Technology for detecting heavy metals in the soil using an ionometer

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Abstract. For the first time in the Article, new methods for determining heavy metals in the soil using an ionometer were covered, the acid-base properties of the soil were determined. It is known that with the formation of soil, rocks are destroyed under the influence of the environment. The environment ensures the circulation of chemicals in the human body. Soil is a place of accumulation and storage of large amounts of substances as a result of anthropogenic human activity and waste from natural sources. It is not characterized by the property of inactivity, as in other natural environments, and as a result is most susceptible to pollution. In addition, many compounds that fall into the soil can be more toxic than the original compounds as a result of chemical and microbiological reactions. As a result of soil contamination, water, air, food products and other elements of the biosphere can be contaminated with carcinogens and radioactive substances. Such harmful heavy metal ions have a huge impact on humanity, flora and fauna. Therefore, the article talks about constant monitoring.

1 Introduction

Heavy metal ions are common pollutants in the current era, due to the negative impact on human health, these ions must be constantly monitored. During montoring, the degree to which heavy metal ions are involved in atomic mass, density, tosychology, distribution in the natural environment, natural and man-made rotations is narrated. In environmental pollution, accumulation of ferrous metal ions in the soil and other problematic scientific works, about 58 metals with an atomic mass of about 50 atomic units, with a density of 5 g/cm^3 in chemistry, are called heavy metals. This is due to the accumulation of heavy metal ions in the soil, which in human organisms is now the cause of various diseases. It is a mistake if we consider that all heavy metals are toxic substances, since these metal ions are part of the soil microcomponents. Some heavy metal ions are involved in soil-forming processes in the chemical and natural erosion of rocks. The ionic composition of chemical compounds and elements in soil is the composition corresponding to their natural concentration in soils of different soil - climatic zones, which do not have a significant anthropogenic effect.

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Currently, on planet Earth, the main source of contamination of the composition of the soil with heavy metal ions accumulates as a result of the combustion of natural sources of organic matter. According to scientists, in the entire history of mankind, 135 billion tons of coal and 45 billion tons of oil were burned [1,2].

It has been found that the total weight of idyllic metal ions is present in the soil at a concentration of 500 g per tons of ash produced by the combustion of coal van oil products.

The ash of coal and oil contains almost all metals at a total concentration of up to 500 g per ton of fuel. This is the essence of the aero-man-made nature of the penetration of heavy ions into the soil.

The accumulation of heavy metal ions in the soil is caused by a large number of types of vehicles operating in oils, teteraethyl lead is added in order to increase the resistance of gasoline to detonation. More than 250,000 tons of lead ions per year are released from the exhaust gases of their gasoline combustion engines to the soil surface.

Emissions into the atmosphere in the form of immersion in the soil (mainly metal oxide) only from railway repair enterprises are more than 380 thousand tons per year. With the brake pads of the train worn out, a further 200,000 tons of metals per year fall into the soil in the form of oxides on the soils near the tracks. Thus, there is a steady increase in the scale of soil contamination with heavy metals. In this case, the most dangerous is the accumulation of metal ion - leaden, which has a pronounced toxic nature in the soil [3-6].

In the production of gases in industry, heavy metal ions have a sensory effect, waste thrown into landfills the accumulation of heavy metal ions in the soil increases day by day.

Metals from the air from the atmosphere were fixed to one degree or another with soil.

The fixation process involves adsorption, deposition, coagulation and Inter-packet absorption by clay minerals [7].

Compounds of heavy metals entering the soil are destroyed by the action of organic acids of the soil or absorbed by the components of the soil absorption complex, or, depending on the soil conditions, precipitate in the form of insoluble salts. Lead, as heavy metal ions, is present in the soil during the mining of lead ores, as well as in the waste of the metallurgical industry. In the case of vehicles driven by gasoline engines, electric batteries, paints, alloys, metal passes in the form of ions. Currently, the amount of lead ions in the soil is high, especially around metal processing plants. According to scientists, the amount of lead metal ions in the soil contaminated with waste from a metallurgical plant in Northern France is 460-1900 mg/kg. In particular, it was found that the amount of lead in ore waste is even higher. Its amount was found to be 6000-10000 mg/kg in metal mines in Colorado, USA.

2 Materials and methods

As an object of research, soils next to car roads were selected in a radius of 3 km around the intersection of Tashkent State Agrarian University. The tests were carried out in the laboratory "biochemistry and physiology" of the Tashkent State Agrarian University, in September 2023, the selection of soil samples was carried out according to methodological guidelines. When choosing, the distance from the source of pollution, the terrain, the soil cover and the type of land were taken into account. Soil samples were taken using a reed bura with a depth of 0-5 (3) and 6-10, 11-20 cm, and when laying plots - from each genetic soil horizon and with a length of 100 m in layers. To study the spatial distribution of the amount of heavy metal ions in soils, soil samples were taken in a radial direction (within a radius of up to 3 km) with respect to points at a certain distance from sources of contamination.

For any environmental object, its permissible concentration value works as a property of the danger of a substance. It is studied by comparing whether the concentration of contaminants is lower than the permissible concentration value, or rather higher

The absorption of heavy metal ions into soils will primarily depend on its pH value. Judging by the data of scientists, in an acidic environment, lead, zinc, copper ions were found to be mainly sorbicized; in an alkaline environment, cadmium and cobalt ions are sorbicized. In soil composition, these heavy metal ions become protoplasmic poisons in the cells when absorbed by plants, causing the processes of metabolism to be bizalized. The Copper II-valence ion forms chelate-like complexes with simple metabolites, while disrupting the body's normal metabolism. As a result of the absorption of copper, iron, dry (II)-valence ions by plants, these heavy metal ions interact with cell membranes, altering their permeability. High lead ion soil prevents plant growth, It should be noted that about 60 soil samples were selected for the study.

The values of heavy metal ions were determined using ionometer PXSJ-217F, The PXSJ-217F ionometer device is a modern highly accurate apparatus that quantitatively determines the concentration of ions in a solution depending on the type of composite electrode.

The instrument supports conventional ion modes and user-defined ion modes. Ion mode Ag^{+}, Na^{+}, K^{+}, NH_4^{+}, Cl^{-}, F^{-}, NO_3^{-}, BF_4^{-}, CN^{-}, Cu^{2+}, Pb^{2+}, Ca^{2+} and hydrogen ion concentration (pH) are available for others. The ion concentration is determined with high accuracy on the corresponding ion-composite electrode.

The device consists of electrical parts and a system of electrodes. The electrode system consists of an ionic electrode, reference electrode and temperature electrode. pH electrode for pH measurement, pH value, lead ion concentration, and copper ion concentration. The pH value of the solution was determined using E-201 composite electrodes. T-818-B-6 electrodes are permanent devices of the ionometer and measure the temperature of the solution. EVL-1M3.1 silver chloride electrode filled with 3.5 M KCl solution was used to determine lead ion.

Selectivity coefficients of ion-exchange membrane electrodes for cations and anions were determined by the modified method of separate solutions. In each case it was calculated using the Nernst equation for the foreign ion. All measurements were performed in a permanent magnetic stirrer under stirring conditions and at a temperature of 298 K.

Soil samples were boiled in deionized water for 3-4 hours, the resulting solution was filtered in a vacuum filter. The filtrate was put into a ready state to detect heavy metal ions into the ionometer in the homogenous state. Using an ionometer, copper and arid ions in the soil were detected. From the results of the analysis, it was found that the ion content of copper in their soils is 22 mg/kg lead ion content is 10 mg/kg.

The results are shown in Table - 1 below.

Table 1. Research results of heavy metal ions.

№	Heavy metal ions	mV	Time response, seconds	pH	Temperature K	Ion concentrates, mg/kg
1	Copper	258	56	6	298	22
2	Lead	256	54	6	298	10

Some of the physical quantities determined by the ionometer, including mV, Time response (seconds), degree of dependence on pH value, degree of accuracy of temperature, measurement of ion concentrations in exact quantity, are represented by the diagram below.

The results are shown on Figure 1.

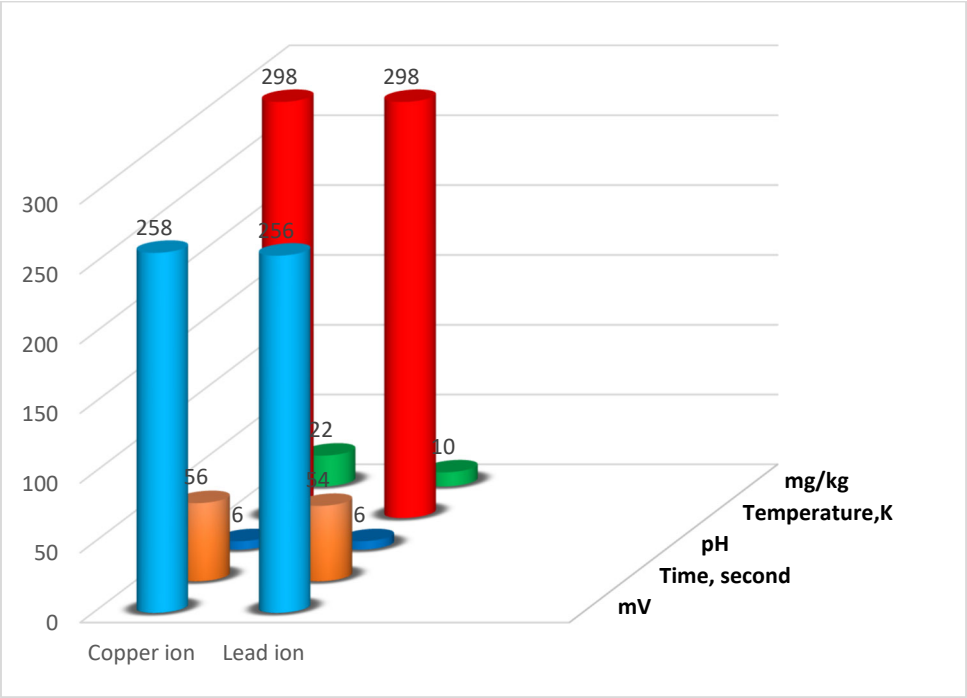

Fig. 1. Research results of heavy metal ions.

3 Experimental results

Put 10 g of soil in a beaker, add 25 ml of 1 N KCl solution, shake and leave for a day. The next day, shake the solution again and determine the pH value on the pH meter by immersing the electrodes directly into the suspension. For mass analyses, it is not necessary to wash the electrodes with water after each detection.

When determining pH using the PXSJ-217F ion meter, the device is turned on by pressing the on button after connecting to the electric current. Click the Save button and select the E-201 composite electrode. T-818-B-6 electrode detects constant temperature. The temperature control switch (on the back of the device) should be in the "AUTO" position. Place the electrodes in the "pH=7" buffer, press the "pH" button and press the "CALIBRATION" button. Repeat the adjustment process several times using buffer solutions, achieving absolutely accurate readings from the device. After installing the device, proceed to determine the pH of the studied solutions, wash the electrodes with distilled water and dry them slightly with filter paper after each determination. E-201 composite electrode for a short period of time determines the pH value of the solution, the ionometer temperature, the ion conductivity eV.

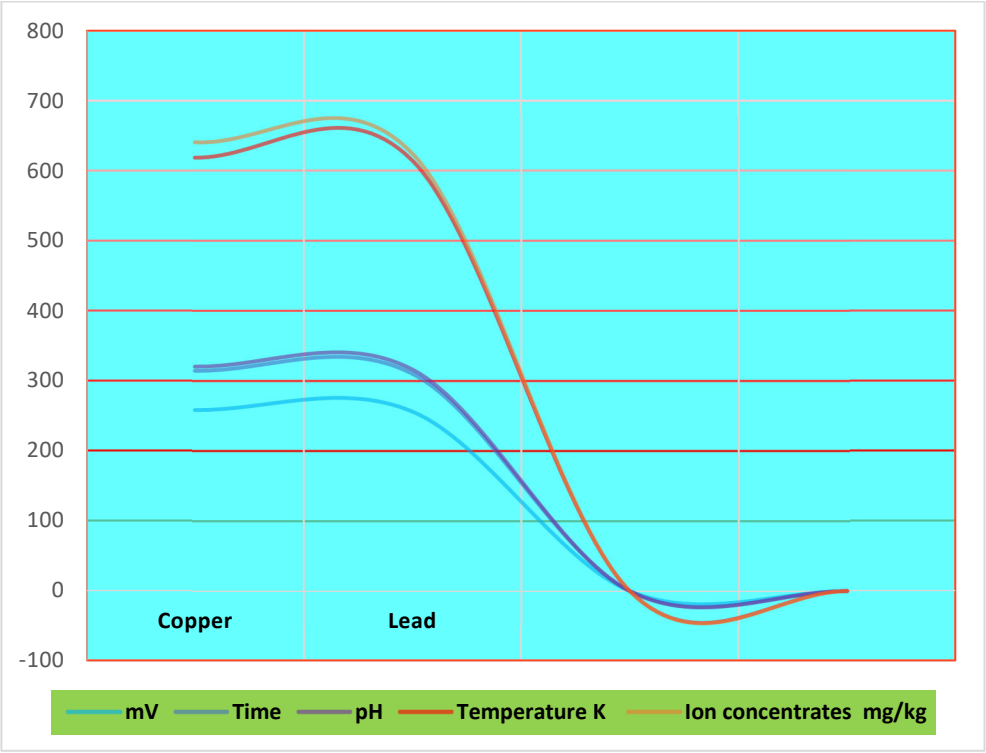

Fig. 2. Research results of heavy metal ions.

3.1 Qualitative analysis of lead and copper ions in soil

Lead ions can be determined in solution using the following reaction: add a solution of potassium iodide KI to the extract. As a result, a solution with a small precipitate of dense yellow color is formed. Pour the aqueous soil extract solution into the test tubes. add an excess of ammoniacal NH_4OH solution. A sign of the reaction is blue-green precipitates.

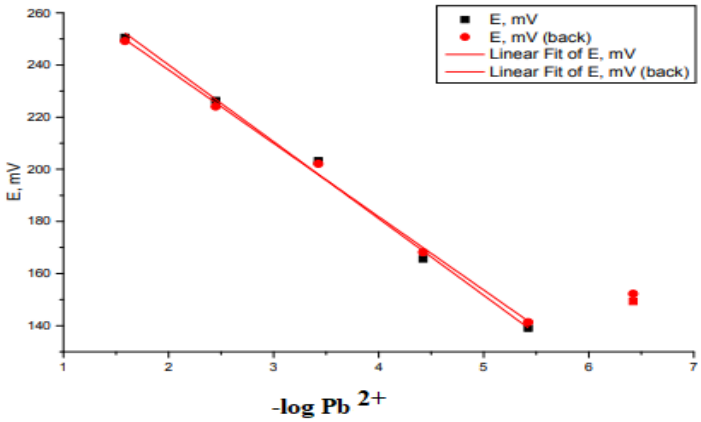

Fig. 3. Calibration graph of lead selective electrode at 25°C.

4 Conclusion

Potentiometric selectivity coefficients were determined by the method of byion potentials in relation to some d-elements, alkaline and alkaline soil metals. Zinc, cadmium, mercury and copper ions have a large effect on membrane reaction, which leads to the use of various masking agents in Potentiometric analysis in the presence of these ions. To increase the selectivity of the membrane on lead ions, a 0.1 M ammonia solution was introduced into the solution analyzed to bind Cu^{2+} and Pb^{2+} ions to more stable ammonia complexes. Based on the values of the selectivity coefficients, it can be concluded that heavy metal ions, after masking with a desimolar ammonia solution, do not have a significant effect on the electrode reaction. Thus, the proposed sensor can be used to detect lead ions in various technological solutions and water bodies.

Recently, the intensity of pollution of the atmosphere and soil of cities with heavy metals, primarily lead, has increased due to emissions from car engines. To change the situation for the better, in my opinion, it is necessary to ban the production of leaded gasoline in the near future. In general, modern cities represent huge man-made geochemical and biological anomalies, which not only affects the health of the population at present, but will also have unpredictable consequences for future generations.

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