Results processing of hydrodynamic studies of wells of the Bazhenovskaya suite

A V Sarancha

Tyumen Industrial University, 38, Volodarskogo street, Tyumen, 625000, Russian Federation
E-mail: 89044914477@mail.ru

Abstract. The main purpose of writing the given article is to highlight the results of hydrodynamic studies of wells drilled in the Bazhenovskaya suite of one of the oil fields located in the Tyumen Region of the Russian Federation. At the mentioned field, studies of the technology of thermal gas exposure on source rocks were carried out. That was the first experience of applying thermal gas exposure to the source rocks of the Bazhenovskaya suite, which was of great interest to specialists from research and design institutes engaged in the design and development of oil and gas fields.

1. Introduction
Structural features of the reservoirs of the Bazhenovskaya suite at a given field and field data on the nature of the operation of production wells do not allow the unambiguously interpretation the results of the conducted hydrodynamic studies. All wells exploiting Bazhenovskaya’s deposits work with a significant decrease in the productivity coefficient during relatively short time (up to several months), up to a full stop. Moreover, it was noted that after a prolonged forced shutdown of production wells, the reservoir pressure measured in them before start-up is restored almost to the initial one, and the whole cycle repeats again. In such conditions, the calculation of the filtration properties of the drainage areas leads to significant errors, therefore, the results processing of the hydrodynamic studies according to standard methods ends with the determination of pressures and productivity coefficient.

2. Results and Discussion
In the case of non-transient inflows, wells were studied by tracking a level or pressure over time. The tracking results were processed by the standard Muraviev-Krylov’s method by plotting graphs \( P_{\text{аб}} - f(\frac{dP}{dt}) \) or \( \Delta H_{\text{дин}} - f(\frac{dH}{dt}) \). Those graphs were used to calculate productivity factors, as well as reservoir pressure or static level.

Also at that field, studies by the method of hydraulic interception were conducted. As disturbing well 219 was chosen, wells No.No. 401, 3000, 3001 and 3002 were the reacting ones.

As an example of the interpretation of hydrodynamic studies, the results for wells 219, 401 and 3000 are presented.

Figure 1 shows the processing of the pressure change curve for the well 219, which consists of the pressure drop curve after the well start-up and the subsequent pressure recovery curve recorded after the well has been stopped.
Processing of recordings was carried out using a computer program for processing measurements from hydrodynamic studies of wells “Sapphire” using the best-match method. According to this method, the actual downhole pressure change curve is matched with the exact solution of the piezo-conductivity equation for a particular reservoir model. The processing algorithm is an iterative process of varying the determined parameters to the maximum possible matching of the actual and the calculated curves.

![Figure 1](image1.png)

**Figure 1.** Processing of the pressure change curve. Well 219.

Based on the analysis of the diagnostic graph, Figure 2, and a review of possible interpretational models, it was found that the best matching of the actual and the calculated curves followed according to the double permeability model.

![Figure 2](image2.png)

**Figure 2.** Diagnostic graph. Well 219.
According to the double permeability model, the reservoir consists of at least two layers of different permeability. The flow between the layers is proportional to the pressure differential between them. These layers are opened in the well, there is filtration to the well for each of them and there is a flow from the low-permeable layer to the high-permeability one. If there is no filtration through the low permeable layer, then the double permeability model is converted into a double porosity model.

Studies were conducted by the pressure recovery and the pressure transient methods. First, the pressure recovery curve was recorded, and then the well worked in three modes with registration of changes in the downhole pressure and flow rate measurements. Two areas are rejected on the pressure recovery curves; they are shown (in Fig. 3) as shaded areas. In the first section, obviously, there was a rise in the level, which passes into the pressure recovery curve in the filled well. Without wellhead pressure, such a composite curve cannot be uniquely processed. Level elevation area is rejected. On the final section of the pressure recovery curve, a bend in the curve is observed, caused by some anthropogenic factor. This curve section is also shown on an enlarged scale. It can be seen from the figure that two branches of the curve can not be joined before and after bending. They have different curvatures. Therefore, the entire curve section in the area of the bend and after it is rejected. The curve section between the shaded areas is processed.

![Figure 3. Diagram of hydrodynamic studies. Well 401.](image)

As a result of processing the pressure recovery curve in the well 401, the following data were obtained:
- the effective length of the horizontal barrel was 39 m. This is only 13% of the total length of the barrel;
- the distance from the lower boundary of the reservoir to the horizontal barrel was 15 m;
- skin factor was -1.42;
- permeability in the horizontal direction was 0.0013 μm²;
- the ratio of vertical permeability to horizontal one was 0.098.

Based on well survey data, an indicator diagram has been constructed for the modes. The indicator diagram has the form of a straight line. The productivity factor was 0.149 m³/day·bar.

The study of the well No. 3000 was recognized as a poor quality one, since the time taken to register the pressure recovery curves was not sufficient to use these curves for obtaining the parameters. On the diagnostic graphs – graphs of derivatives, its growth is observed, alternating with a fall. Further, the graph should be cooled and go to the horizontal section. At the same time, to determine the parameters of the reservoir on the converted pressure recovery curve, a straight line segment is selected that
corresponds in time to the horizontal section on the derivative graph. The absence of a horizontal section indicates that the pressure recovery curves are not still recovered properly.

3. Conclusion
1. Insufficient amount of research measurements and their poor quality does not allow making unequivocal and reliable conclusions about filtration properties. In the future, it is necessary to provide for a comprehensive research program that takes into account the need to increase the information content of the hydrodynamic studies. 2. In the area of well No. 219, the type of reservoir can be represented as a reservoir consisting of two media: draining and non-draining ones. 3. In the area of well No. 401, the vertical permeability is 10 times lower than the horizontal one.

References
[1] Baturin Y E 2010 Bazhen without benefits so it will remain. Oil and Gas vertical 23-24 12-16
[2] Deliya S V, Drandusov K A, Karpov V B and Mamaev D.A. 2015 RITEK: Prospecting experience, prospecting, reserves calculation and deposit developments of bazhen formation/ Subsurface management XXI century. 1 (51) 80-83
[3] Korovin K V, Pecherin T N 2016 Analysis of operating results from the bazhenov formation of deposits of the territory of KHMAO-Yugra. International research magazine 12 (54) 91-94
[4] Nesterov I I, Brekhuntsov A M 2010 Oil bituminous clay, siliceous clay and carbonate-silica-clay rocks Vestnik CKR Rosnedra 6 3–16
[5] Sarancha A V., Sarancha I S 2014 Analysis of the bazhen formation development at Ulyanovskoe field. Academic magazine of West Siberia 10-1 128-129
[6] Sarancha A V, Garina V V, Mitrofanov D A and Levitina E E 2015 Pilot Development Planning’s results of bazhenformation of Zapadno-Sakhalinskoe field. Fundamental researches. 2-14 3052-3055
[7] Sarancha A V, Mitrofanov D A, Sarancha I S and Ovezova S M 2015 Bazhen formation development of Ay-Pimskoye field// Current problems of science and education 1-1. 204-208
[8] Tolstolytkin I P 2012 Oil reserves use at the fields of KHMAO-Yugra. Science and FEC 5. 4 26-28
[9] Shandyrin A N, Shpurov I V, Bratkova V G 2015 State and prospects of shale oil deposits development. Subsurface management XXI century. 1 (51) 52-63