# Laboratory works

## Laboratory work № 1
## Determination of carbon dioxide and of ammonia content in air

**Purpose of the work** is to determine the concentration of carbon dioxide and ammonia in the atmosphere by chemical analysis

**Equipment and devices:** flask with the volume of 50 ml, syringes, the sheet of white paper, the absorption solution [0.04 ml of 25% ammonia solution and 1-2 drops of 1% phenolphthalein solution are added into 500 ml of a distilled water (1 gram of phenolphthalein is dissolved in 80 ml of ethanol and it is brought to 100 ml with water)], the absorbed solution [6 ml of 0.01N.of sulfuric acid solution and 1-2 drops of 0.06% solution of methyl orange or methyl red (an indicator of 60 mg is dissolved into 50 ml of distilled water at a temperature of 40-50 ° C and brought to 100 ml with water)] are added 50 ml of distilled water.

### The order of work:

### 1. Determination of carbon dioxide

It is necessary to put air into the syringe and under the pressure to bring it through a needle into a container with the absorbed solution. It is necessary to pass the air to the color solution changes. It is necessary to determine the volume of air consumed for changing the solution color, knowing the number of required strokes and the filled volume of the syringe with the air.

Calculation $CO_2$ content (in percent) is carried out according to the following formula:

$$X = \frac{0,04 \cdot V}{V_1},$$

Where V is a volume of the open air, which had gone for the discoloration of the absorbed solution in $m^3$; V1 is the volume of air of tested area which had gone to the discoloration of the absorbed solution in $m^3$; 0.04 is the carbon dioxide content in the air in %.

2. Determination of ventilation air volume

The calculation of the ventilation air volume ($m^3$ / h), i.e. the volume of the fresh air, which should be put into the room for one person in such way that $CO_2$ content does not exceed the permissible level (0.1%),is necessary to do the according to the following formula:

$$L = \frac{K}{p - X},$$

Where K is the number of $CO_2$ liters breathed by one person at one astronomical hour at a quiet sedentary work (for an adult, in average it is 22.6 l /h); p is the maximum $CO_2$ content in the air of training room (0.1% or 1 l /$m^3$); X is $CO_2$ concentration in the tested zone (percent or l /$m^3$).

Knowing the ventilation air volume let's calculate the rate of ventilation (W), which shows how many times within 1 hour the air of room must be replaced that $CO_2$ content does not exceed the permissible level:

$$W = \frac{L}{V_{в.к}} - 2 .$$

Air cubic is calculated by the formula

$$V_{в.к} = \frac{V}{n} - 2 ,$$

Where Va/c is the air cube in m3 for one person (the physiological norm for person per hour is 15-20 $m^3$, hygiene standard is 4.5-5 m $^3$ per person); V is volume of the studied area (classrooms) in $m^3$; n is the number of people in the zone.

## 1. Determination of ammonia

It is necessary to put air into the syringe and under the pressure to bring it through a needle into a container with the absorbed solution. It is necessary to pass the air to the color solution changes. It is necessary to determine the volume of air consumed for changing the solution color, knowing the number of required strokes and the filled volume of the syringe with the air.

Calculation must be done according to the formula:

$$C_{NH_3} = \frac{1020 \cdot V_1}{V_2 \cdot 1000} ,$$

Where $C_{NH_3}$ is the concentration of ammonia in mg / $m^3$; 1020 is the mass of ammonia 1 mg per liter of solution; V1 is the volume of the absorbed solution in mL; V2 is the volume of the considered air in ml.

### Questions

1. Chemical composition of the atmosphere
2. The structure of the atmosphere
3. Main properties of the atmosphere layers
4. The Ozone layer – what is it, why do we need it, where it is located

## Laboratory work № 2.
## Determination of dry and anneal residues and water hardness

Dry residue characterizes content non-volatile solutes (mainly mineral) and organic substances in water, which have a boiling point higher than 105-110 ° C, non-volatile with water vapor and not decompose at this temperature.

The amount of dry residue in surface water reservoirs for drinking and community use purpose should not exceed 1000 mg / l (in some cases may be up to 1500 mg / l).

Ignited residue - a mass of matter remaining after ignition of dry residue at a temperature of ≈ 600 ° C. Ignition residue value gives an indication of water mineral composition, and a loss on ignition - amount of organic compounds.

Water Hardness is the presence of calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), strontium ($Sr^{2+}$), barium ($Ba^{2+}$), ferric ($Fe^{3+}$), manganese ($Mn^{2+}$) ions.

But the calcium ($Ca^{2+}$) and magnesium ($Mg^{2+}$) have the biggest part in ions water content, that's why the sum of calcium and magnesium ions usually calls total water hardness.

Total water hardness = carbonate hardness (temporary, can be eliminated by boiling of water) + non-carbonate (constant) hardness

carbonate hardness – the presence of calcium and magnesium bicarbonates

non-carbonate hardness - the presence of sulfates, chlorides, silicates, phosphates and nitrates of these metals.

Water hardness is expressed in mEq / l.

Water can be classified in next way:

very soft - 1.5 mEq / l.
soft - 1,5-3,0 mEq / l.
medium hardness - 3,0- 5,4 mEq / l.
hard - 5,4-10,7 mEq / l.
very hard - – >10,7 mEq / l.

Total hardness of drinking water should be no more than 7 mEq / L

For the majority of living organisms moderate hardness water are more favorable, as with water the body receives necessary amount of calcium.

**Purpose of the work** is to learn the content of the main groups of compounds in natural waters and methods of their determination.

**Equipment:** analytical balances, porcelain or quartz cups of 50 ml, burettes.

Reagents: 0.05 N. Trilon B solution; 0.1N. sulfuric acid solution; ammonium buffer solution (pH = 10); dark blue chromium solution as an indicator; methyl orange solution as an indicator .

## The order of work

### 1. Determination of the dry residue

The method is based on gravimetric determination of the solutes. It is necessary to put 10 ... 50 mL of filtered analyzed water sample into ignited, cooled and weighed porcelain or quartz cup. The water should be evaporated on electric stove. Then it is necessary to weight the cup. Dry residue content (mg / L) x should calculated according to the formula

$x = ((a - b) 1000) / V$,

Where a is the mass of the cup with a dry residue, mg; b is the mass of empty cup, mg; V is the volume of the analyzed sample of water, ml.

### 2. Determination of the total hardness of water

The method is based on the formation of a durable complex compound at pH 10 calcium and magnesium ions with sodium ethylenediaminetetraacetate (Trilon B Na2EDTA). The minimum determined concentration is 0.05 mEq / L (in titration of 100 ml of sample). It is necessary to put 100 ml analysis sample into a conical flask for titration then we should add 3-5 ml of ammonia buffer solution and 7 ... 8 drops of indicator - chrome dark blue, which color the water into pink red tint. Then, from the burette we add a solution of Trilon B by drops & all the time stirring the contents of the flask by rapidly rotating motion until the color changes in the equivalent point (the transition color solution from pink-red to blue-violet.)

Especially the water should be intensively stirred to the end of the definition, since the color change does not occur immediately, but gradually. The last drops of the solution should be added slowly with some intervals without stopping the mixing the water in the flask.

Total hardness of test sample, mEq / L, is numerically equal to the volume in ml of consumed 0.1N. solution of Trilon B, which was spent for the titration of 100 ml of water.

**3. Determination of carbonate hardness of water**

100 ml of tested water should be poured into the flask for titration and also two drops of methyl orange indicator solution must be added thus the water is colored into straw-yellow tint.

Then 0.1N sulfuric acid solution should be carefully by drops added in water while stirring the flask contents by rotational motions. The addition of acid should be stopped with the last drop, from which straw-yellow color of the water turns into the orange tint. Carbonate hardness of fresh water in mEq / L is numerically equal to the volume in ml of consumed 0.1N acid which was spent for the titration of 100 ml of water.

Example. 100 ml of water is taken for the determination of the carbonate hardness in it. 1.7 ml sulfuric acid is spent. Carbonate hardness of water is equal to 1.7 mEq / L.

**4. Determination of noncarbonated water hardness**

The value of noncarbonated hardness is defined as the difference between the total and carbonate hardness.

## Questions

1. What are the dry residue, the ignited residue?
2. What is the water hardness?
3. What is the total water hardness?
4. What are the carbonate hardness and the non-carbonate hardness?
5. Why do we need the medium water hardness for drinking water?

## Laboratory work № 3
## Determination of anion content in surface waters

There are different anions nature in surface waters: $HCO_3^-$, $CO_3^{2-}$, $SO_4^{2-}$, $Cl^-$, $NO_3^-$, $PO_4^{3-}$, $HSiO_3^-$ and others.

According to the prevailing anion natural waters are divided into three classes:

1) bicarbonate and carbonate (most mineralized waters of rivers, lakes, reservoirs and some underground waters);

2) sulfate water (intermediate between hydrocarbonate and chloride water, genetically related to the various sediments);
3) chloride water (highly mineralized oceans, seas, salt lakes water, groundwater and etc.).

Maximum permissible concentration(MPC) for chlorides in drinking water 350 mg / l. MPC for fishery water - 300 mg / l.

The main natural source of sulphate are processes of chemical weathering and dissolution of sulfur-containing minerals, mainly gypsum and sulfide oxidation and sulfur.

Significant amount of sulfates enter the water bodies in the process of the withering away of living organisms, terrestrial and aquatic oxidation of plant and animal substances.

Of anthropogenic sources of sulfates in the first place the mine water and industrial plants that use sulfuric acid wastewater.

Sulfates are also coming from municipal and agricultural wastewaters.

Sulfates in drinking water does not have toxic effects on humans, but worsen the taste of water.

MPC for sulfates in drinking water – 500 mg/l, MPC for fishery water - 100 mg / l.

MPC for phosphates in drinking water – 3,5 mg/l, MPC for fishery water – 0,2 mg / l.

Excess of nitrate and phosphate ions can cause water eutrophication.

**The purpose of the work is** to determine the content of some of the main anions in natural water, to characterize the studied water & to show possible ways of anions entering into the given pond.

**Equipment:** pencil box for the determination of phosphate number, burette and conical flask of 250 ml for titration, tin stick.

**Reagents:** 0.24 n. silver nitrate solution (1 ml is equal to 0.5 mg chlorides), sulfomolibdat ammonia solution, a 5% potassium chromate solution.

## The order of work

### 1. Determination of chlorides

The method is based on titrimetric precipitation of chlorides in neutral or alkalescent medium by silver nitrate in the presence of potassium chromate as an indicator. 5 drops of potassium chromate solution should be added into the water sample of 50 ml then it is should be mixed well and titrated with a solution of silver nitrate. Titrant solution must be added till the stable brown tint appears in the water.

The content of chlorine ions in the water sample will account x, mg / l

$$x = \frac{V_1 \cdot N \cdot E \cdot 1000}{V_2}$$

Where V1 is a volume of silver nitrate solution which was spent for titration, ml; N is normality of silver nitrate solution; E is milligram-equivalent of chlorine (35,5); V2 is a volume of the tested water, ml.

## 2. Determination of phosphates

The essence is that sulfomolibdat solution added in the tested water sample in the presence of tin rod (reducing agent) immersed in it reacts with the phosphate, whereby water is colored into blue tint, the intensity of which is greater when the concentration of phosphates in water is higher.

2 ml of the filtered water sample must be added into volumetric tube, and then it is necessary to bring the volume of liquid with sulfomolibdat solution to 10 ml. Then tin stick which was purified with sandpaper & rinsed with distilled water should be added into the solution. After 5 minutes (during this time the solution in a test tube with a tin stick must be 2 ... 3 times slightly mixed) tin stick with the cork should be removed from the tube and it is necessary to compare the color of the test solution with the color of the standard color scale. To do this a pencil box, where there is holder with phosphate scale must be removed from the back wall of the lab box. Then we must remove the holder and put measuring tube into it (through the upper hole) so that it is in a special slot on background milk glass next to the cell color scale.

Behind the holder there must be a light source placed so that the coloring of the test solution is compared with the standard color scale in the scattered transmitted light.

Phosphate number of water corresponds to the figure standing against the scale of the cell; the color of which coincides with the color of the solution in a test tube or it is the closest to it.

Phosphate scale is calibrated in accordance with the content of phosphate ions (RO43- mg / l) in water. The scale should be kept in a case (it should be on the light only during colorimetry).

## Questions

1. How can be divided natural waters according to the prevailing anion?
2. How much is the MPC for chlorides?
3. How much is the MPC for sulfates?
4. How much is the MPC for sulfates?
5. How much is the MPC for phosphates?
6. What is the eutrophication?

# Laboratory work № 4
## Determination of natural waters oxidation

### Theory:

There are two types of redox processes: aerobic (in a presence of dissolved oxygen) and anaerobic (without free oxygen).

In aerobic processes resulting chemical substances are $CO_2$ and $H_2O$ – oxides in the high level of oxidization.

In anaerobic processes microorganisms use for oxidization of chemicals oxygen from nitrates, sulfates, and other compounds.

Examples of reactions:

$C_{organic} + 2NO_3^{-} + 2H^{+} \rightarrow N_2 + 2{,}5CO_2 + H_2O$

or:

$C_{organic} + SO_4^{2-} + 2H_2O \rightarrow H_2S + 2HCO_3^{-}$

fermentation also possible:

$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ - alcoholic fermentation

$CH_3–CH_2–OH \rightarrow CH_3–COOH + H_2$

$CH_3–COOH \rightarrow CO_2 + CH_4$ - methane fermentation

One of the characteristics of natural waters is their oxidation - the total amount reductants contained in the water (usually organic compounds) that react with strong oxidizing agents, for example, bichromate, permanganate, and others.

The most complete oxidation of compounds is achieved by using potassium dichromate, dichromate oxidation therefore often referred to as "chemical oxygen demand"(COD)

The COD standards for water reservoirs: domestic water - 15 mg O / l, cultural and community water - 30 mg / l.

**The purpose of the work**: To get acquainted with the methods of determining the total amount of organic pollutants in water with the help of the definition of natural waters oxidation.

**Reagents:** sulfuric acid with the of density of 1.84 g / cm3; N - phenylanthranilic acid (0.25 g of acid is dissolved in 12 ml of 0.1 N NaOH solution and diluted with water to 250 ml.); potassium dichromate of 0.25 n. standard solution; Mohr's salt of 0.25 n. solution (Mohr’s salt solution titer is pre-installed on a standard solution of potassium dichromate.

## The order of work

2.5 mL of 0.25N. solution of potassium dichromate should be put into the water sample (in 5 ml) then while stirring the concentrated sulfuric acid in an amount of 15 ml should also added. Thus the solution temperature rises above 100 ° C. After 2 minutes 100 ml of distilled water should be added to the mixture cooled to the room temperature and dichromate excess should be titrate. To do this 10-15 drops N - phenylanthranilic acid solution must be added and with the help of burette Mohr salt solution which interacts with the unreacted amounts of potassium dichromate must be added into the mixture.

It is necessary to carry out a blank experiment. With using 5 ml of distilled water the same operations which are done with natural analyzed water sample are carried out.

The amount of COD, mg O / L is determined by the formula

$$O_{мг} = \frac{(a-b)N \cdot 8 \cdot 1000}{V},$$

where a is the amount of Mohr’s salt solution which was spent for titration of the blank sample, mL; N is the normality of Mohr's salt; V is the volume of analyzed sample ml; 8 is the equivalent of oxygen.

**Requirements for the report**

The report shows the title and purpose of the work, the results of the calculation of chemical oxygen consumption by dichromate method; concludes about the content of organic pollutants in the test water.

### Questions

1. What types of redox processes you do know?
2. What chemicals do appear in result of aerobic process?
3. What chemicals do appear in result of anaerobic process?
4. Give the definition of oxidation.
5. What is the "chemical oxygen demand"?
6. What are the standards of COD for domestic and cultural and community water?

## Laboratory work № 5

## Determination of nitrate content in plant bodies

**Theory:**

The atmosphere contains nitrogen in the amount of ≈ 78%

Nitrogen becomes available to the living organisms after the assimilation soils with nitrogen-fixing bacteria and tuber bacteria that live on the roots of legumes, as well with blue-green algae of the hydrosphere.

Nitrogen has many valence states available and can exist in the environment in a number of forms, depending upon the oxidizing ability of the environment. The oxides of nitrogen represent the most oxidized and least thermodynamically stable forms. These exist only in the atmosphere.

Ammonia can exist in gaseous form in the atmosphere but rather rapidly returns to the soil and waters as ammonium, $NH_4^+$ .

**Fixation** of atmospheric $N_2$ by leguminous plants leads to ammonia, $NH_3$. In aerobic soils and aquatic systems $NH_3$ are progressively oxidized by micro-organisms via nitrite to nitrate. The latter is taken up by some biota and used as a nitrogen source in synthesizing amino acids and proteins, the most thermodynamically stable form of nitrogen.

After the death of the organism, microbiological processes will convert organic nitrogen to ammonium (**ammonification**) which is then available for oxidation or use by plants.

Conversion of ammonia to nitrate is termed nitrification, whilst **denitrification** involves conversion of nitrate to $N_2$.

Nitrates excess in water and food harms human health since the appearance of nitrite in the body recovered from the nitrate causes the formation of methemoglobin, in which oxygen is strongly associated with hemoglobin, which reduces the ability of red blood cells to carry oxygen. The highest nitrate content in water bodies causes rapid growth of phytoplankton leading to eutrophication of water reservoir.

+ Nitrate cycle from your lectures

**The purpose of work** is to explain the notion of migration of nitrogen in the biosphere & to determine the content of nitrate nitrogen in plants.

**Reagents**: nitrate tester, electrodes, silver chloride and nitratselektive solution KNO3, 1% solution of potash alum.

## The order of work

First a sample of the plant material in an amount of 0.25 ... 0.5 kg should be washed and dried with filter paper, and then it is necessary to crush. 5-10 g of sample should be weighed and placed in a vessel. It is necessary to add 50 ml of a 1% solution of potash alum into the vessel and stir the mixture for 1-2 minutes.

It is necessary to immerse electrodes into the homogenized mass and determine the value of EMF on the scale of the device. Using the Table. 4it is necessary to determine the nitrate content in plant studied issues, mg / kg.

These values are compared with the sanitary standards of nitrate content in vegetable products (tab. 5) and we must make a conclusion about the content of nitrates in plants and soils in place of plant growing.

Table 4

### Indications of nitrate tester depending on the content of nitrates in the investigated products, mg / kg

| мВ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 36,0 | 37,5 | 39,0 | 40,7 | 42,4 | 44,2 | 46,0 | 48,0 | 50,0 | 52,0 |
| 10 | 54,4 | 57,0 | 58,3 | 61,1 | 64,0 | 67,0 | 70,1 | 71.8 | 75.1 | 78,7 |
| 20 | 82,4 | 84,3 | 88,3 | 92,4 | 96,8 | 101 | 104 | 109 | 114 | 119 |
| 30 | 125 | 128 | 134 | 140 | 147 | 150 | 157 | 164 | 172 | 180 |
| 40 | 184 | 193 | 202 | 212 | 222 | 227 | 238 | 249 | 261 | 267 |
| 50 | 279 | 292 | 306 | 321 | 328 | 343 | 360 | 377 | 394 | 404 |
| 60 | 423 | 442 | 463 | 474 | 496 | 520 | 544 | 570 | 583 | 611 |
| 70 | 640 | 660 | 701 | 718 | 751 | 787 | 824 | 843 | 883 | 924 |
| 80 | 968 | 1013 | 1037 | 1085 | 1137 | 1190 | 1247 | 1276 | 1336 | 1399 |
| 90 | 1465 | 1499 | 1570 | 1644 | 1721 | 1802 | 1844 | 1931 | 2022 | 2117 |
| 100 | 2217 |  | 2376 |  | 2605 |  | 2791 |  | 3061 |  |
| 110 | 3280 |  | 3596 |  | 3943 |  | 4225 |  | 4633 |  |
| 120 | 4964 |  | 5443 |  | 5832 |  | 6395 |  | 7012 |  |
| 130 | 7513 |  | 8238 |  | 8827 |  | 9679 |  | 10371 |  |
| 140 | 11372 |  | 12469 |  | 13360 |  | 14649 |  | 15697 |  |
| 150 | 17211 |  | 18443 |  | 20222 |  | 22173 |  | 23759 |  |
| 160 | 26051 |  | 27914 |  | 30607 |  | 32796 |  | 35960 |  |

Table 5

**Sanitary standards and permissible levels of nitrates in vegetable products**

| Product | Permissible levels, mg/kg | Product | Permissible levels, mg/kg |
|---|---|---|---|
| Potato | 250 | Bow onion | 600 |
| Carrot: early | 400 | Sweet pepper | 200 |
| >> late | 250 | Apples | 60 |
| beet | 1400 | Pears | 60 |
| Onion | 80 | | |

## Questions

1. What is the concentration of nitrogen in the atmosphere?
2. How does the nitrogen become available to the living organisms?
3. What is the ammonification?
4. What is the denitrification?
5. Which harm can cause nitrates for human body and for water objects?

## Laboratory work № 6
## The study of the photosynthesis process
## Products of photosynthetic reactions

**Photosynthesis** is a process used by plants and other organisms to convert light energy into chemical energy that can later be released to fuel the organisms' activities

We can write the overall reaction of this process as:

$$\mathbf{6H_2O + 6CO_2 \text{ ----------> } C_6H_{12}O_6 + 6O_2}$$

Along with photosynthesis of higher plants and algae, followed by release of O2, in the nature of bacterial photosynthesis is carried out, wherein the oxidizable substrate is not water but other compounds having a more pronounced reducing properties, for example sulfur dioxide and hydrogen sulfide. Oxygen in bacterial photosynthesis is not allocated, for example .:

$$2H_2S + CO_2 \xrightarrow{h\nu} 2S + [CH_2O] + H_2O$$

Thus, in the process of photosynthesis radiation energy is converted into chemical energy of carbon compounds.

In the future, these high-energy compounds are cleaved again to form carbon dioxide and water with release of energy. The processes of organic compounds oxidation by oxygen in the air are called breathing. Respiration - a source of energy consumed by the cell for all its needs.

Plants also breathe, and breathe day and night, while the photosynthesis occurs only in the daytime.

Breathing and combustion have the same nature. Fuel, or oxidizing agents, interact with oxygen consumed by the body from the air and burns to form carbon dioxide and water:

**Organic matter (food) + $0_2$ -» $C0_2$ + $H_20$ +energy**

released energy is converted into chemical energy which is then used in all physico-chemical processes occurring in the living body, - the processes of synthesis of proteins and nucleic acids, transport agents and direct the movement and operation of the muscles.

Thus, photosynthesis and respiration - are two opposite processes in the natural environment, which form the basis of energy processes in the biosphere.

**The purpose of work** is to learn the process of the formation of the photosynthetic carbohydrates in plant tissues.

**Equipment and devices**: ceramic container, stove; ethyl alcohol, solution of iodine in potassium iodide.

### The order of work

It is necessary to take two leaves of plant, one of which was subjected to the lightness & the other one to the darkness.

Then the leaves are placed in a cup with 90% ethanol, and boiled for 5 ... 10 min, after that it is necessary to put a leaf into a cup of water and boil until it becomes colorless. We should take out the leaves then spread them in a Petri cup and put on them a solution of iodine in potassium iodide. It is necessary to mark the different reactions to the starch in the leaf which was subjected to the lightness & the other one to the darkness.

It is necessary to sketch the observations to conclude the processes of photosynthesis.

### Questions

1. What is the photosynthesis as a process?
2. Write the reaction equation of photosynthesis for green plants.
3. Write the reaction equation of bacterial photosynthesis.
4. Which process is opposite for photosynthesis? Write the reaction equation.
5. Why the leaves in your work have had different reaction with iodine?

## Laboratory work № 7

## Radioactivity of the environmental objects evaluation

Radioactivity is a spontaneous transformation (decay) of atomic nuclei of certain chemical elements (uranium, thorium, radium, californium etc.), which leads to a change in their atomic and mass numbers and is accompanied by the emission of ionizing radiation.

The disintegration of atoms is accompanied by ionizing radiation as passing through different substances; such radiation can cause ionization of its atoms as in direct collision or indirect one. Natural radioactive substances emit three types of rays: $\alpha$-, $\beta$-, $\gamma$ rays.

$\alpha$-radiation is a stream of positively charged $\alpha$-particles (nuclei of helium atoms). Penetration of such particles is small & they are absorbed by aluminum foil with a few microns thickness. The danger is the ionizing power of $\alpha$ -rays. The ionization leads to a change in physico-chemical properties of the substance but in biological tissues it leads to the violation of their life.

$\beta$-rays is a stream of fast electrons (or positrons). Speed of moving such particle is near the speed of light. They have lower ionizing but greater penetrating ability as compared with $\alpha$-rays; : Clothing absorbs up to 50% of $\beta$-emission but aluminum layer with thickness of 1 mm absorbs it completely.

$\gamma$-radiation is a short wave electromagnetic radiation having a high penetrating ability. To protect against $\gamma$ -radiation a special radiation-protective materials such as heavy concrete, pure lead, special polymers are used.

Radioactive radiation is an essential problem of the environment. Natural background radiation of the Earth is created by cosmic radiation and natural radioactive nuclides (uranium, thorium, and their decay products), naturally distributed in the earth, water, air, food and human body. Over the biological history of the planet, this pattern has remained practically unchanged, causing radiation dose close to 10-12 mkR / h. The natural background is considered safe for biological objects. As a result of human activity the natural background radiation changes, and technologically modified radiation background appears. Artificial radiation arising during testing of nuclear weapons are making these changes, in violation of operation of radioactive facilities (nuclear power plants, research institutes of an appropriate profile, etc.) & the formation of radioactive waste at nuclear power plants.

**The purpose of work** is to deepen the notion of radioactivity of different objects of the environment, to estimate the radioactivity of a particular object, to master the method of measurement of radioactivity.

**Equipment & devices**: an indicator of radioactivity "RADEX"

**The order of work**

Radioactivity evaluation is carried out indirectly by the intensity of $\gamma$-radiation measured object. Objects are given by a lecturer. With the help of an indicator of radioactivity "RADEX" at different points of the measured object it is necessary to measure the samples in accordance with the rules of work with the devices.

In determining the radioactive contamination it is necessary to bring the device to the test subject at a distance of 5 to 10 mm left side laterally.

It is necessary to make measurement of power equivalent to dose of the object.

After the cycle of the observation we can see on display the following the difference between the measured equivalent dose power and rate background dose power. The value of the measured equivalent dose for the test object consists of these two values.

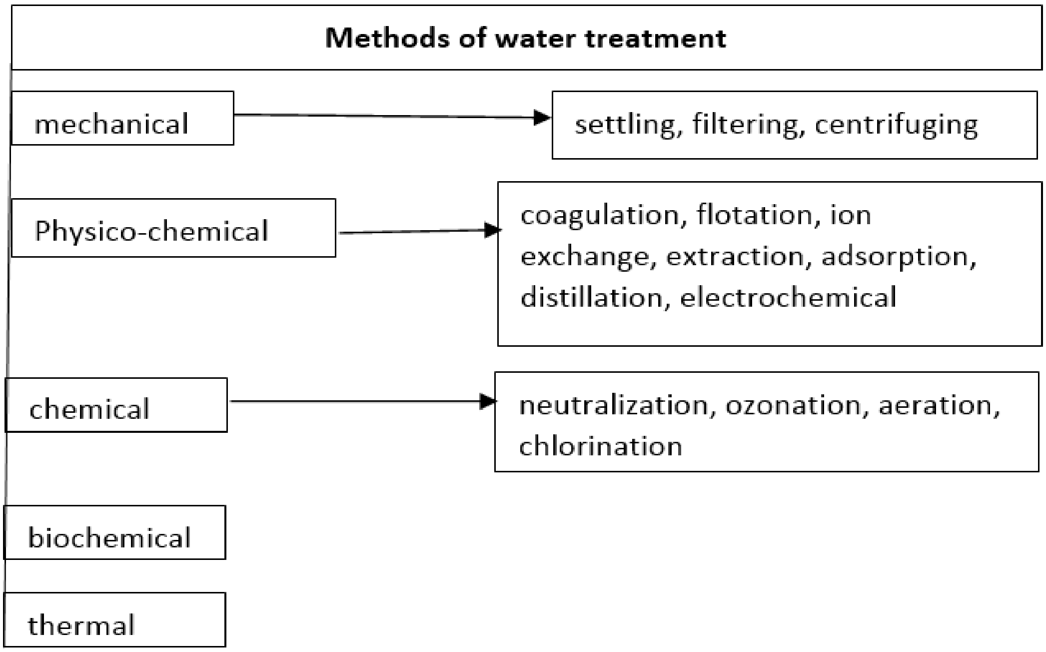
## Questions

1. Give the definition of a radioactivity.
2. What is the α- rays?
3. What is the β- rays?
4. What is the γ rays?
5. Which rays has the highest penetration ability?
6. Which natural sources of radioactivity you do know?
7. Which artificial sources of radioactivity you do know?

## Laboratory work № 8

## Mechanical purification of water

**Waste water** is the water which has been used in household, industry or agriculture, or having passed through some contaminated and polluted land. Depending on the formation conditions wastewaters are divided to domestic sewage, meteorological and industrial wastewaters.



**Sedimentation** is used for the precipitation of coarsely dispersed impurities from wastewater. For this purpose sand traps, sedimentation tanks and clarifying tanks are used. In all these facilities the particles settle due to force of gravity.

**Physical-and-chemical** methods of wastewater purification include coagulation, flotation, adsorption, ion exchange, extraction, rectification, evaporation, distillation, reverse osmosis and ultrafiltration, crystallization, desorption etc. These methods are used to remove the finely-dispersed suspended particles (solid and liquid), dissolved gases, mineral and organic substances from the waste water.

**Coagulation** - is the process of dispersed particles consolidation as a result of their interaction and assembling into aggregates.

**Flotation** is used for removing the insoluble dispersed impurities from water, which are not prone to sedimentation. Flotation consists in treating wastewaters with gas or air bubbles, which carry over the particles and molecules of pollutants.

**Absorption**, as a process, is concentration of one substance in a volume of another substance. It is a selective capturing of one or more components from a gas mixture by liquid. The reverse process, i.e., removal of condensed gas molecules from liquid volume, called degassing or de (ab) sorption.

The liquid us called a solvent, or absorbent.

Absorption can be two types: physical absorption and chemical.

When it is physical absorption, physical dissolution of absorbable component in a solvent occurs, and the absorbent molecules and molecules of a gas not enter into a chemical reaction.

When it is chemical adsorption, occurs chemical reaction of liquid and gas molecules with formation of new chemical compounds.

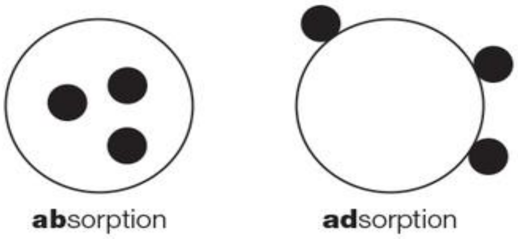
Devices, which used for absorption, called absorber.

**Adsorption** is the adhesion of one chemical substance to a surface of another chemical substance. So, adsorption is a surface-based process while absorption involves the whole volume of the material.

Chemical component, on which surface adhesion occurs, is called adsorbent.

In the most cases adsorbent is a solid matter.

The same as in absorption, it can be physical and chemical adsorption.



**The purpose of work** is to learn the methods of mechanical purification of sewage

**Equipment and reagents**: fabric, fiber & paper filters; porcelain cups; electric cooker; scales.

**Order of work**

Sewage containing insoluble impurities is necessary to filter through paper, cloth, and cotton filters then we should determine the dry residue in the original and in the sewage & in filtrate. For this purpose it is necessary to place 15 ml of analyzed water samples into the calcined, cooled and weighed ceramic cup. It is necessary to evaporate the water on an electric cooker and then to weigh the cup together with the residue.

Dry residue content (mg / L) x should calculated according to the formula

$x = ((a - b) 1000) / V$,

Where a is the mass of the cup with a dry residue, mg; b is the mass of empty cup, mg; V is the volume of the analyzed sample of water, ml.

According to the received values it is necessary to determine the purification rate (%) for each of the studied filters:

$$m = \frac{(a-b)\cdot 1000}{V},$$

Where m1 is mass of dry residue of the original waste water, g; m2 is mass of dry residue after filtration, g

It is necessary to provide information on the degree of purification for each type of filter material and to evaluate the effectiveness of their use.

## Questions

1. What is a waste water?
2. What is a sedimentation?
3. Which mechanical methods of water treatment you do know?
4. Which physical-and-chemical methods of water treatment you do know?
5. What is a coagulation?
6. What is a flotation?

## Laboratory work № 9 Purification model water from dye by adsorption method.

**The purpose of work** is to carry out purification of the model sewer containing dyes; to evaluate the effectiveness of sorption materials used.

**Equipment and Reagents**: flasks (250-500 ml), the model contaminated water (containing dye), sorption materials, scale of color range.

### The order of work

100 ml of contaminated water must be added into each of 4 flasks. It is necessary to select 4 different sorption materials and to put 1 g into separate flasks with contaminated water. Within 15 minutes it is necessary to stir the contents of the flasks, then to filter them through a paper filter and compare the color of treated water to the scale of color range. It is necessary calculate the efficiency of water purification according to the formula

$$E = \frac{C_{bp} - C_{ap}}{C_{bp}} \cdot 100\%$$

where $C_{bp}$ and $C_{ap}$ - concentrations of pollutants in solution before and after purification, mg / dm3

It is necessary to make a conclusion about the effectiveness of various water purification model sorption materials.

## Questions

1. Which methods of water treatment you do know?
2. Which physical-and-chemical methods of water treatment you do know?
3. Which chemical methods of water treatment you do know?
4. What is a absorption?
5. What is a adsorption?