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ELECTROKINETIC EFFECTS IN POROUS MEDIA AS CHARGE INTERACTION DISPLAY

Abstract

Filtrational properties of heterogeneous systems in porous media is considered in the paper.

In filtration of aqueous solutions of NaCl, the oscillations of fluid consumption Q and electropotential $\Delta\varphi$ in time was observed. And under different concentrations of electrolyte, the oscillations have chaotic or periodic character. The obtained «bridging» effect leading to the decreax of fluid consumption is explained by charge interactions.

The filtration of sea-water used in ail production conditions is also studied.

Nowadays the study of multi-phase filtration stipulated by the unstationary state is of great interest.

The investigation of there processes shows that physico-chemical processes and phenomena [1] play a great role in filtrational zones along with physical process.

As it is shown in papers [1,3], in gassy fluids there arises periodic and random oscillations of filtration velocities the cause of which is the colmatage process and the subsequent decolmatation of pore channels in the course of formation and growth of gas microbubbles.

On the other hand the oscillation process is observed in filtration stipulated by charge interactions when the fluid contains charged particles in the form of ions, colloidal or suspended particles [2].

In this paper, the investigation results of filtration properties of aqueous solution of $NaCl$ and sea water through the porous medium of silica sand with permeability $K = 0{,}08 mkm^2$ are reduced. Electrical-kinetic investigations were carried out in a horizontal cylindrical pipe under constant pressure drop.

In filtration of aqueous solution of $NaCl$ the oscillations of fluid consumption Q and electricpotential $\Delta\varphi$ in time were observed. The oscillations gained chaotic character (fig. 1-4) in $NaCl$ concentrations more or less $C = 3{,}3\%$.

The change of $Q(t)$ characteristics picture depends on the electrolyte concentration, since in adding the electrolyte to water, its electrical conductivity is increased (~ twice), and dielectrical permeability is decreased. It is also known that in fluid filtration in a porous medium the displacement velocity in the direction of ions admixture and colloidal particles filtration may be different depending on the charge sign. The authors show [2] that the formation of volume electrical charges of opposite sign in filter fluid promotes the velocity difference of these particles. The formation of charges on the pore may be explained by two-layer charge accumulation model suggested by the authors [4]. The same name charges accumulated in the exit may create «the bridging» effect leading to the consumption decrease, and their bearing out-to the consumption increase that may be described by dynamics of conflicts.

We investigated these processes under various pressure drops at the expense of openness degree alternation of the output sections of filtration column plug.

As we see from figures 5 and 6 while decreasing the output section, the fluid consumption continued to increase and then was decreased, that was observed and at the fixed output section. And the consumption continued to decrease even under initial maximal output section, i.e. the system was stable with respect to small perturbations in the form of output section alternation, that is peculiar to dissipative structures, and the displacement of maximums of dependences $Q(t)$ and $\Delta\varphi(t)$ on the phase may reflect the opposite sign charge competition of the system. Consequently we may suppose that the fluid motion is defined by processes that occur in the system, namely by the destruction and formation of charge structure of fluid. We observe this picture at concentration of $NaCl$, $c = 3{,}3\%$ both in screenless case and in the screened system case.

Investigations showed that while increasing the concentration of $NaCl$ $(c = 4{,}1\%)$ the smooth character of consumption alternation goes over to chaotic one; the dependencies $Q(t)$ already represent saw tooth oscillations. Under constant output and varying section for the given concentration fluids, chaotic consumption oscillations at the prime domain are of the same type (fig. 4,7). At the next stage the investigations were carried out on the above-mentioned experimental installation with sea-water, characterized by the values represented in the table.

Table

Ca mgequ /100g	Mg mgequ /100g	Na mgequ /100g	Cl mgequ /100g	SO_4 mgequ /100g	HCO_3 mgequ /100g	Density g/sm^3
1.64	6.06	19.81	20	6.68	0.25	1.0077

While filtrating seawater, the flowing potential at first decreased relatively rapid and then increasing in the course of long time out flowed to the plateau. But the fluid consumption chaotically oscillating decreased, and the consumption curve consisted of two similar sections (fig.8).

After adding 1% NaCl to sea water the fluid consumption dynamics looked like the alternation of flowing potential - the decrease with the consequent exit to the plateau (fig.9).

As we see from the figure one can found correspondence between the dependence sections $Q(t)$ and $\Delta Q(t)$ at the following time intervals: 0-16 and 11-356, 16-49 and 356-368, 49-412 and 368-412 min. Minimums of these curves were shifted with respect to each other for 320 minutes. We are also to note that the fluid consumption as in the case of the filtration of aqueous solution of NaCl under concentration C=3,3% was varying «smoothly».

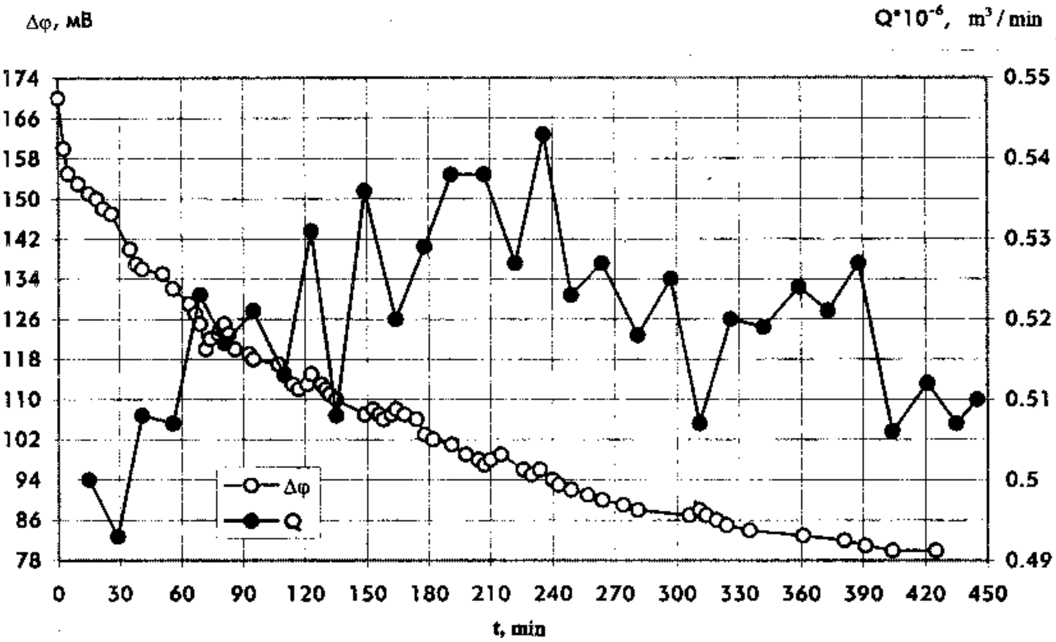

Fig. 1. Dependencies of $\Delta\varphi(t)$ and $Q(t)$ on water filtration.

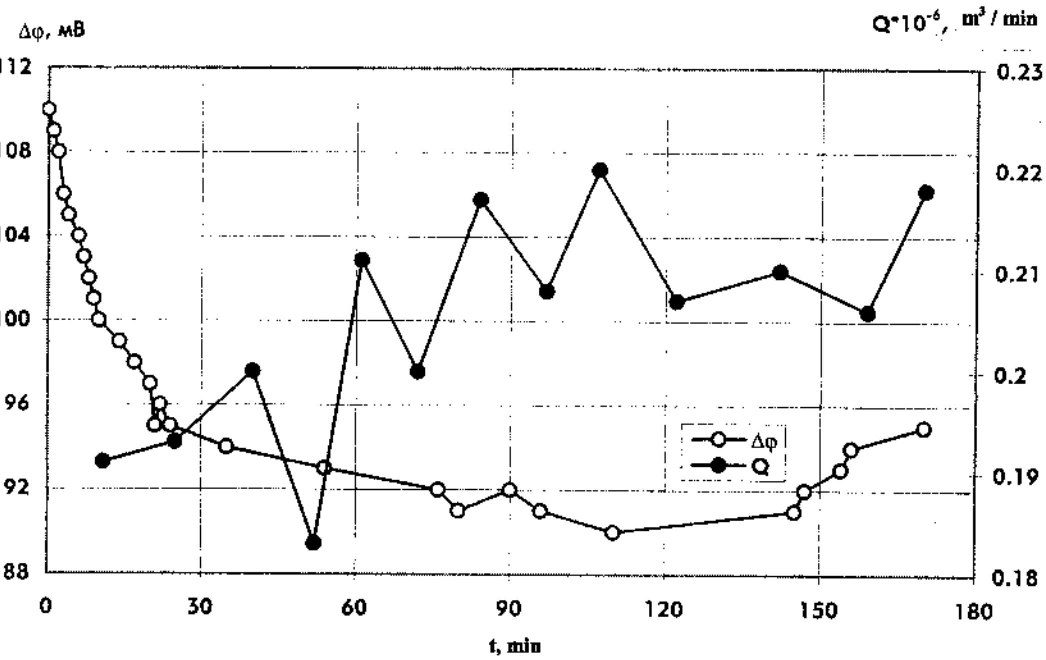

Fig. 2. Dependencies of $\Delta\varphi(t)$ and $Q(t)$ on aqueous solution of NaCl (C=1%).

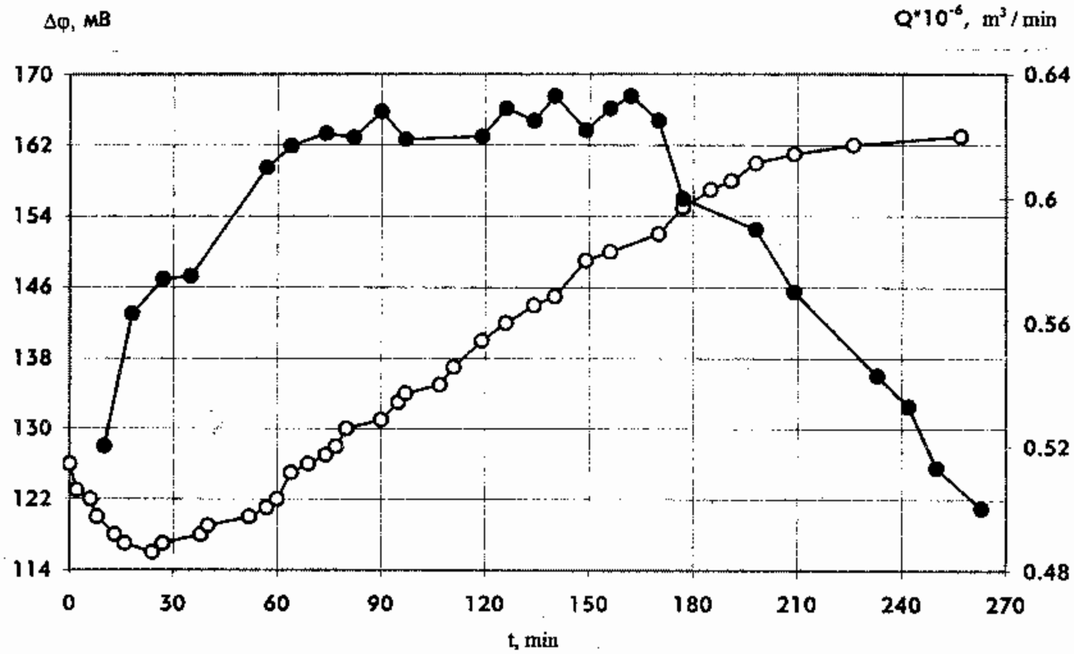

Fig. 3. Dependencies of $\Delta\varphi(t)$ and $Q(t)$ on aqueous solution of NaCl (C=3,3%).

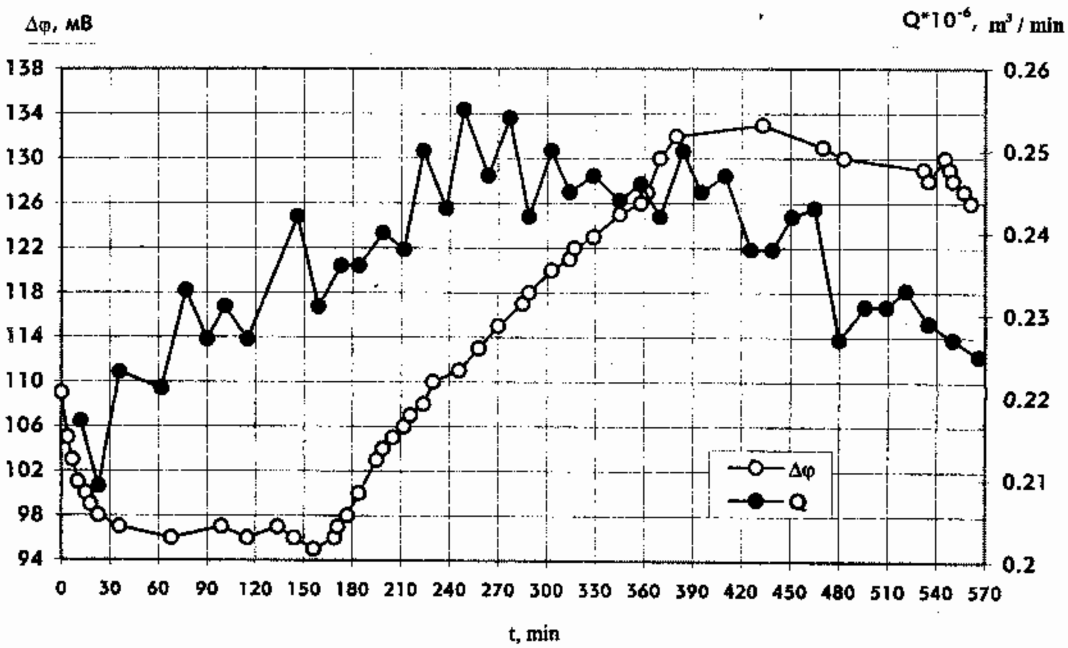

Fig.4. Dependenceies of $\Delta\varphi(t)$ and $Q(t)$ on aqueous solution of NaCl (C=4,1%).

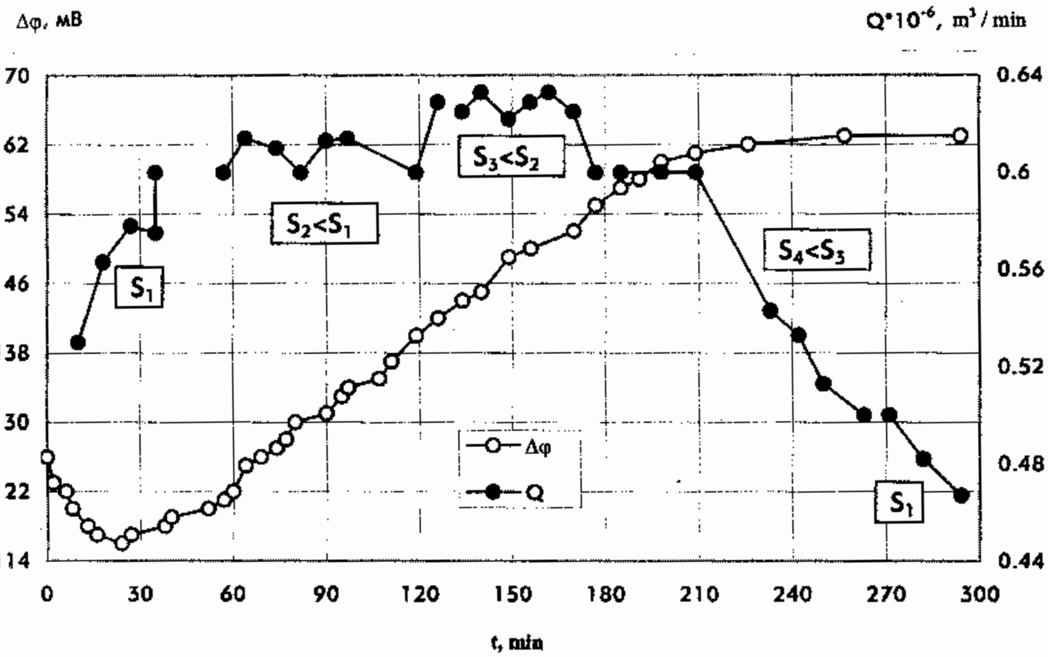

Fig.5. Dependence's of $\Delta\varphi(t)$ and $Q(t)$ on aqueous solution of NaCl (with screen).

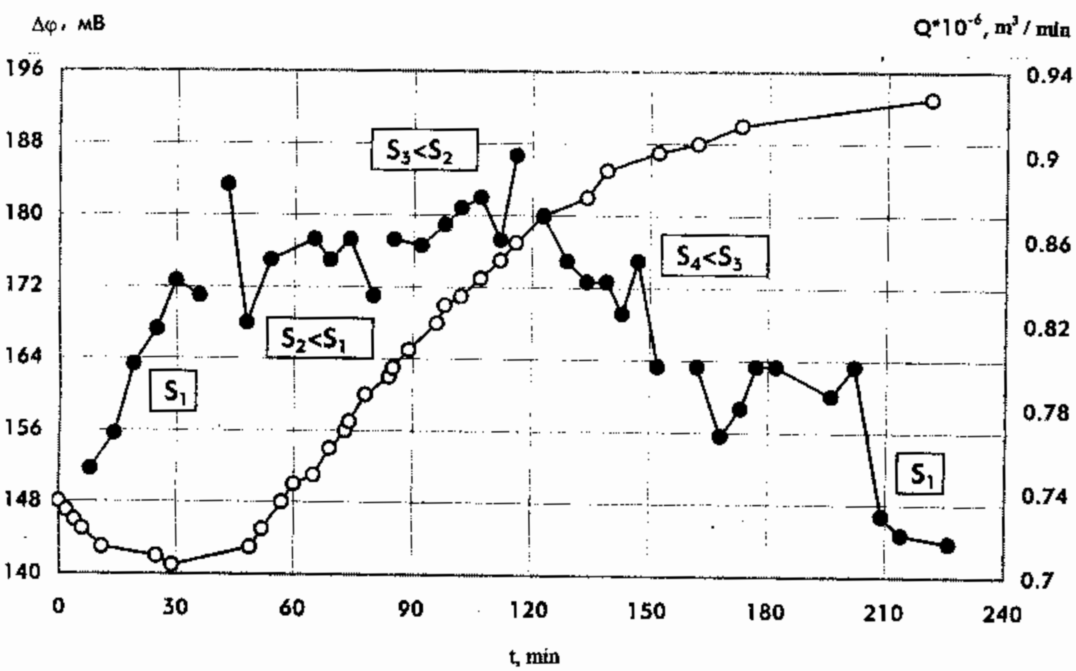

Fig.6. Dependence's of $\Delta\varphi(t)$ and $Q(t)$ on aqueous solution of NaCl.

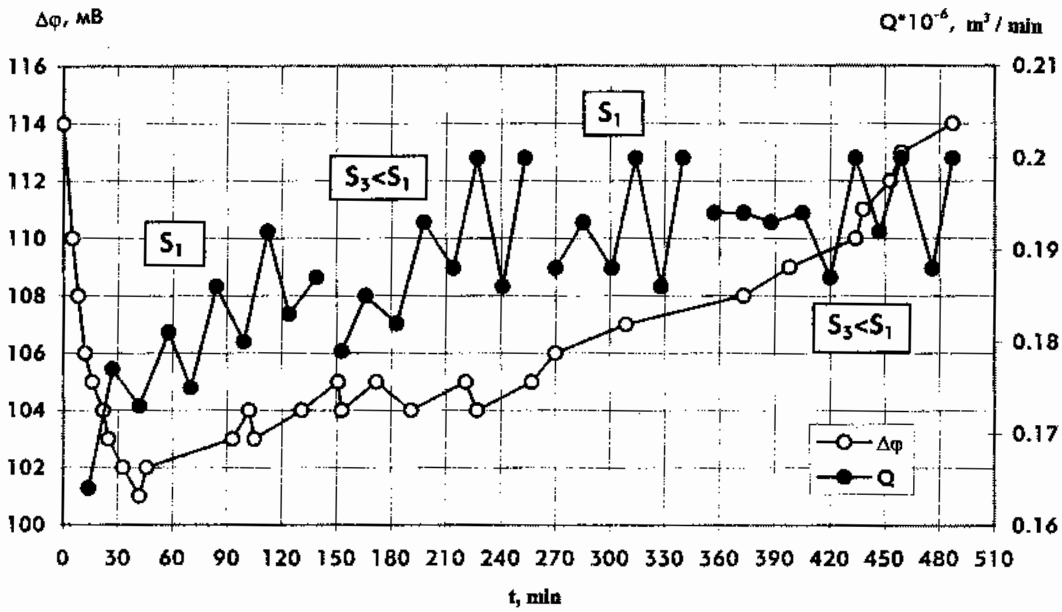

Fig.7. Dependence's of $\Delta\varphi(t)$ and $Q(t)$ on aqueous solution of NaCl (with screen).

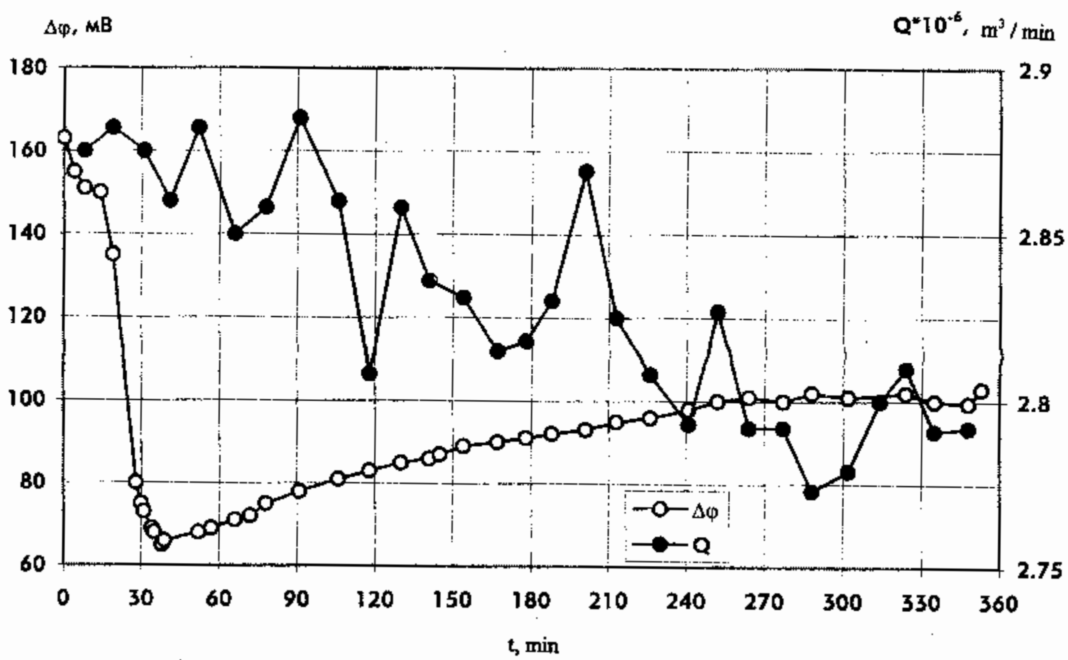

Fig.8. Dependence's of $\Delta\varphi(t)$ and $Q(t)$ on sea water filtration (with screen).

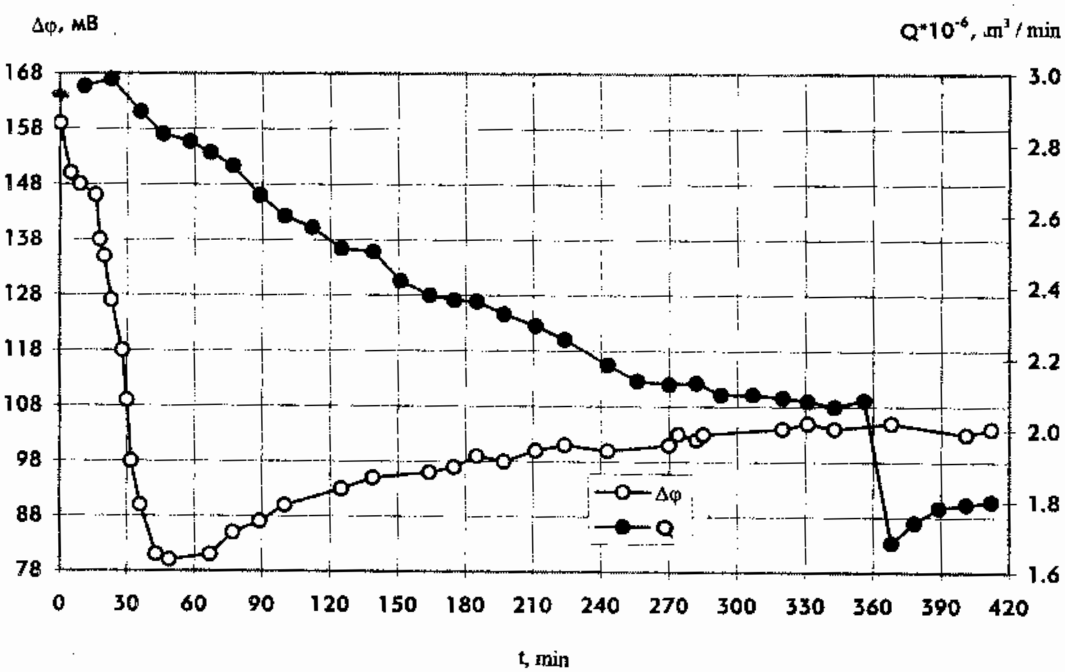

Fig.9. Dependence's of $\Delta\varphi(t)$ and $Q(t)$ on the filtration of sea water +1% NaCl (with screen) solution.

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