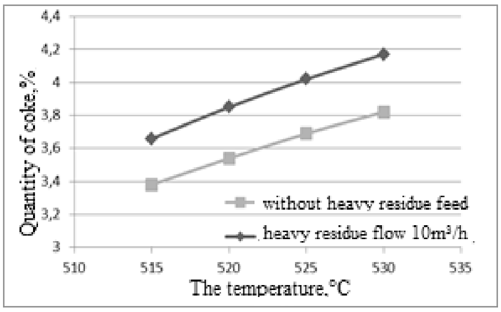
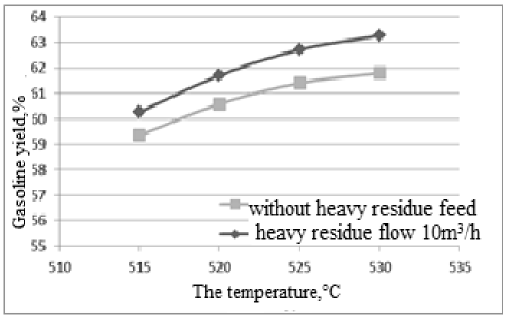
According to Figure 3a, keeping up the flowrate of heavy residue in the riser at 10 m^3/h provides the increase of coke amount in riser reactor due to leakage of polycondensation reactions involving heavy hydrocarbons (aromatic hydrocarbons and resins). When the process temperature is increased to 521,4°C to 530,0°C the coke amount is increased from 3.6% to 4.2% (Figure 3a).





a) *b)*

Fig. 3. a) The dependence of coke yield from the catalytic cracking process temperature.
b) The dependence of gasoline yield from the catalytic cracking process temperature

Thus, increasing the load of coke while maintaining the flow rate of the heavy residue in the riser at 10 m^3/h and process temperature at 525°C (maintaining the catalyst circulation ratio at 5.7) lead to increasing the concentration of coke to 4.0% and accordingly increased the temperature of cracking catalyst after regeneration. The yield of high octane gasoline increasing (Figure 3b) from 60.1 to 62.7% (the octane number of gasoline by motor method 87 p.), the output of wet gas rich in propane-propylene and butane-butylene fraction was 18.3% for raw materials.

Thus, optimization the thermal regime of processing of raw materials with a high content of paraffins and naphthenes by increasing slops flow rate (10 m^3/h) in the catalytic cracking reactor allows to increasing the yield of coke and 4.0%, and respectively increasing the catalyst temperature after the regenerator, without increasing the reactor temperature to 535°C.

References

1. Khadzhiev S.N. Cracking of petroleum fractions on zeolite catalysts. – M.: Chemistry, 1982 – 276 p.

IDENTIFICATION METHOD OF INDICATOR DIAGRAM BY INTERPRETING THE MEASURED RESULTS OF GAS-DYNAMIC WELL TESTING

Nguyen Thac Hoai Phuong
Scientific advisor professor V.L. Sergeev
National Research Tomsk Polytechnic University, Tomsk, Russia

Development of a method for identification and interpretation of the measured results of gas-dynamic well testing (GDWT) by indicator diagram (ID) allows taking into account additional prior information, improving the accuracy of the reservoir pressure and flow parameters determination, reducing testing time.

Stabilized flow gas-dynamic well testing is one of the main methods to determine the flow parameters and the productivity of a gas well. A major limitation of traditional methods of identification and interpretation GDWT is a large number of flow periods to obtain the required stabilized data to provide the accuracy of results [1].

To ensure the sustainability and improve the accuracy of the methods of interpretation GDWT by ID it is recommended to use the method of the integrated system of ID models based on a priori information about the parameters of the reservoir, which allows us to integrate the raw data, additional prior knowledge, experience and knowledge into a single system model that provides stability assessments and significantly increases their accuracy [2, 3].

Models ID and interpretation algorithms with a priori information**.** The method of interpretation of stabilized flow GDWT used an integrated system model of ID $p_{пл}^2 - p_з^2 = aq_i + bq_i^2$ (Forchheimer) with variable parameters based on a priori information about the reservoir pressure $P_{пл}$

$$\begin{cases} y_i^* = \alpha_1 + \alpha_2 q_i + \alpha_3 q_i^2 + \xi_i, \\ \overline{\alpha_1} = \alpha_1 + \eta, i = \overline{1,n} \end{cases} \leftrightarrow \begin{cases} Y^* = F\alpha + \xi, \\ \overline{\alpha_1} = \alpha_1 + \eta \end{cases}, \qquad (1)$$

where $y_i^* = P_{i,з}^2$, q_i - the square of the bottomhole pressure and flow rate obtained within well test period *i*; $F = (1, -q_i, -q_i^2, i = \overline{1,n})$ - matrix of the known values of flow rates; $\alpha = (\alpha_1 = P_{пл}^2, \alpha_2 = a, \alpha_3 = b)$ - vector of unknown parameters of model ID; $\overline{\alpha_1} = \overline{P}_{пл}^2$ - additional priori information and expertise square reservoir pressure; ξ_i, η - random values; *n*- the number of flow period. Method integrated model of ID (1) provides a stable estimates of the filtration reservoir parameters and, at the same time, can significantly increase their accuracy by using additional priori information.

Definition parameters of integrated model ID (1) is reduced to solving optimization problems in the form:

$$\alpha^*(\beta) = \arg\min_{\alpha} \Phi(\alpha, \beta) = \arg\min_{\alpha} \left(\left\| Y^* - F\alpha \right\|^2 + \beta \left\| \alpha - \overline{\alpha} \right\|_W^2 \right), \qquad (2)$$

optimization problem (2) is reduced to solving a system of linear algebraic equations:

$$(F^T F + \beta W) \cdot \alpha^*(\beta) = (F^T Y^* + \beta W \overline{\alpha}), \qquad (3)$$

here $\arg\min_x f(x)$ means the minimum point x^* of the function $f(x)$; $\|X\|_W^2$ means quadratic form $X^T W X$; $W = diag(h_1, 0, 0)$ - diagonal matrix of the control parameters determining the importance (weight) of priori data. For receiving (3) the partial derivatives of the parameter α must be taken from the combination (2) and equate them to zero. It should be noted that when $\beta = 0$, the priori information is not taken into account (traditional method of least squares) and the system of linear algebraic equation (3) will be in the form

$$(F^T F)\alpha^*(0) = F^T Y^*, \qquad (4)$$

The results of the gas-dynamic well testing by model ID. The results of the interpretation GDWT in the Urengoy gas condensate field of the Tyumen region are shown in Figures 2-5.

Figure 1 shows the measured values of bottomhole pressure and production rates of wells number 1 and number 2, depicted by lines 1 and 2, respectively

Figures 2, 3 present the estimates of reservoir pressures on different flow periods of wells 1, 2 obtained by solving a system of linear algebraic equations (3) (line 1) and (4) (line 2). Expert estimates of reservoir pressures $\sqrt{\overline{\alpha}_1}$ for wells 1,2 equal 316 atm and 264 atm, respectively.

Figures 2-5 show that the proposed method, the models (1) and algorithms interpretation by ID (2),(3) make it possible to determine the reservoir pressures, the filtration resistance coefficients more accurately, and reduce the number of flow periods well testing as compared to the traditional interpretation of technology based on the method of least squares (4).

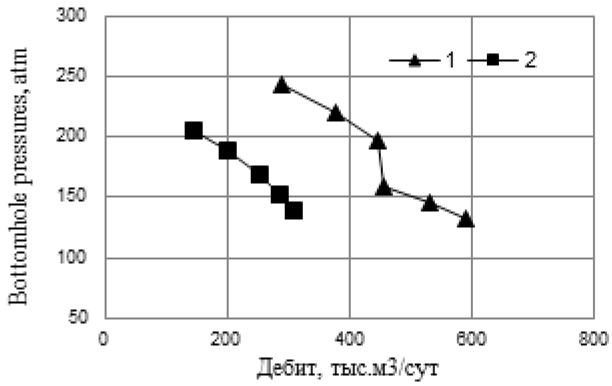


Fig. 1. Indicator diagrams of wells 1, 2

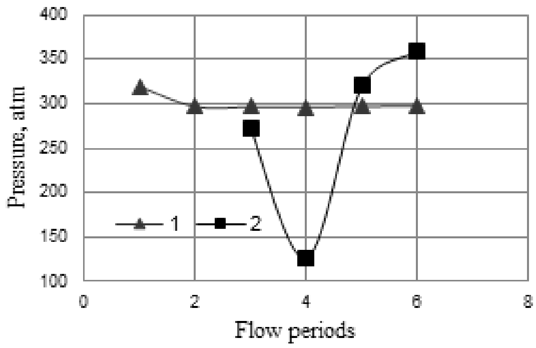


Fig. 2. Estimates of reservoir pressure of well 1

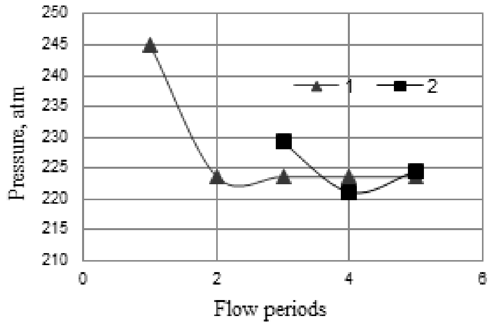


Fig. 3. Estimates of reservoir pressure of well 2

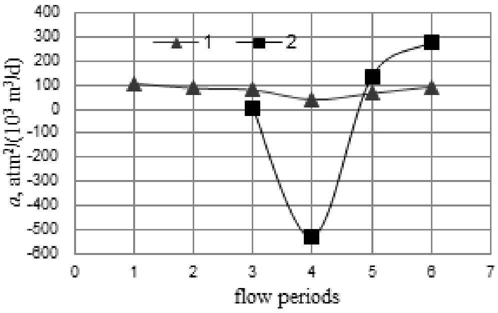


Fig. 4. Estimates of filtration resistance coefficient a of well 1

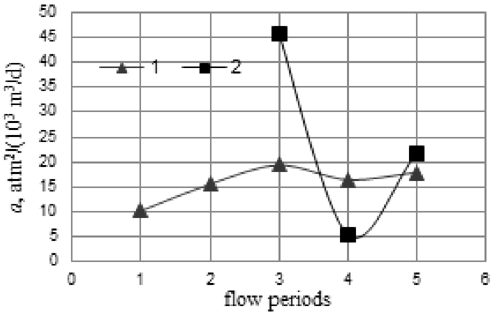


Fig. 5. Estimates of filtration resistance coefficient a of well 2

To determine the parameters of gas and condensate reservoirs as a result of stabilized flow gas-dynamic well testing is proposed to use the method of interpretation based on the priori information allows obtaining good results with a small flow periods of testing. The study of the interpreted data of gas-dynamic of two wells testing in the Urengoy gas condensate field shows that the proposed method, models, and algorithms for the identification and interpretation allow determining reservoir pressure, increasing the accuracy of the estimates of the filtration resistance coefficient, reducing the time for well testing.

References

1. Aliev Z.S., Gritsenko A.I., and others. Rukovodstvo po issledovaniyu skvazhin [Well test guide]. Moscow, Nauka Publ., 1995. 523 p
2. Sergeev V.L. Integrirovannye sistemy identifikatsii [Integrated systems of identification]. Tomsk, TPU Publ. house, 2011. 198 p
3. Nguyen Thac Hoai Phuong., Sergeev V.L. Identification method of indicator diagram by interpreting the measured results of gas-dynamic well testing // Bulletin of the Tomsk Polytechnic University. Geo Assets Engineering. 2005. T.326. № 12. pp. 54-59.

THE PROGRAM OF ENERGY EFFICIENCY OF OIL AND GAS COMPANIES

I.S. Ostranicyn, N.A. Rodionova, S.S. Tugutova
Scientific advisor assistant E.M. Vershkova
National Research Tomsk Polytechnic University, Tomsk, Russia

Effective management of resources of the enterprises is not a recent issue. Effectiveness of use of resources is traditionally understood as an optimum ratio between results and costs of their achievement when at minimum expenses of resources the greatest result (effect) is provided [4].

Procedures of formation of resource efficient strategy in oil corporation have to consider all factors of direct and indirect influence affecting functioning of oil company.

It is necessary to analyze in details factors of the internal environment and, first of all, the available resource capacity of the enterprise and extent of its effective use (Fig. 1).

Now questions of energy saving are especially actual practically in all industries. The oil and gas extraction enterprises (OGE) are compelled to develop and introduce the whole complexes of energy saving actions [2]. The energy audit of all technological processes for the purpose of defining links where effectiveness of use of energy resources is insufficiently high is carried out and there is a potential for energy saving (Fig. 2).

It is necessary to develop the comprehensive program of energy efficiency for the direction of exploration and production of the oil and gas companies of the Russian Federation.

The processes aimed at energy efficiency include [1] (Fig. 3):

1. Development of actions for energy efficiency increase;
2. Monitoring of realization and receiving economic effect of actions;
3. Distribution of the best practices in the field of energy efficiency;
4. Motivation to energy efficiency increase.