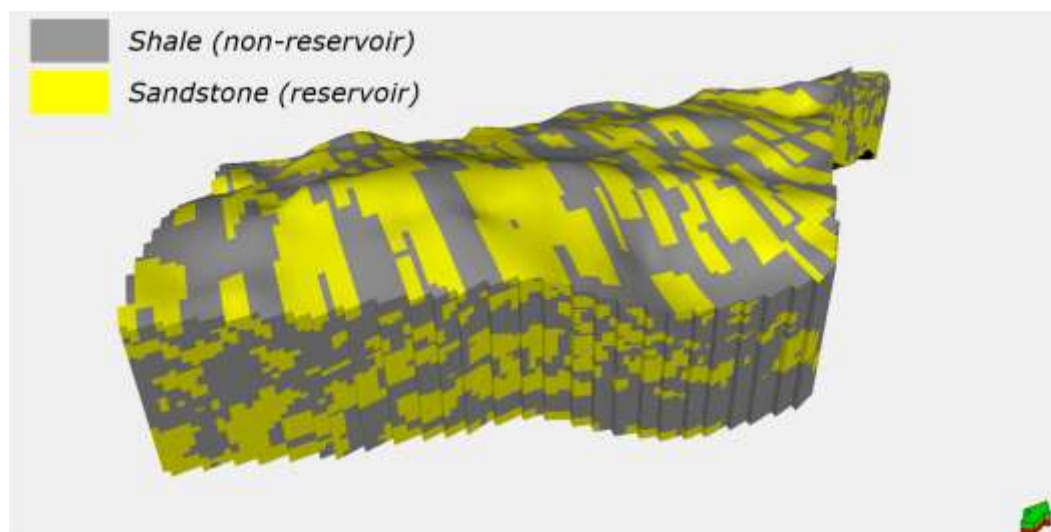


Fig. 2. Simplified geological model (sand bodies distribution)

After PVT-properties was adjusted, «Fishbone» wells of different designs were analyzed. First of all, design of horizontal well and «Fishbone» well with 6 and 8 tracks were compared. It can be said that «Fishbone» wells are even more effective than wells with horizontal section which is two times longer than main hole of considered «Fishbone» wells (Figure 3).

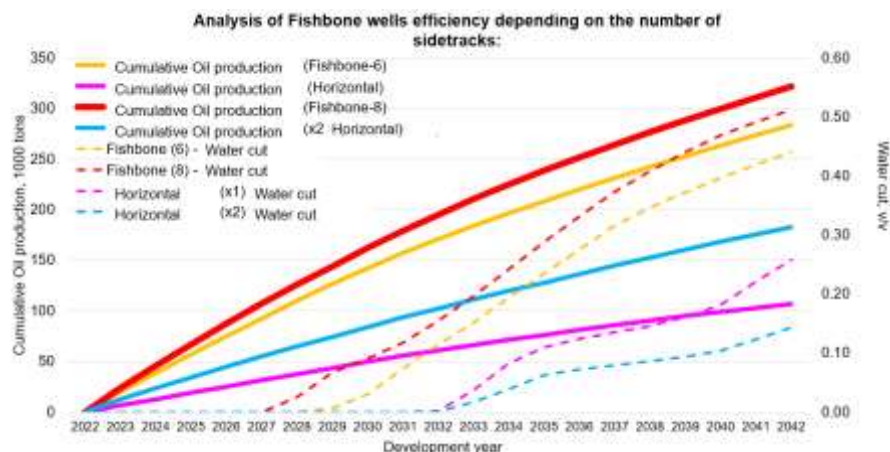


Fig. 3. Comparison of horizontal and «Fishbone» wells with various number of sidetracks

According to literature review and conducted model analysis, growth of angle increases drainage area and change sidetracks interfering [3]. However, when certain angle is achieved, higher values of angle cause relative low growth of production. For following calculation optimal angle between main hole and sidetrack is assumed to be 45°.

Then, the three cases of line drive flooding development systems were compared: with horizontal producers, «Fishbone» producers with 6 and 8 sidetracks. The resulted is presented at the Figure 4.

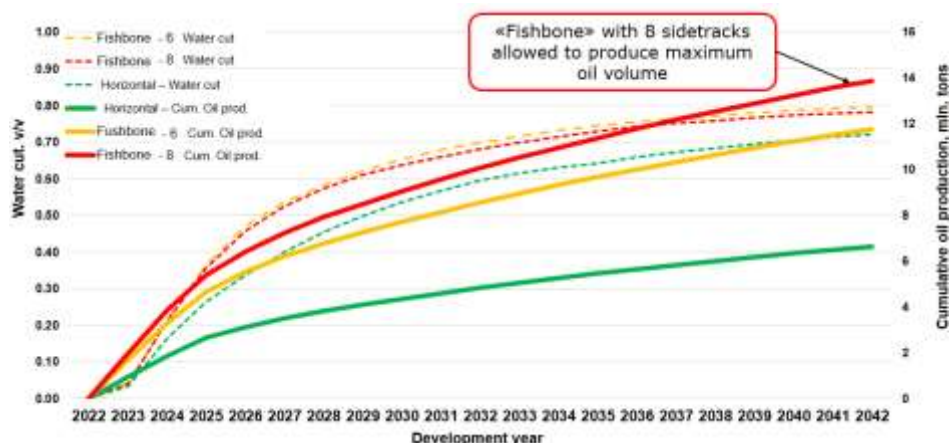


Fig. 4. Comparison of the development schemes

At the end, some completion recommendations can be made.

Development of cyclite C.

For tectonic blocks with oil-saturated thicknesses – drilling of multilateral wells (in shaly zones) and horizontal wells (zones with good properties) is effective. Length of horizontal sections – 1000 m. Drilling of wells should be made in the southeast direction, azimuth 225° (along large channel systems).

Development of cyclite B.

Calculations proved the efficiency of «Fishbone» wells of lateral design with 8 sidetracks (angle 45°). For further optimization, it is possible to increase the number of sidetracks to 10-12 (further increase will be impractical due to high wellbore interfering and too small distance between the tracks) and the angle with the main hole for accelerated production. When developing in blocks with oil-saturated cyclite "C" - drilling of the main hole in "C" with subsequent sidetracking in cyclite "B" should be made in order to involve it in development. The length of the parent wells is 1000 m, sidetracks – 300 m. Drilling of wells in the southeast direction, azimuth 225° (to involve a larger number of isolated lenses).

Development of cyclite A.

It should be performed only after development of the oil part of the reservoir. It is advisable to develop oil-saturated thicknesses according to the same principle as cyclite "B" (similar morphology of reservoir bodies).

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