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THE PROBLEM OF CONSTRUCTION OF AUTOMATIC CONTROL SYSTEM OF PNEUMOHYDRODYNAMIC TREATMENT ON ANISOTROPIC SATURATED MASSIVES

PAVLYSH Vladimir[1], LAZEBNAYA Ludmila[2], ISMAIL Haser Dayeh[3], PERINSKAYA Elena[4]

Department of Numerical Mathematics and Programming, Donetsk National Technical University, 58, Artyoma str., 83001, Donetsk.

Corresponding author: PAVLYSH Vladimir, E-mail: pavlyshvn@mail.ru

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Abstract. The problem of automatic control of technological process of pneumatic and hydrodynamic treatment on anisotropic underground rock massive, saturated with carbo-hydrate minerals, is considered. The treatment applies as a way of directed changing of massive status for intensification of mineral extraction. The structure of the system and the algorithm of control parameters selection is proposed.
Keywords: process, mathematical model, control, massive, system.

1. Introduction.

During the development process of formation of mineral deposits, in particular oil and gas arrays, there comes a time when lightly extracted part of the product ends and significant reserves remain sequestered within the array, resulting in reduced production volumes. In this case becomes important problem of increasing the intensity of extraction of useful product. One of the main ways of solving the problem is a purposeful change in the properties of the array by external influences, particularly pneumatic and hydraulic dynamical processing, while negative effect anisotropy array. Quality implementation exposure provided by automatic process control, which allows you to quickly react to put out of negative influence of anisotropy and ensure the stability of technological parameters. In this context, the theme of the work is actual.

Purpose of the work - to study the structure of the system and control algorithms process steps pneumohydrodynamic impact on saturated rock massive.

2. Section contents.

Pneumohydrodynamic saturated groundwater treatment is carried out by high-pressure arrays aerated fluid injection through wells drilled from the surface on the horizon is to change its status to intensify the yield of usable product. In addition, hydrodynamic impact on the producing formation is carried out in order to alter the balance of his status as a method of pre-selection activation of hydrocarbons [1, 2].

Essence pneumohydrodynamic impact is compulsory introduction mixture of air and liquid in the array developed under high pressure with subsequent discharge (Fig. 1).

Integrated pneumohydrodynamic impact is complex multifactorial process, and it is necessary to apply the rational organization of automated control. Consider the basic provisions of the modern concept of Geotechnology commercial production of hydrocarbons due to the energy of natural forces.

Virtually all applicable Geotechnology reduced to the well producing hydrocarbons and consist of:

- Drilling from the surface to the producing formation with its opening;
- The impact of different kinds of wells in the reservoir to increase its natural gas permeability;
- Pumping up filtering [3].

The means for the implementation of the pneumohydrodynamical impact on the rock via surface wells for stimulation of gas include the following equipment:

– oil pump for the hydrodynamic impact device management;
– compressor;
– tubing;

– hydrodynamic impact;
– casing with punch holes;
– valve, pressure gauge, tees and tube;
– reducer, electric motor and generator.

The availability of high-performance compressor high pressure provides compensation for minor leaks air from the system (up to 1.5 m^3/min) and the achievement of the required pressure of compressed air.

Technical characteristics of the hydrodynamic effects of device:

– maximum flow gaz contain pulp, m^3/s 0.6;
– maximum pressure in the tube complect, MPA 10.0;
– maximum pressure in the hydraulic cylinders, MPA 10.0;
– operating pressure in the hydraulic cylinders, MPA 5.0;
– the time of complete opening wedge high pressure gate valves, s not more than 0.5;
– unit weight (without control panel and connecting hoses), kg 185;
– overall dimensions, m 1.8×0.4×0.4;
– remote control-weight, kg 50;
– working fluid in hydraulic cylinders oil;
– mean time between failures, cycle 600;
– high pressure gate valves DN, mm 100.

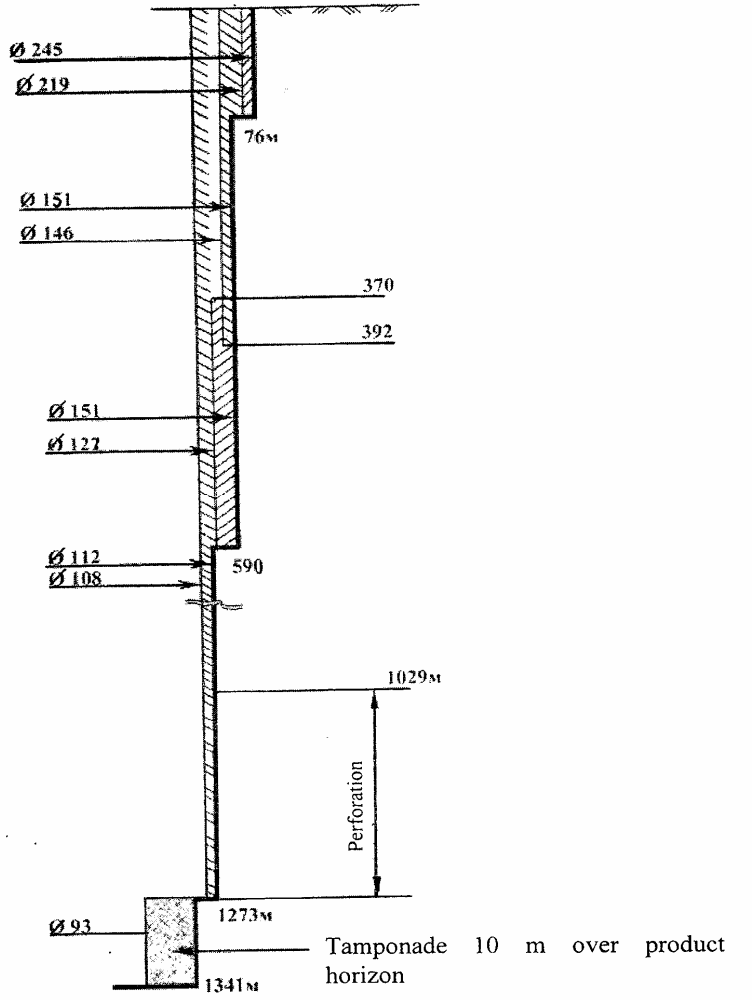

Fig. 1. Geological section of the surface of the well.

This approach is commonly referred to as "traditional".

Differences "alternative" approach to a "traditional" Truce in the second paragraph and theoretical assumptions [4]. For "alternative" approach to the second point can be formulated as "the creation of conditions for self-hills on well (exposure of the array into the well) to initiate (start) out of hydrocarbons". The basic idea of an alternative approach, except for changing the direction of the stimulation on the opposite, the assumption is that the permeability of the reservoir and discharge sources are shown simultaneously and technogenic origin.

If we consider a system of "productive layer - production (well)" in terms of synergy, the traditional scientific knowledge of saturated arrays undergo significant changes. For example, a well-known fact that from a certain depth of exploitation array acquires the ability to self-destruct with the formation of spin zone is interpreted as the formation of an ordered tree of

man-made cracks – "dissipative structures". These and other kinds of dissipative structures, consisting of man-made cracks in the vicinity of the exposed surface, usually referred to as "tree" system of cracks [5].

Second example. The hydrocarbon layer appears "active" medium, i.e. environment in which there supposedly "canned" energy, which during the passage of the front of the softening process, "connected" and involved in the further development of this process. Consequently, the processes occurring in the saturated rock masses, at certain critical conditions, are autowave.

Basic (sufficient) evidence on which the system "saturated layer - production (well)", falls under the typical tasks of synergy, the following:

- The system is open for some time (some time because after the dynamic or gas-dynamic phenomena it closes itself, so there are conditions for the damping effects);
- The system is very distant from its equilibrium, for example, at the opening of the producing formation or

mining operations, as evidenced by, respectively, the gas-dynamic phenomena on the mega-level and self-destruction of the array at the macro level (the growing crack, spin, cartridge, etc.);

- Formed in the system dissipative structures on LI Prigogine type Benard cells, i.e. at the critical density of rock pressure environment clears excess mechanical energy by restructuring in the direction of increasing its capacity, which confirms the observations in the mine, such as peeling, cartridge, the destruction of the core. Cracks are not visually observed due to the small hiatus, but recorded a special laboratory tests of samples taken after a certain distance.

Medium under consideration is, in the terminology of

synergy, "active medium" as the medium contains sources of additional energy, which are the gravitational forces and the gas pressure, appearing immediately after the passage of the front of the formation of dissipative structures, as evidenced by the observed geodynamic phenomena.

Known techniques to stimulate extraction through the wells drilled from the surface, for example, hydraulic fracturing directed hydrodismemberment layers, etc. are used when drilling the resulting "tree" system cracks around technological injection well in which the working fluid or other agent in order to further their disclosure.

When designing technology schemes of pumping of liquid agent must make a preliminary calculation of the basic parameters, such as injection pressure, flow rate (tempo), and others.

To solve the problem, a linearized model of fluid flow in fractured porous media is applied [3]:

$$\frac{\partial P}{\partial t} = \frac{\partial}{\partial x}\left(K(x)\frac{\partial P}{\partial x} \right)$$

The equations of the same type are obtained to describe the process of movement of air, or gas-liquid mix.

The automatic control system was effective for the treatment of an array, you must use the model in real time, and on the other hand, the filtration characteristics of the reservoir are actually random variables whose values are initially based on average data exploration. In the circumstances, the following approach adopted.

The system of using two models:

- the original model of the rock massive with its characteristics of geological data;
- a forecast model, reflecting the expected state at the moment, on the basis of the information on the results of the effects in real time.

This approach allows you to escape from the identification procedure object parameters (filtration coefficient, the coefficient of the anisotropy of the effective porosity, etc.).

In the mathematical modeling of hydraulic stimulation in filter mode through a single hole, "one-dimensional". Solving equation of nonlinear elastic filtering with initial conditions, formed on the basis of the technological scheme, you can find the pressure distribution on a specific section of the axis at any point in time, which makes it possible to calculate parameters of appropriate stimulation scheme. However, having decided to task for some "standard" variables, one can obtain a solution of a large class of tasks, go to the reverse conversion "normed" solutions.

The simulation of the one-dimensional flow does not provide sufficient information for the theoretical understanding of the nature of the process. To solve the problem of mathematical modeling of hydraulic impact to an array with a two-dimensional (planar) formulation technique of longitudinal-transverse direction (Douglas). The equation is of the form:

$$\frac{\partial p}{\partial t} = \frac{\partial}{\partial x}\left[k(p)\frac{\partial p}{\partial x} \right] + \frac{\partial}{\partial y}\left[k(p)\frac{\partial p}{\partial y} \right]$$

Task selection and effects that improve the quality of treatment in spite of the unfavourable structure of the array. In other words, it is also necessary to improve technology to processing to compensate for unfavourable characteristics of the building of the reservoir. One possible way is the way of the hydraulic impact through the cascade of wells (way to cascade moisturizing treatment). Studies of fluid discharge in coal seam through the cascade wells led to the conclusion that the use of this method to improve the uniformity of processing array.

When you build a system of management of an important component is the unit software, designed to simulate the condition and operational definition of current results.

As stated above, the purpose of automation-stabilization technology options.

The system includes the technological schemes of all interventions, coordinating the work carries out central module (CM). The generalized structure of the system is shown in Figure 2.

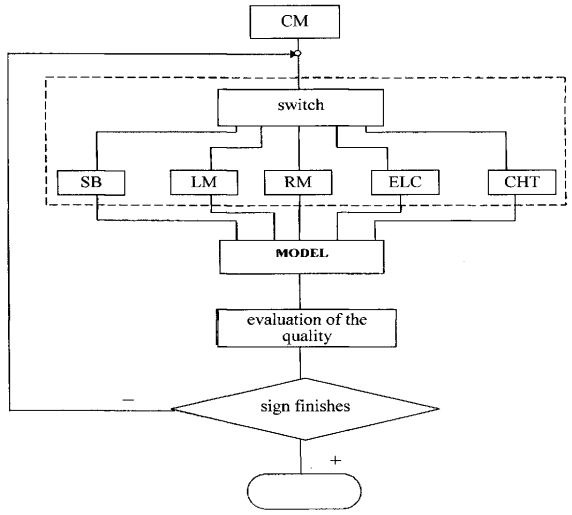

Fig. 2. Structural-functional diagram of the system

Here SB – a single borehole, LM – local method, RM –regional method, ELC – effects on a layer in the complex, CHT – cascade Hydro-treating.

The switch selects the specified flow chart and sets the direction of further operation.

The mathematical models form the basis of a software management system. The main feature of the process is the impact that the object (mountain range) "closed" from direct observation, and a mathematical model to simulate the process of impact, based on information about the "reaction" to the impact of the object.

Comparing the data, the system fulfills team correction controlled parameters.

Fig. 3 shows the functional- logical structure of automated control system (ACS).

Selection and subsequent design of the system is complicated by uncertainty, which is a fundamental feature of the implementation process and the impact of management principles algorithmization.

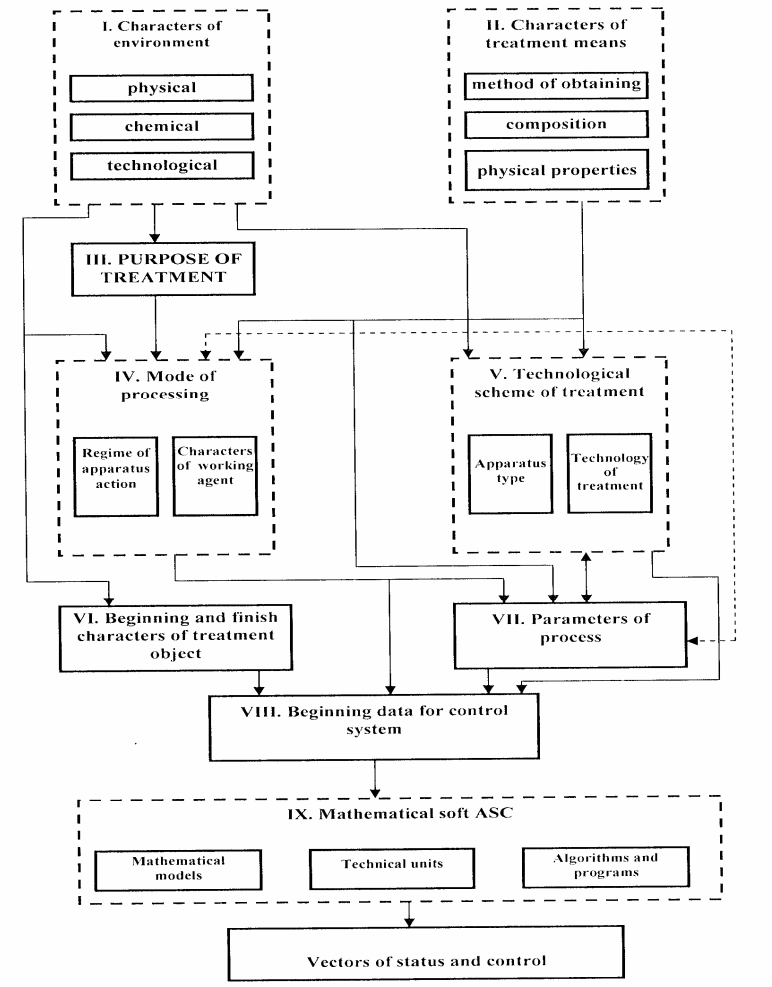

Fig. 3. Functional-logical structure of the system Automatic Control System (ACS)

Table 1 shows the comparative characteristics of the main types of management structure: functional, matrix and project [5].

In the context of the turbulent environment and significant parametric and structural uncertainties are more acceptable matrix and project management

structure.

Simulation modeling to determine the overall trend in the direction of a process runs automated selection of parameters of operational management. However, it is necessary to have the current choice of the complex algorithm parameters. Fig. 3 shows a block diagram of the control of the selection algorithm set close to optimal.

Table 1.
The main types of control structure.

Criteria for assessing the structure	Functional	Matrix	Project
Uncertainty medium	low	high	high
Technology implementation	standard	complex	new
The complexity of process	low	medium	high
Duration of the process	short	medium	high
Mutual relationship between the individual components	low	average	significant
Criticality runtime	low	medium	high
Communication with higher-level systems	strong	medium	weak

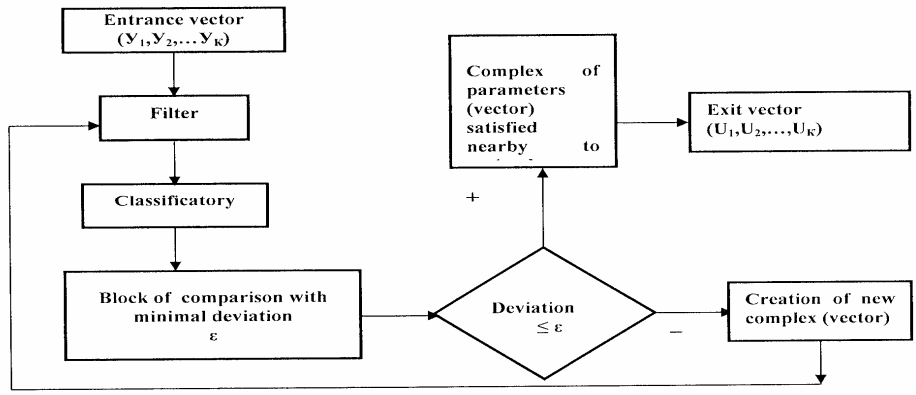

Fig. 4. Flowchart selection of the current control vector.

The input selection block conditionally optimal set of parameters control receives information vectors, which are formed in databases quickly replenished by information from technical controls. The degree of correction, which is subjected to the input vectors, depends on several factors determine the trend of the process. If the value of the criterion ε decreases during the process, all the input vectors are considered candidates for review.

3. Conclusions.

As a result of technological implementation process pneumohydrodynamic anisotropic effects on underground saturated mass is forced introduction of air and liquids under high pressure in natural cavities, causing an array of structural changes, accompanied by the expansion of pores and cracks. After discharge the activated selection of hydrocarbons into the well of the array.

On the basis of theoretical concepts, received practical advice on choosing the structure and technological parameters of the automated control system, developed an algorithm for selecting the optimal approximate vector control process pneumohydrodynamic impact.

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