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Evolution Of Petroleum Stratum Efficiency By - Multi-Factor Regression Analysis

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ABSTRACT

The forecast of the final petroleum effect of stratums of deposits, being - entered into the development is too complicated. On tile base of multifactor of 27 petroleum and 15 under gas deposits, related to carbonate collections regression equations were derived. Models described by these equations are actual for the deposits with similar geological, physical, and techno¬logical parameters. Usage of these models allows us to make a prognosis of the final petroleum effect of deposits, being introduced into the development.

KEYWORDS

Oil, deposit, layer, fields, stock, oil recovery, floodings, statistical models, geological field factors, carbonate collectors, the project of development.

INTRODUCTION

The considerable number of statistical techniques of the definition of recoverable oil reserves and final oil recovery is known (1).

The majority of statistical techniques are based on studying of dependencies of the cumulative oil production on the cumulative selection of liquid and water. The parameters entering these dependencies depend on geological physical characteristics of a deposit and the system of flooding. Advantage of statistical techniques – the simplicity of calculations.

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However an essential shortcoming them is incomplete accounting of the majority of geological physical and technical factors and also their changes in a process, developments. Therefore, considerable errors in calculations are possible at their utilization.

THE MAIN FINDINGS AND RESULTS

The most authentic forecast of indicators of flooding of oil pools can be carried out only on the basis of detailed studying of a geological structure of real oil-bearing layers with the use of the complete information from each well and mathematically determined process modeling of oil recovery from layers taking into account all features of their geological physical properties and conditions of development.

However, in many cases, especially at an early stage in the study of deposits, direct calculations of oil recovery are difficult, since information on the structure of the layers is not enough for detailed geological modeling. In these cases, it can be greatly beneficial to analyze data on the fields that are under development and have similar geological and physical conditions.

1. Currently, there are several statistical models for different oil and gas regions of the country, which can be used for an approximate estimation of oil recovery [1–4, 6–8; 11, 31-34,]. These models are based on the analysis of various geological and field information.

It is relevant to apply any statistical dependences only to conditions to similar in what they are received. Therefore, when using multidimensional correlation dependencies it is necessary that geological and technological factors of the studied deposits corresponded to input data of statistical models. The most exact results can be received in case parameters, fields are close to average values of the parameters used at creation of models [1].

Oil from deposits is retrieved at the continuous influence of different geological, physical, and technological factors. They characterize an environment of the deposits sating those fluids, the applied systems of development and they are shown not separately, and in a difficult interaction. Studying them helps not only to establish the reasons for the varying degrees of using oil reserves but also to solve the main task of developing deposits - to achieve the maximum possible oil recovery coefficient based on the implementation of various measures to reduce their negative impact. Using this mathematical apparatus allows us to evaluate the simultaneous influence of several parameters and to determine the relationship between oil recovery and the main characteristics of the reservoir and the applied development systems. In addition, the method of regression analysis solves the problem of reducing the initial number of parameters by discarding uninformative signs and using only significant factors. In turn, the method of principal components is based on the use of factor analysis. Its essence lies in the transition from the description of a certain set of studied objects with a large set of directly measurable features to the description of a smaller number of maximally informative variables called factors. For interpretation of results of observations, basic data will be transformed by method of the main component that allows reducing considerably a number of the random variables taken into account without essential loss of information about the variability of the studied objects.

As a result of calculations, 5 main components were established that significantly affect the value of the oil recovery coefficient, which accounts for 81.16% of the total dispersion. The revealed main components correspond to the properties of the formation fluids, the values of the permeability coefficient, the value of oil-saturated thickness, the mode of formation drainage, and the density of the well network.

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Significantly, the oil recovery is affected also by the ratio of volumes of oil and gas phases. At the same time, it is noted that with the increase in the volume of a gas phase, the design of oil recovery decreases. (6, 11.12).

In this regard, geological statistical models for assessment of final oil recovery of layers need to be created for deposits of oil, relatives on geological and physical conditions. Therefore, we divide them into four groups: the oil pools dated for terrigenous collectors; sub gas oil - to terrigenous; oil - to carbonate; sub gas oil - to carbonate (5, 167-171).

For receiving geological statistical models for assessment of final oil recovery of layers of branch-off groups on the basis of the researches method of the main component selected the following geological field factors: sandiness coefficient, viscosity of reservoir oil, hydraulic conductivity of layer, the density of a grid of wells, and in sub gas oil objects. Also a gas part ratio of volume to all volume of layer.

According to [1, 3, 4], the following geological and production factors were selected for studying oil recovery in the oil deposits of Uzbekistan, confined to carbonate reservoirs: effective, layer thickness h; permeability coefficient - $k_{пр}$; sandiness coefficient - $k_п$; reservoir oil viscosity - $\mu_н$; reservoir hydraulic conductivity - $kh/\mu_н$; the density of the grid of wells -S, and in sub-gas oil facilities also the ratio of the volume of the gas part to the entire volume of the reservoir (gas + oil) - $V_г/V_п$. The studied parameters for 27 oil deposits had the following meanings: h=1,4÷38 m; $h_{сред}$=10,34; $k_{пр}$=0,040÷0,819 mkm^2; $k_{пр.сред.}$=0,134; r_n-0,022 + 0,95; $r_{п.сред}$= 0,515; $\mu_н$= 0,7÷129,0 mPa*s; $\mu_{н.сред}$=14,073; $kh/\mu_н$ =0,04÷ 1,669 мкм^2*m/mPa*s; $kh/\mu_{н.сред}$=0,258; S= 1,832÷54.4 га/скв; $S_{сред}$=15,297.

The studied parameters changed in limits for 15 sub gas oil objects: h=1,4÷85 m; $h_{сред}$ =13,69; $k_{пр}$=0,060÷0,450mkm^2; $k_{пр.сред.}$=0,300; $k_п$=0,047÷1,0; $k_{п.сред}$=0,0300; $\mu_н$=1,17÷5,28 mPa*s; $\mu_{н.сред}$=2,539; $kh/\mu_н$=0,014÷2,429 mkm*m/mPa*s; $kh/\mu_{н.сред.}$=0,659; $V_г/V_н$=0,121÷0,97; $V_г/V_{н.сред.}$ =0,446; S=2.55÷63.66; $S_{сред.}$=14,559.

As a result of calculations using a computer multivariate analysis program, the following regression equation is obtained:

a) For oil deposits:

$$\eta=0,2456+0,0026*h+0,1819*k_{пр}+0,0861*k_н+0,0010-\mu_н++0,0087kh/\mu_н-0,0009*S \quad (1)$$

The coefficient of multiple correlation of the received model is equal to 0.761;

б) For sub-gas deposits:

$$\eta=0,2607+0,0051\bullet h+0,2367\bullet k_{пр}+0,1013\bullet k_н-0,0044\bullet \mu_н+0,0087\bullet kh/\mu_н-0,0625\bullet V_г/V_н-,0006\bullet S \quad (2)$$

The coefficient of multiple correlation of the received model is equal to 0.816.

Table 1 and Table 2 show the actual oil recovery data of some deposits in Uzbekistan at the final stage of operation, as well as the oil recovery values adopted in technological schemes and development projects and the calculated values according to equations (1) and (2).

Table 1

Coefficient of oil recovery of some oil pools in Uzbekistan dated for carbonate collectors (on a status 01.01.2019)

Field	Horizon	Oil recovery efficiency		
		current	adopted in technological schemes and development projects	calculated by the equation (1)
Sev. Urtabulak	XVHP +XVR	0,380	0,470	0,482
Namangan	V	0,214	0,247	0,285
Sev. Xaudag	I—IV	0,287	0,320	0,336
Amudarya	I- III	0,162	0,467	0,223
Koshtar	I+ II+III	0,122	0,236	0,317
Xodjaabad	V-VI	0,306	0,305	0,215
Xodjaabad	VII	0,130	0,479	0,235
Xartum	VIII	0,201	0.30l	0,320
Zap. Palvantash	V + VI	0,271	0,310	0,324
Xankiz	VII	0,080	0,314	0,267
Apval	V	0,203	0,352	0,281

Apparently (tab. 1, 2), the received equations (1) and (2) give results that are quite comparable to the continuous and design data, in the big range of their fluctuations caused by a significant change of geological field conditions of development of deposits that demonstrates sufficient reliability of models.

Thus, geological and statistical models have been created to justify the final oil recovery coefficient corresponding to the geological and physical conditions of the oil deposits of Uzbekistan.

They can be used both to determine the final oil recovery of newly introduced deposits and to clarify the final oil recovery of long-developed facilities.

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Table 2

Coefficient of oil recovery of some sub gas deposits of Uzbekistan dated for carbonate collectors (on a status 01.01.2019).

Field	Horizon	Oil recovery efficiency		
		current	adopted in technological schemes and development projects	calculated by the equation (1)
Akdjar	XV	0,060	0,207	0,218
K-B Saritash	XV	0,111	0,432	0,223
Umid	XV	0,060	0,200	0,207
Shurchi	XV	0,392	0,299	0,434
Shurchi	XVI	0,154	0,470	0,272
Shurchn	XVII	0,134	0,309	0,274
Djarkak	XV	0,106	0,437	0,227
Zap. Yulduzkak	XVa	0,133	0,420	0,225
Kruk	XVHP+XVR	0,266	0,384	0,421
Karaktay	XV—XVa	0,289	0,842	0,758

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