LABORATORY NO. 5

5.1. CHEMICAL PROPERTIES OF THE DRINKABLE WATER

In water we find three types of substances:

- **Toxic substances**, which have a harmful action upon the organism. They are: As, Pb. Hg, nitrates, F, the cyanides, Cd, Cr, Se, Ni, aromatic policyclic hydrocarbons, trihalometans and pesticides.

These substances are rigurously standardised.

- **Undesirable substances**. These substances aren't harmful, but in greater concentrations in water they modify the quality of water (organolepticaly and physically). They are: Ca, Mg, Fe, Mn, Zn, Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}.

We have two limits:

- maximal admited concentration;
- exceptional admited concentration.

- **Polution indicators.** They are the substances which do not act harmfully upon the organism, and not modify the organoleptical and physical quality of water, but their presence indicates water pollution.

They are:

- organic substances expressed by $KMnO_4$ consumption as an oxidant substance or O_2 consumption (CCO);
- NH_3 which results from oxidation of organic substances or reduction of NO_2^-;
- NO_2^- which results from oxidation of NH_3 or reduction of NO_3^-;

The next degradation phase of organic substances is NO_3^-, but it is considered a harmful substance.

In this way we find water pollution with microorganisms and organic substances (feces and other pollutants from residual water).

5.1.1. TOXIC SUBSTANCES

Toxic substance that we find is NO_3^-.

The sources are:

- the soil;
- pollution with organic substances;
- pesticides which contain N_2 (nitrogen);
- the nitrate fertilisers used in agriculture.

They can produce methemoglobinemy which blocks the blood oxygen and diminishes the HbO_2 (oxyhaemoglobin) formation.

Also, nitrates determine cancer through nitrosamines.

NORMAL VALUES

It is accepted maximum 45 mg/m^3 of water.

5.1.2. UNDESIRABLE SUBSTANCES (THE HARDNESS OF THE WATER)

Hard water contains more minerals than usually.

We find three types of water depending on the mineral contents:

a) soft water - water with hardness under 5^0G. This water presents the following disadvantages:
   - It doesn't give the physiological daily dose of minerals that ensures the human needs;
   - It produces corrosion in metallic and concrete pipelines.

b) water with moderate hardness - is tap water with hardness between 5 and 20^0G; that is drinking water.

c) hard water - water with hardness over 20^0G. This water presents the following disadvantages:
   - Vegetables do not boil in it.
   - It doesn't make foam with soap.
   - It makes crusts on the vessels boiling time.
   - It determines irritation on the teguments (cutaneous irritation) and on the mucous membranes.

A great advantage of this water is the good action upon the cardiovascular diseases, especially on ischemic cardiopaty.

NORMAL VALUES FOR HARDNESS

maximum - 20^0G;
exceptional - 30^0G.

where:
1^0G = 10 mg CaO/l water;
1^0F = 10 mg $CaCO_3$/l water;
1^0E = 10 mg $CaCO_3$/750 ml water.
In Romania we use the unit ^{0}G.

5.1.2.1. ESTABLISHMENT METHOD TEMPORARY HARDNESS

The principle -consists of neutralisation of the $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ with HCl in presence of the methyl-orange as indicator.

$$th = N \times 2,8$$

where: th - temporary hardness;
N - volume of HCl in ml that we used to titrate;
2,8 - equivalent.

5.1.2.2. TOTAL HARDNESS ESTABLISHING METHOD

The principle - consists of the reaction between metal's cations (Ca^{++} and Mg^{++}) with dinatrium salt of etylendiaminotetraacetic acid (EDTA-Na), at a pH degree equal to 10, and with a stable complex formation, without colour. The end of the reaction is marked by black eriocrom T change the colour from red to blue.

The material which we need:
25 ml water:
1 ml NH_4Cl;
0,1 g black eriocrom T

We titrate with EDTA-Na (Complexon solution), until the colour becomes blue.

$$Th = \frac{V1 \times f \times 0,561 \times 1000}{V \times 10}$$

where:

Th - total hardness;
V_1 - EDTA-Na_2 volume which we used to titrate;
f - EDTA-Na_2 factor
V - water volume;
0,561 - equivalent;
10 - equivalent in mg CaO for 1 ^{0}G hardness.

5.1.2.3. PERMANENT HARDNESS ESTABLISHMENT

It is realized with the formula:

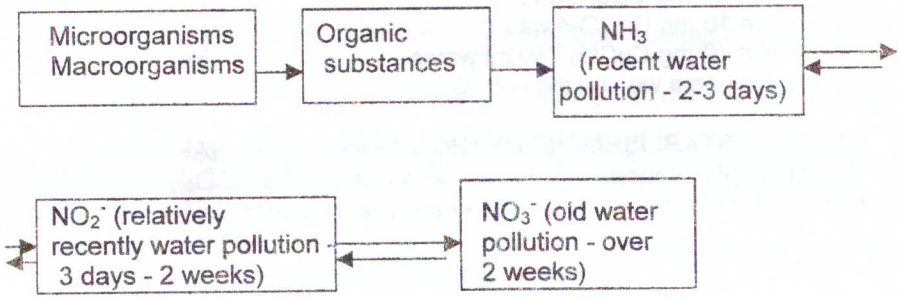
$$ph = Th - th$$

where:

ph - permanent hardness;
Th - total hardness;
th - temporary hardness.

5.1.3. ESTABLISHMENT METHODS FOR SUBSTANCES WHICH INDICATE WATER POLLUTION

For a good understanding of sanitary importance of the substances which indicate water pollution we use the following scheme:



Where: → - oxidation;
← - reduction.

The substances which indicate water pollution are:

- organic substances;
- NH_3;
- NO_2^-.

5.1.3.1. ORGANIC SUBSTANCES ESTABLISHMENT METHOD

Sources:

- water pollution;
- from soil.

The principle consists of organic substances oxidation with $KMnO_4$ (kalium permanganat) in acid medium (when the water contains less than 300 mg chlorine salt / dm^3 water) or in allcaline medium (when water contains chlorine salt more than 300 mg/dm^3 of water).

NORMAL VALUES

Organic substances expressed in mg $KMnO_4$:
maximum - 10mg/dm^3 of water
exceptional - 12 mg/dm^3 of water.

5.1.3.2. NH_3 DETERMINATION METHOD

Sources:

- water pollution;
- NO_2^- reduction.

The principle consists of colorimetric appreciation of the oximercuramonium iodine - an yellow complex which results after the reaction between NH_3 from water and Nessler reagent, in the presence of Seignette salt. The colour intensity is proportional with water NH_3 concentration.

NORMAL VALUES

maximum - 0 mg NH_3/dm^3 water

exceptional - 0,3 mg NH_3/dm^3 water in case of the water from underground sources with a depth greater than 60 m, without chlorine, that can be drunk.

5.1.3.3. NO_2^- ESTABLISHMENT METHOD

Sources:

- water pollution;
- NO_3^- reduction.

The principle consists of red azoic complex formation, in presence of the sulpfanilic acid and α-naftylamine, in intense acid medium. The colour intensity is direct proportional with NO_2^- concentration in water.

Normal values:

maximum - 0 mg NO_2^-/ dm^3 of water

exceptional - 0,3 mg NO_2^-/ dm^3 water for deep wells with depth greater than 60 m, without chlorine, that can be drunk.

5.1.3.4. ESTABLISHMENT METHOD FOR DISSOLVED OXYGEN IN WATER

Sources of dissolved oxygen in water:

- water physical aeration (introduction of air in water);
- photosynthesis of aquatic plants.

Consumption:

- fast consummers of the oxygen from water: SO_3^-, S, Fe;
- micro and macroorganisms from water.

Biological consumption of the oxygen was considered CBO_5 (biological consumption of oxygen within five days).

The importance of the method:

Water dissolved oxygen is an indirect indicator for water pollution.

If we have a great concentration of organic substances in water, we have a great consumption of oxygen, and a small concentration of water dissolved oxygen.

The principle consists of oxidation (produced by water dissolved oxygen) of the $Mn(OH)_2$ to MnO_3H_2, which in acid medium eliberates iodine from KI (kalium iodine) solution, proportional with oxygen concentration in water. The free iodine is titrated with $Na_2S_2O_3$ (natrium tiosulphate), in presence of the starch as indicator.

NORMAL VALUES

We meat three types of water:

- type 1:
  - drinking water;
  - water for food industry;
  - water used for the swimming pools.

We admit minimum 6 mg O_2/dm^3 of water.

- type 2:
  - water used in fish rising pools;
  - water used for nautical and entertainment purposes;
  - water used for urbane purpose.

We admit minimum 5 mg O_2/dm^3 water.

- type 3:
  - water used for agriculture;
  - industrial water except food industry water.

We admit minimum 4 mg O_2/dm^3 water.