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### **THE STUDY OF ADSORBING SODIUM AND POTASSIUM CHLORIDES THROUGH NATURAL ADSORBENTS: SAND AND PEAT**

*SUMMARY.* This article considers the phenomenon of filtering solutions of sodium chloride and potassium through unconsolidated adsorbent systems. It gives the results of the filtering capacity study of Velizhansky peat and sand reservoir. Here are presented and described the experimental methods and apparatus. It can be seen the experimental data obtained by filtering different concentrated salt solutions through porous adsorbents. The salt content in the solution that passed through a sample of the porous medium was evaluated by measuring the electrical conductivity because the dependence of the electrical conductivity on the concentration in this case is linear. The mass of salt adsorbed by sample solids from the solution was determined. The authors prove the dependence of the electrical conductivity of the solution after filtration, and the ratio of the specific weight of salt absorbed per mass unit, depending on the concentration of the solution. The resulting graph shows a comparison of sand and peat with different concentrations of NaCl and KCl.

*KEY WORDS.* Adsorption, filtration, electrical conductivity, solution.

Filtration is vital for building hydraulic structures, water supply, oil and gas production. Due to oil mud disposal drilling stations may cause the change in ground water mineral composition. The most environmentally dangerous are water-soluble salts which happen to appear in intake facilities during sedimentary migration and filtration. That is why the unit (described below) was given a model of salt solution movements through porous unconsolidated adsorbent systems. The electrical conductivity measurements allow to see the portion of salts adsorbed during sand and peat filtration (as sand rocks and peat-bogs are the most widely spread soils in Western Siberia).

**The description of the unit.** The unit was constructed to do experiments on purifying solutions by filtration through porous media. Its image is shown in Figure 1; its main flow chart is given in Figure 2 [9–10].

The experimental unit to study filtration is composed of a solid samples study chamber (1), a liquid supply reservoir (3), a liquid disposal regulating tap (4), yielding air container (5), balances (6), manometer (7).

The liquid phase samples were presented by NaCl and KCl solutions produced by mixing with distilled water. They were poured into the liquid supply reservoir (3). Then a hose took the solution to the solid samples study chamber, the solid samples were taken from Velizhansky peat and sand reservoir, with 24 g of dry peat and 94 g of sand.

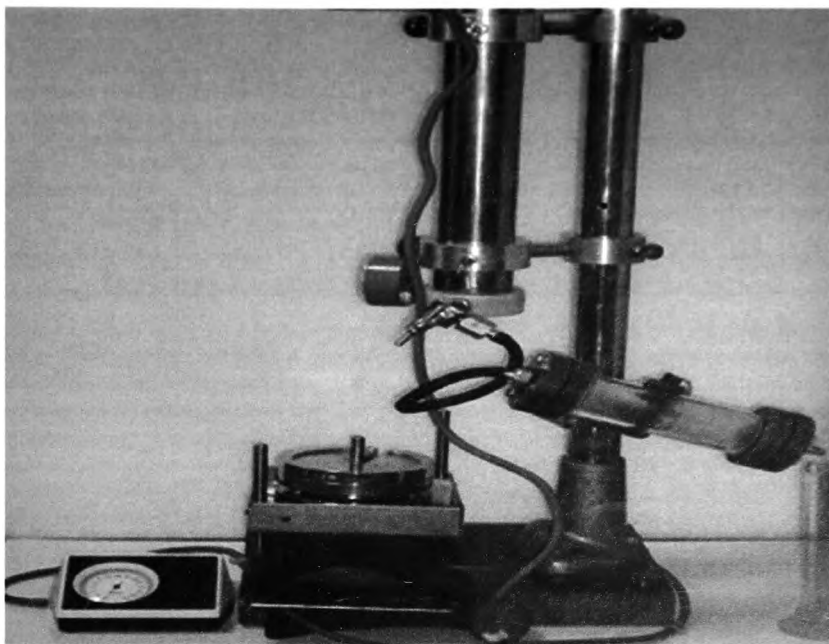


Figure 1: The image of the experimental unit.

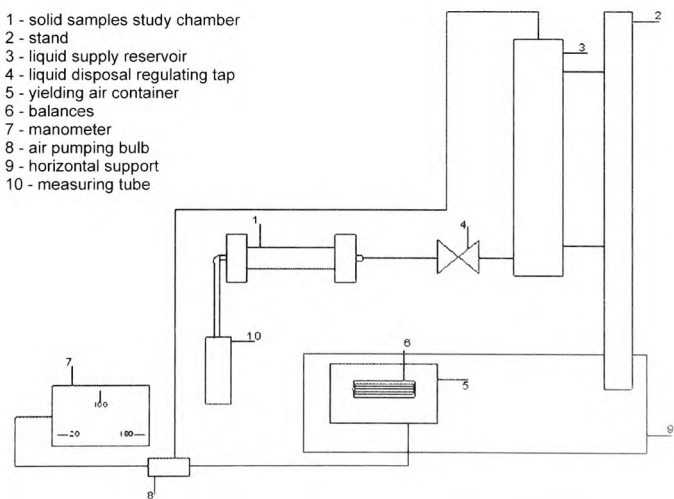
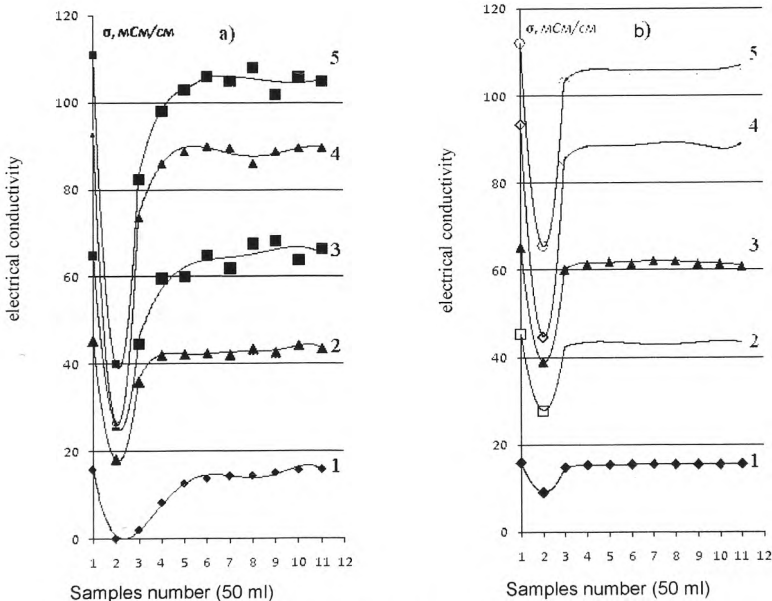


Figure 2: Main flow chart.

The conductometer ANION-7020 was used to measure the liquid phase electrical conductivity. The system pressure was sustained by the yielding air container with the interval  $2.6 \div 21.3$  mPa, the manometer was given a required value. After the tap had been opened, the solution went to the chamber for the filtration to take place, and the liquid went to a volume measuring container for the resulting solution (dram vial), a portion was 50ml.

**The experiment results.** The filtration study was performed for 1%, 3%, 5%, 7%, and 10% NaCl and KCl solutions. Electrical conductivity and concentration dependence is linear, so the change in electrical conductivity characterizes the amount of salt adsorbed during filtration. The use of inorganic salts can be explained by the fact that they are water-soluble and have high electrical conductivity values. Water-soluble salts that can be taken for long distances are of the most interest.

The mass of salt adsorbed by peat and sand can be found by comparing the electrical conductivity values of the initial solution and those of the filtered one. Figures 3–4 show the dynamics of electrical conductivity change and correspondently the mass of salt adsorbed during filtration, caused by the amount of the filtered NaCl solution.



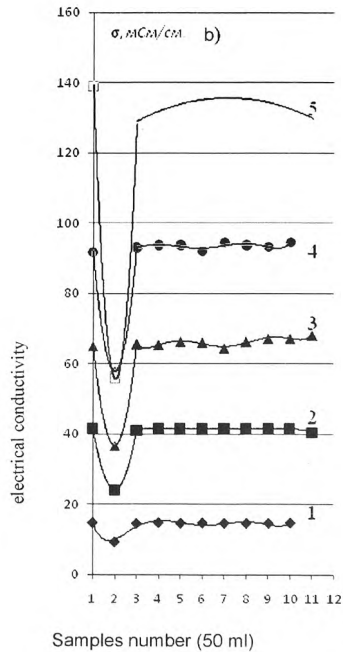
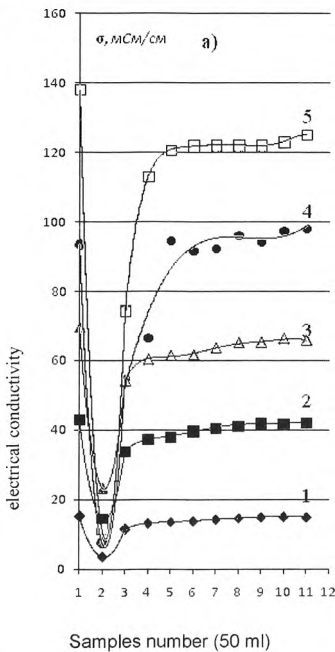
Figures 3-4: The dynamics of electrical conductivity caused by the amount of the filtered NaCl solution through peat (a) and sand (b) (1–1%, 2–3%, 3–5%, 4–7%, 5–10% solutions).

The point characterizing No.1 of the sample shows the initial electrical conductivity of the solution, before adsorption. The sharp decrease in electrical conductivity can be explained by the intensive salt adsorption and gradual saturation of the absorbent surface along the current flow. After this the sample becomes less active and the value of the electrical conductivity heads the initial one.

Salt adsorption is more active through peat because its specific surface is larger.

Figures 5–6 show the electrical conductivity change of the KCl solution samples (50 ml each) which went through peat and sand.

When comparing the diagrams for different chlorides (Figures 3–4 are for NaCl and Figures 5–6 are for KCl) it can be noticed that the decrease in salt ions molecular weight influences the solid sample adsorption. It happens due to a large leap between the first (initial) sample of the solution and the second one. It has been noticed that filtering KCl solutions through peat led to the highest electrical conductivity value thus to the highest concentration in the second sample. Then the dynamics changed expectedly.



Figures 5–6: The electrical conductivity change dynamics dependent on the amount of the KCl solution filtered through peat (a) and sand (b) (1–1%, 2–3%, 3–5%, 4–7%, 5–10 solutions).

**The experimental data analysis.** The received diagrams and the formulae given below allow calculating the mass of salt adsorbed during filtration:

$$m = \frac{\sum_{i=1}^n \sigma_i * m_0}{(\sigma_0 * n)},$$

where  $\sigma_i$ —the total for all the concentrations of the portioned solution filtered through the peat sample;  $m_0$ —the mass of salt solved in distilled water to receive a requires concentration;  $\sigma_0$ —the concentration value of the solution prepared for filtration;  $n$ —the portions of the solution filtered through the adsorbent sample. The received value serves to estimate the rate of salt adsorption from the solid sample.

Figures 7–8 show the dependence the adsorbed mass of salt and the salt solution concentration, the diagram for sand goes lower due to the smaller adsorbing surface. It can be seen that the higher is the solution concentration, the more salt is adsorbed.

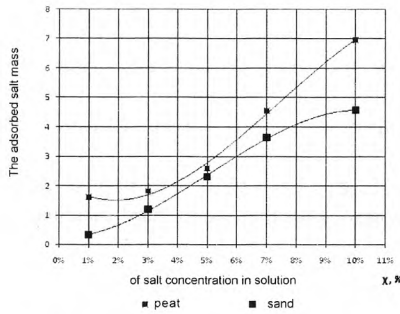


Figure 7: The dependence of the adsorbed alt mass and the NaCl solution concentration.

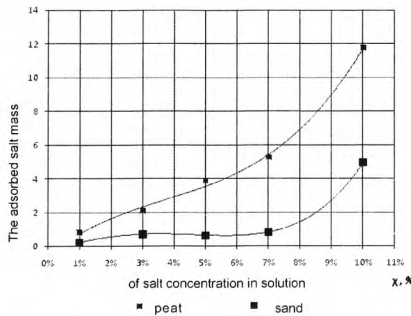


Figure 8: The dependence of the adsorbed alt mass and the KCl solution concentration.

If the initial NaCl solution concentration increases, the mass of adsorbed salt increases too. At lower concentration values (<5%) the peat dependence increases slowly. It can be explained by the fact that the salt adsorbed through peat covers its surface along the current flow. After the first monolayer surface is covered, the dependence  $m(\chi)$  becomes linear, which is explained by the increase of adsorbing capacity due to the salt which has already been adsorbed.

The sand filtration features of solutions with different NaCl concentration are characterized by the difference in the mass of salt being linear with the concentration in the beginning and above 7% — less significant.

For KCl solutions the dependence is different. When filtered through peat the adsorbed salt dependence looks quite linear. When filtered through sand—at < 7% it is actually constant, and after that it increases sharply.

**Conclusion.** The described results of the filtering capacity study of Velizhansky peat and sand reservoir prove that when filtering salt solutions of different concentration through a solid sample, the adsorption takes place in first three or four portions, after that the process becomes less intensive.

Figure 9 shows the dependence of the mass of NaCl adsorbed per adsorbent mass unit. The diagram for sand is linear and comes to 0.05. The change of  $\Delta m$  for peat is more diverse. The intervals of filtration values for sand and peat are different for this salt.

When KCl (shown in Figure 10) is adsorbed, the values of  $\Delta m$  at 7% and below are found in the same interval, after that the forecast increase can be seen at relevant values.

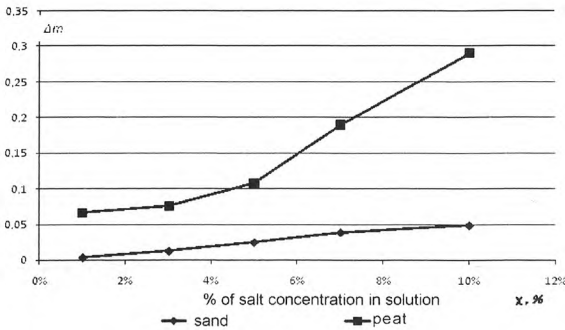


Figure 9: The change of  $\Delta m = m_{\text{filtered}} / m_{\text{adsorbed}}$   $\Delta m = \frac{m_{\text{доцз}}}{m_{\text{абсорб}}}$

for different concentrations of NaCl.

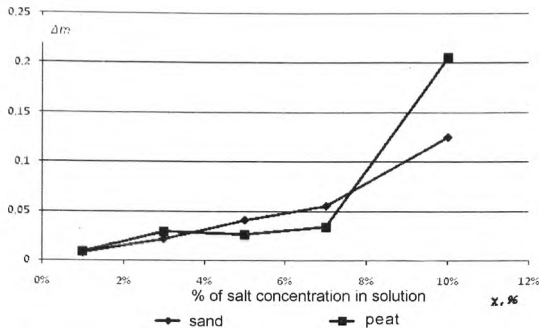


Figure 10: The change of  $\Delta m = m_{\text{filtered}} / m_{\text{adsorbed}}$  for different concentrations of KCl.

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