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# MATHEMATICAL MODEL OF THE OIL AND GAS PROCESS AND SOFTWARE

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## ABSTRACT

*The article describes the implementation of the oil and gas gas process using the quantity of the function saturation method on the problem of 3-phase modeling and the developed software. The results of the practical application of the proposed algorithms are also provided.*

**KEYWORDS:** *Porous Media, Oil, Gas, Darcy's Law*.

## INTRODUCTION

Mineral and oil and gas resources, such as oil and gas, are located in the porous settings of the Earth. We consider the layers of oil and gas fields as a porch environment.In addition to oil and gas extraction in the oil and gas industry, these minerals are obtained by natural pressure, most of them are also extracted using financial methods. One such medium-sized method is the method of expelling oil reserves with water after extraction by the pheasant method.

The question of oil and gas will be discussed in the framework of the mathematical model of the three-phase flour of indecisive liquids. The differences and gravitational forces between the phases are not taken into account.

We define the oil and gas process to simulate the process, that is $S_2 = S_s$ water saturation and, according to $S_1 = S_n$ and $S_3 = S_g$ functions of saturation of oil and gas fillers. This is equal to $S_3 = 1 - S_1 - S_2$.

## MATHEMATICAL MODELS OF THREE-PHASE FILTRATION PROBLEMS.

The quality of mathematical modeling of processes largely depends on how important the mathematical models depend on the study. Most of the phase filtration processes have been identified for the termination process of the same rocky fluid

$$W = -\frac{k}{\mu} \cdot \left(\partial P / \partial x - \rho \cdot g\right) \quad (1)$$

based on Darcy's law. Here *W*, *μ*, *P* and *ρ*, filtration rate, dynamic viscosity, pressure, and density. Darcy's law for multiphase filtration processes (1)

$$W_i = -k_i / \mu_i \cdot f_i\left(S_1, S_2\right)\left(\partial P_i / \partial x - \rho_i \cdot g\right), i = \overline{1,3}, \quad (2)$$

$$m \cdot \partial S_1 / \partial t + \partial q_1(S_1, S_2) / \partial x = \partial[a_{11}(S_1, S_2) \cdot \partial S_1 / \partial x + a_{12}(S_1, S_2) \cdot \partial S_2 / \partial x] / \partial x$$

(3)

$$m \cdot \partial S_2 / \partial t + \partial q_2(S_1, S_2) / \partial x = \partial[a_{21}(S_1, S_2) \cdot \partial S_1 / \partial x + a_{22}(S_1, S_2) \cdot \partial S_2 / \partial x] / \partial x$$

will have an appearance. (3) a system of partial differential equations is a separate system of parabolic type, $a_{ij}(S_1, S_2) \geq 0$ .

(2) the disadvantages of mathematical models of the three-phase leakage process, structured on the basis of the equations of motion, are that $(S_1, S_2)$ bottom of the saturation functions $S_1 = \underline{S_1}$ , $S_2 = \underline{S_2}$ and high $S_1 = \overline{S_1}$ , $S_2 = \overline{S_2}$ в значениях (3) в системе equations $a_{ij}(S_1, S_2)$ the canditors are formed by 0, (3) A system of differential equations and corresponding limit conditions is formed (change of type). This leads to difficulties in the digital mathematical model on the computer to ensure that the mathematical model is not fully compatible with unknown functions.

In this paper, Darcy's law for multiphase propagation processes $W_i = -k / \mu_i \left(\partial P_i / \partial x - \rho_i \cdot \overline{g}\right) - G_{jk}$ (4)

$$i, j, k = \overline{1,3}, i \neq j, i \neq k, j \neq k$$

(4) the mathematical model based on the action equations will be visible to the saturation functions (3), but in this case (3) in the system of differential equations $a_{1,i}(S_1, S_2) = (k / \mu_2) / v \cdot \partial P_{1,2}(S_1, S_2) / \partial S_i + (k / \mu_3) \cdot v \cdot \partial P_{1,3}(S_1, S_2) / \partial S_i$ ,

$$a_{2,i}(S_1, S_2) = (k / \mu_2) \cdot (1 + v_0) / v \cdot \partial P_{1,2}(S_1, S_2) / \partial S_i + (k / \mu_2) \cdot v / v_0 \cdot \partial P_{1,3}(S_1, S_2) / \partial S_i ,$$

и $a_{1j}(S_1, S_2) \geq 0$ , $a_{2j}(S_1, S_2) > 0$ the conditions are met. Hence, the system of equations (3) of saturation (4) of equations of motion is unpleasant. This mathematical model has more adequacy of the real physical process. Bounded conditions against saturation functions must be calculated, and they are free from nausea.

The mathematical model of the capillary pressure between the phases is performed in a quantity with a limited mode of transport. System of equations against saturation from capillary pressures and gravitational forces between phases

$$m \cdot \partial S_1 / \partial t + W \cdot \partial q_1(S_1, S_2) / \partial x = 0$$

(5)

$$m \cdot \partial S_2 / \partial t + W \cdot \partial q_2(S_1, S_2) / \partial x = 0$$

a system of hyperbolic equations.

For future comfort it is considered $S_1 \equiv S_n$, $S_2 \equiv S_s$, $S_3 \equiv S_g$. Здесь $S_n$, $S_s$ и $S_g$ - saturation of the function of oil, water, and gas.

In general, it is difficult to solve the system of partial differential equations of personality by analytical methods. Hence, the approximate method number is used to solve equations (3) and (5).

$$S_n(x,0) = S_{ni}, \; S_s(x,0) = S_{si} \qquad (6)$$

$$S_n(x,0) = S_{nr}, \; S_s(x,0) = S_{sr} \qquad (7)$$

**II. LIMITED CONDITIONS FOR SATURATION FUNCTIONS.**

Assume, at the point, Gx the driving well, and at the point Gф let the oil produce (or use). If will depend only on the water phase in the well (pushing the oil and gas phase out of the oil layer) and that the volume of the phase will be W. It is a mathematical expression of a physical state

$$W_1 = -((1+g_1)/(1+g_1+g_2)) \cdot k/\mu_1 \cdot (\partial P_1/\partial x - \rho_1 g) + (g_2/(1+g_1+g_2)) \cdot k/\mu_2 \cdot (\partial P_2/\partial x - \rho_2 g)$$
$$W_2 = (g_1/(1+g_1+g_2)) \cdot k/\mu_1 \cdot (\partial P_1/\partial x - \rho_1 g) + ((1+g_2)/(1+g_1+g_2)) \cdot k/\mu_2 \cdot (\partial P_2/\partial x - \rho_2 g)$$

formed on the basis of the action equation:

$$W_2\big|_{\Gamma_x} = \left[\varphi(S) \cdot W - a(S) \cdot \partial S/\partial x + b(S) \cdot g\right]\big|_{\Gamma_x} = W \qquad (8)$$

HERE $\varphi(S)$, $a(S)$, и $b(S)$ identified with functions. (8) from the ratio for the function at the point (in the driving well), the constraint is determined by:

$$\left[\varphi(S) \cdot W - a(S) \cdot \partial S/\partial x + b(S) \cdot g\right]\big|_{\Gamma_x} = W \qquad (9)$$

and

$$\left(\partial S/\partial x\right)_{x=0} = \left[-[1-\varphi(S)] \cdot W/a(S) + b(S)/a(S) \cdot g\right]\big|_{x=0} \qquad (10)$$

After that, let's assume that the user is positioned in place, let the phases in the well be proportional to their mobility functions. This can be derived from the mathematical expression of the physical state (8):

$$W_1\big|_{\Gamma_\phi} = \{\left[1-\varphi(S)\right] \cdot W + a(S) \cdot \partial S/\partial x + b(S) \cdot g\}\big|_{\Gamma_a} = Q_1, \qquad (11)$$

$$W_2\big|_{\Gamma_a} = \left[\varphi(S) \cdot W - a(S) \cdot \partial S/\partial x + b(S) \cdot g\right]\big|_{\Gamma_a} = Q_2, \qquad (12)$$

here

$$\frac{Q_1}{Q_2} = \frac{G_1}{G_2} \text{ or } \frac{Q_1}{Q_2} = \frac{g_1(S) \cdot W}{g_2(S) \cdot W} = \frac{g_1(S)}{g_2(S)}, \quad Q_1 + Q_2 = W \qquad (13)$$

From the last (13) relationships $Q_2 = g_2(S)/[g_1(S) + g_2(S) \cdot W]$ (14)

it's not hard for that to be the case. So (11) - (12) the boundary condition is

$$W_2\big|_{x=L} = [\varphi(S) \cdot W - a(S) \cdot \partial S / \partial x + b(S) \cdot g]\big|_{x=L} = g_2(S)/[g_1(S) + g_2(S) \cdot W]\big|_{x=L} \quad (15)$$

comes to watch and

$$[\varphi(S) \cdot W - a(S) \cdot \partial S / \partial x + b(S) \cdot g]\big|_{x=L} = g_2(S)/[g_1(S) + g_2(S) \cdot W]\big|_{x=L} \quad (16)$$

condition $S(x,t)$ for the saturation function $x = L$ it can be considered a boundary condition at a point, and this can be given in the form

$$(\partial S / \partial x)_{x=L} = \{\varphi(S) - g_2(S)/[g_1(S) + g_2(S)]\}/a(S) \cdot W + b(S)/a(S) \cdot g\,\big|_{x=L} \quad (17)$$

**III. METHODS AND ALGORITHMS FOR THE NUMBER OF MATHEMATICAL MODELS.**

(5), (6), (7) solving the problem D= {0 ≤ x ≤ l, 0 ≤ x ≤ T} identification of the demand for the field. Industry flat $x_i = i \cdot h$, $t_j = j \cdot \tau$, $i = 0, 1, ..., N$, $j = 0, 1, ..., M$ covered with mesh, $h$ and $\tau$ - training moved table movement and time.

(5) in a system of differential equations, the system of the following confidential devoid equations is formed by changing the ratio of the limiting spices.

$$\begin{cases} m \cdot (S_{ni}^{j+1} - S_{ni}^{j})/\tau + W \cdot (q_{ni}^{j} - q_{ni-1}^{j})/h = 0 \\ m \cdot (S_{si}^{j+1} - S_{si}^{j})/\tau + W \cdot (q_{si}^{j} - q_{si-1}^{j})/h = 0 \end{cases} \quad (18)$$

Here $j$ and $i$- single room shelves, τ and $h$- respectively, t and x are variable steps. From here $S_n(x,t)$ and $S_s(x,t)$ functional values of pure nodes

Over time, a step-by-step algorithm appears:

$$S_{ni}^{j+1} = S_{ni}^{j} - (W \cdot \tau)/(m \cdot h) \cdot (q_{ni}^{j} - q_{ni-1}^{j})$$

$$S_{si}^{j+1} = S_{si}^{j} - (W \cdot \tau)/(m \cdot h) \cdot (q_{si}^{j} - q_{si-1}^{j}) \quad (19)$$

$S_n(x,t)$ and $S_s(x,t)$ the values of the functions are based on the computational algorithms of (18) relations. when $j = 0$ the formulas are ( 18)

$$S_{ni}^{1} = S_{ni}^{0} - (W \cdot \tau)/(m \cdot h) \cdot (q_{ni}^{0} - q_{ni-1}^{0})$$

$$S_{si}^{1} = S_{si}^{0} - (W \cdot \tau)/(m \cdot h) \cdot (q_{si}^{0} - q_{si-1}^{0}) \quad (20)$$

comes to appear. Here, the" 0 " superscript represents the t layer time. The initial conditions are given in this layer (6). Therefore, (20) the expressions on the right side of the relation can be considered exact. $S_{n0}^{j}$, $S_{s0}^{j}$ values $j = 0,1,...,m$ (7) determined from the boundary conditions.

Thus, $S_n(x,t)$ и $S_s(x,t)$ assume that the functions are calculated in the first time layer. Now in the formula ( 18) comes out $j=1$

$$S_{ni}^2 = S_{ni}^1 - (W \cdot \tau)/(m \cdot h) \cdot (q_{ni}^1 - q_{ni-1}^1)$$

$$S_{si}^2 = S_{si}^1 - (W \cdot \tau)/(m \cdot h) \cdot (q_{si}^1 - q_{si-1}^1) \quad (21)$$

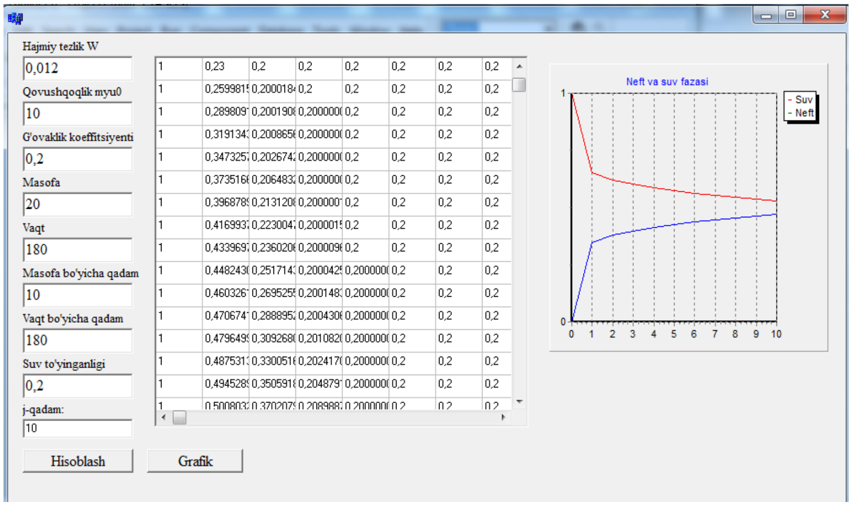
From formulas $S_n(x,t)$ и $S_s(x,t)$ the functions stand in the second layer t time, etc.

## IV. SOFTWARE AND EXPERIMENTAL CALCULATIONS.

$S_н$ (x, t) и $S_c$ (x, t) the calculation program in the function values is shown in Figure 1. It is also clear from this program that this problem consists of modules of this problem on the computer resolution. $f_n(S_n,S_s)$ , $f_s(S_n,S_s)$ , $f_g(S_n,S_s)$ , $q_n(S_n,S_s)$ , $q_s(S_n,S_s)$ The calculation of the function values of the corresponding models is performed by non-standard functions. Parameters of oil and gas layers in the Bouder S ++ 6 environment (M-porosity coefficient, *k*- conductivity coefficient)), phase parameters ( $\mu_n$ , $\mu_s$ , $\mu_g$ -dynamic viscosity) is defined as the main parameters. The most optional calculations can be performed easily by changing their values.

**TABLE 1 VALUES OF THE FAT, GAS, AND WATER PHASE SATURATION FUNCTIONS**

| x | $S_H$ | $S_C$ | $S_Г$ |
|---|---|---|---|
| 0 | 0.15 | 0.75 | 0.1 |
| 1 | 0.391 | 0.480 | 0.129 |
| 2 | 0.386 | 0.478 | 0.136 |
| 3 | 0.382 | 0.477 | 0.141 |
| 4 | 0.380 | 0.476 | 0.144 |
| 5 | 0.379 | 0.474 | 0.147 |
| 6 | 0.381 | 0.471 | 0.148 |
| 7 | 0.384 | 0.466 | 0.149 |
| 8 | 0.389 | 0.460 | 0.150 |
| 9 | 0.397 | 0.453 | 0.151 |
| 10 | 0.407 | 0.441 | 0.151 |
| τ = 0,0001; h = 1.0; ( j1 = 10000; j2 = 20000;) j3 = 30000; t = 30000; $S_{ni}$ = 0,45; $S_{si}$ = 0,25; $S_{ni}$ = 0,15; $S_{si}$ = 0,75; $\mu_0 = \mu_n / \mu_s$ =20.0; $\upsilon_0 = \mu_n / \mu_g$ =100,0; m = w = 0,375; $t_s$ = 3,000000 | | | |




## V. CONCLUSION

Computer calculations on a computer demonstrated the operation of a program developed using numerical methods. The results of the calculation of the experiment in the framework of a porous medium, the development of software for computer modeling showed more concrete results.

The results of the calculation of oil and gas gas on computer simulations on computers correspond to the results of natural oil production allows us to conclude that the software can be used.

## REFERENCE

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