DYNAMICS OF A FILTRATION OF HOMOGENEOUS AND HETEROGENEOUS FLUIDS IN FINEPOROUS ENVIRONMENTS AT THE ELEVATED PARAMETERS

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Introduction. Heterophase the condition of hydrothermal fluids is customary for a wide interval of P-T-conditions of earth crust. Spatial division of phases can lead to so significant change of phase saturations (for example, waters saturation), that within the limits of a uniform stream of a fluid size of the attitude a fluid – rock will undergo significant changes. The present research is devoted to a special case heterophase to a filtration, namely, a biphase filtration of system water – gas through contact of porous environments of various permeability. Such lamination in real conditions is more likely a rule, than exception, and takes place in many types of the stratified soils, and the difference in permeability contacting soils can reach several orders.

Results of theoretical modeling. The preliminary analysis of features of transport processes at a biphase filtration shows, that function of water saturation can be explosive on boundaries of environments of various permeability at the account of a gravitational field, at the account of capillary effects (a difference of capillary pressure in porous layers of various permeability) and at the account of non-equilibrium liberation of gas at a filtration

Values of water saturation, w, on boundaries has undressed at the left and to the right of contact of porous layers are defined by the equations

$$W_{n,\,n+1} = -\,\nu\eta/K_n\,(\mathrm{grad}_{n,\,n+1}\,P + \rho_l g\sin\theta)^{-1} \text{ and } W_{n+1,\,n} = -\,\nu\eta/K_{n+1}\,(\mathrm{grad}_{n+1,\,n}\,P + \rho_l g\sin\theta)^{-1}$$

where, ν, η, $\mathrm{grad}_{n,\,n+1}$ P and ρ_l is a speed, viscosity, a gradient of pressure and density of a fluid accordingly, K – permeability, g – normal acceleration and θ – a corner of wetting.

Results of modelling calculations have shown [1,2,3,4], that the major condition of occurrence of jump of water saturation on contact of porous layers of various permeability is the order of a location of layers. If at a filtration from below hill up less permeable the layer is located behind more permeable, the size of arising jump of water saturation пренебрежимо is small (less than 0.001), and water saturation gradually decreases in a direction of a filtration practically the same as if all porous environment was homogeneous, with the permeability, equal those for less permeable a layer. At a return location of layers when more permeable the layer is located behind less permeable, on contacts of layers there are jumps of water saturation, that is value of water saturation at the left and to the right of boundary between layers are various, and this difference depending on conditions can reach significant sizes.

Scales of jump depend on permeability of layers and a parity of their thickness. In this connection experiments have been lead with a vertical location of filters of various length and contrast permeability.

Technics of experiment. Experiments are lead on the multielectrode cell specially developed for analysis of dynamics of change of water saturation of rock on electrical conductivity of a pore solution simultaneously in its several sections [5]. Size of water saturation estimated on size of electric resistance of all filter or its fragments. Such approach allows to define localization and development in time of jump of water saturation. All experiences were spent at a room temperature and pressure of a fluid up to 60 ат. In experiments filters from granite (permeability k = nЧ10-17 - nЧ10-18 $м^2$; porosity 0.4 – 1.48 %) and sandstone (permeability k = 4Ч10-15 $м^2$; porosity of 19 %). Filters, represented cylinders in diameter of 13.6 mm and height from 6 up to 28 mm [6]. To simulate influence of a gravitational component a filtration it is lead from below hill up with compound filters located vertically.

Experimental results. Experiments have been lead with the filters made of pair granite-sandstone (experience 1932) and with three-layer filters granite-sandstone-granite (experience 1933a and №1935). Below results of experiments are resulted.

Experience №1932. In experience 1932 filter has been made of granite 3-82a/96 located from below and sandstone 1p located from above. On a lateral surface of granite on contact to sandstone one electrode (4) has been mounted. On a lateral surface of sandstone two pairs electrodes have been mounted. The first pair (3) is closer to contact of sandstone to granite, and the second pair (2) - in the middle of sample of sandstone.

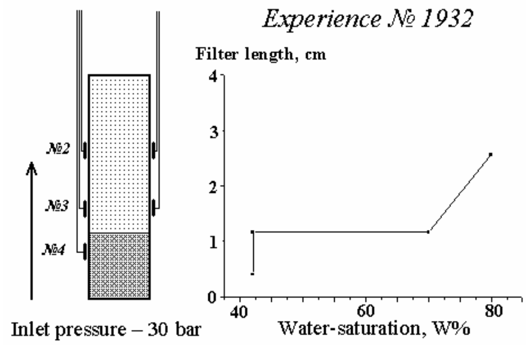

Fig.1.

The electrode (№4) was in granite on (№3) party of the filter opposite from an electrode. Water saturation in sandstone above, than in cross section sandstone-granite (a line 4-3). It testifies to presence of jump of water saturation on boundary granite - sandstone. Results of theoretical modelling will well be coordinated with experimental data.

Experience №1933a. In experience 1933a sample of sandstone 1p-b has been placed between two samples of granites having close permeability: 3-82a/96 and 3-773/275. Granite (3-773/275) was above sandstone. Measurements are lead at pressure of a fluid upon an input to the filter 3.9, 6.5, 9.9, 14.5, 19.7, 25.9, 31.2, 38.7 and 55.0 kg/sm2. At P above 10 kg/cm^2 water saturation of sandstone remained is almost constant. During too time in granites its steady falling caused by growth of quantity of a gaseous phase with growth of pressure on an input in the filter was fixed.

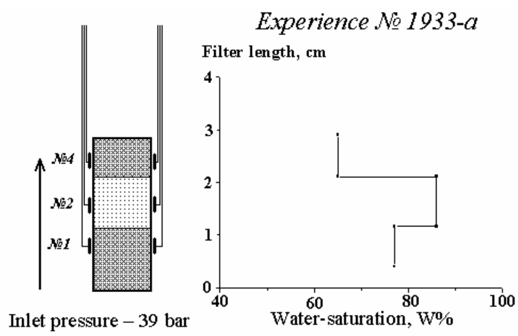

Fig.2.

Nevertheless, measurements have fixed higher size of water saturation in sandstone in comparison with those in over - and underlaying samples of granites. The result оп.1933a shows presence of jump of water saturation on boundaries between samples of sandstone and granite which will well be coordinated with theoretically predicted.

Experience №1935. As it was already marked, the size of jump of water saturation strongly depends on a parity of lengths of the first and the subsequent filters. In experience 1935 sample of sandstone 1p-c has been placed between two samples of granites (577/1 and 3-8/96), but the length of the bottom granite was more twice, than in the previous experience, and the length of sandstone and the top granite - approximately twice is less. Measurements are lead at P a fluid on an input to the filter of 30.3 kg/cm^2. On fig.3 distribution of water saturation of the compound filter is shown.

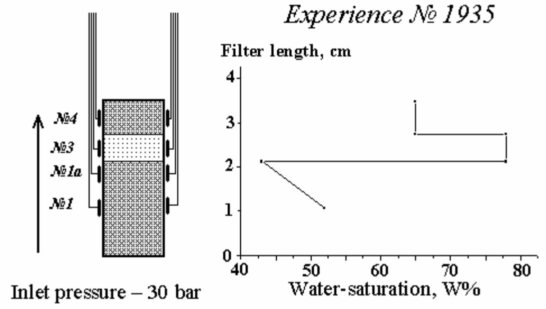

Fig. 3.

Measurements have fixed higher size of water saturation in sandstone in comparison with water saturation over-and underlaying samples of granites. However there are also differences from experience 1933a. First of all, the size of water saturation in sandstone (№3) has a little bit smaller value. But thus it differs from water saturation of the bottom granite (№1a) on the greater size, than in оп.1933a, that is greater jump of water saturation is observed. Result exp.1935 a theoretical conclusion that the size of jump of water saturation depends on length of filters.

Conclusions. 1. Results of experiments show, that a structure of water saturation lengthwise the filter made of alternating samples of rocks of various permeability, looks like, characteristic for the gravitational mechanism of occurrence of jumps, namely, water saturation on contact from more permeable a layer always above. 2. Jumps of water saturation arising on boundaries actually define a level of water saturation within the limits of separate layers and, thus, - possible repeated gang of modes of a filtration (with rock – on fluid – dominated and back) within the limits of a uniform filtrational stream of fluids.

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