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PHYSICAL MODELING OF MECHANICAL AND FILTRATION PROCESSES IN THE VICINITY OF THE PERFORATION HOLE IN WELLS OF LOW - PERMEABILITY RESERVOIR ROCKS

Abstract

This article presents the results of a series of experiments on physical modeling of mechanical and filtration processes in productive formations in the implementation of the directional unloading method, implemented by creating perforation holes on the wall of the well. The work shows the dependence of filtration properties of the studied samples on the type of stress - strain state, conclusions about the possibility of using the directional unloading method for uncased wells are made.

Keywords

Low - permeability rocks, enhanced oil recovery, perforation hole, directional unloading method.

The main tasks of geomechanics and applied geology in the oil and gas industry are still field discovery, determination of mineral reserves, designing field development systems, designing horizontal and directional well profiles, and modeling various measures aimed at improving oil recovery (IOR) and increasing the completeness of field development. The latter tasks are becoming more and more urgent nowadays in view of permanent depletion of easy - to - recover reserves and beginning of active development of hard - to - recover (HTR) hydrocarbon reserves. The development of fields with low - permeability rocks is a rather complicated process not only technically, but also ecologically.

In order to increase the permeability of the productive formation, an environmentally friendly, effective and economical directional unloading method has been developed in IPMech RAS. The idea of this approach is to lower the pressure in the well (from the values of rock pressure), which causes in its vicinity the occurrence of stresses that lead to the emergence of micro - and macro - cracks system, thereby increasing the permeability of the rock [1]. Another variant of the implementation of this method is the creation of a perforation holes system, in the vicinity of which the stresses increase, leading to the formation of cracks in the rock and, accordingly, increasing the permeability of the productive formation. In this case, all the necessary for specific fields

values of stresses are determined by direct physical modeling on rock samples using the Triaxial Independent Load Test System (TILTS) [2].

In this work a series of experiments on physical modeling of mechanical and filtration processes in productive formations of the Astrakhan gas condensate field (GCF) in the implementation of the directional unloading method, implemented by creating perforation holes on the wall of the well was carried out. Testing of samples was performed according to the program corresponding to the case of perforation hole in the cased well [3]. Experimental samples were strongly cemented sandstones with zero initial permeability, extracted from the Astrakhan gas condensate field from the depth interval of 3780 - 3790 meters.

During a series of experiments, rock behavior was simulated at the contour of the uncased well, the perforation hole contour: at 1.25 perforation hole radius and 2 radius, and at the tip of the perforation hole (sphere surface). Figure 1 and Figure 2 show plots of force and permeability dependence on time, as well as deformation curves. The result of the particular experiment is the destruction of the experimental sample with an avalanche - like growth of permeability, which allows us to judge about the possibility of successful application of the directional unloading method on the well of Astrakhan gas condensate field.

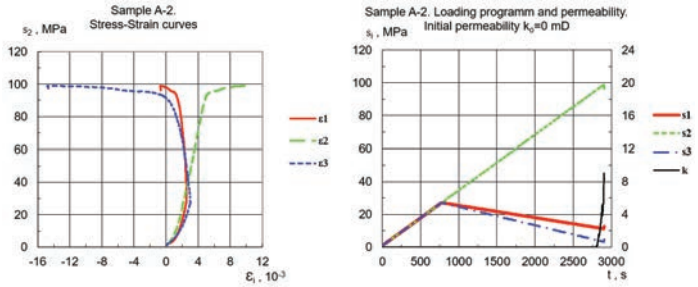

Figure 1. Stress - Strain curves and loading program with the permeability curve of sample A - 2. Source: developed by the authors.

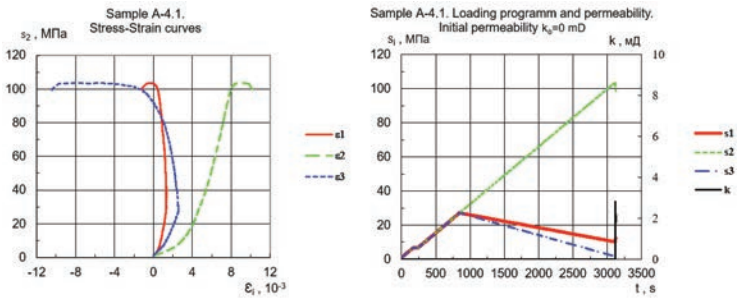

Figure 2. Stress - Strain curves and loading program with the permeability curve of sample A - 4.1. Source: developed by the authors.

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APPLICATION OF NUMERICAL MODELING METHODS TO SOLVE GEOMECHANICS PROBLEMS

Abstract

The article presents a historical overview of the main stages of development of numerical methods in oil and gas science. The contribution of each scientist to the formation and evolution of numerical methods used for modeling geomechanical processes in productive formations is described consistently and in detail. The main advantages and disadvantages of different approaches are described.

Keywords

Numerical simulation, geomechanical processes, two - and one - dimensional filtration, explicit and implicit calculation schemes, stochastic models.

Continuous improvement of electronic computing technology, increasing computing power of computers and the emergence of specialized software packages contributed to the active development of numerical simulation methods. When they are used, the initial data of the problem and the solutions obtained are presented as a set of numbers. Numerical methods are applied in the case when it is difficult enough to solve the problem analytically due to the lack of simple explicit dependencies for the system under study. The founders of numerical methods are Peaceman D. W. and Rachford, H. H. [1].