LABORATORY WORK NO. 13

PHYSICAL AND CHEMICAL ANALYSIS OF DRINKING WATER

■ **PRINCIPLE:** Naturally occurring water is never pure, it always contains a certain amount of dissolved substances, gases and dissolved solids. Some of these substances cause so-called hardness of water.
Water hardness is caused by dissolved calcium and magnesium salts.

We distinguish following **water hardness:**

a) temporary (carbonate) – it is caused by calcium and magnesium bicarbonate. It is removed by boiling.

$Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O$

b) permanent – it is caused by dissolved calcium sulfate or magnesium. It is removed chemically by using so-called softening agents such as Na_2CO_3.

$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$

c) total – it is given by the concentration of Ca^{2+} and Mg^{2+} cations in water. The result of defining water hardness is generally measured stated in German degrees of hardness (° N).

TASK NO.1 PHYSICAL ANALYSIS OF WATER

■ **CHEMICALS:** drinking water from the public water supply and drinking water from a well

■ **AIDS:** beakers, graduated cylinder, watch glass, burner, support stand, thermometer, pH meter, conductometer

■ **PROCEDURE:**

A) Assessment of water by sensual tests

1) Taste of unboiled water is determined after the microbiological examination. Samples of drinking water must be microbiologically safe. Water must have temperature of 15-20 ° C when we taste it. It should not have any taste or flavor.
2) Bad smell: 200 ml of tested water is heated in a beaker to 20-60 ° C and we cover it with a watch glass. After lifting the glass, we feel the smell more clearly. Drinking water shouldn´t have any bad smell.
3) Turbidity - drinking water must be clear. We find out the turbidity in a cylinder from colourless glass. We observe it in daylight against a white and black pad.

B) The pH of drinking water

We put 100 ml of drinking water into the beaker and, using pH paper, we determine approximately the pH of the sample and write it down. We repeate the same using the pH meter.

C) Water conductivity

We put 100 ml of drinking water into the beaker and, using a conductometer, we determine the conductivity of water and write it down.

D) Water temperature

We put 100 ml of water into the beaker and measure the temperature. We write down the values.

- **CONCLUSION:** Write down all proven physical characteristics.

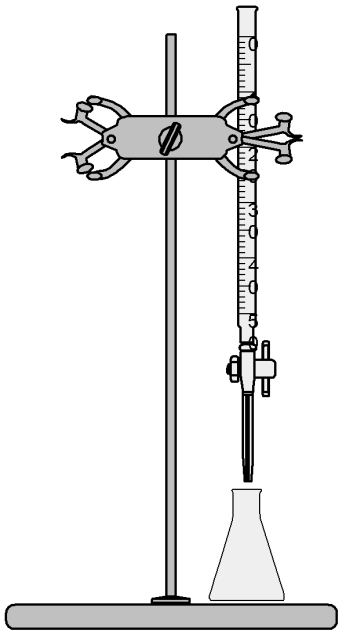
TASK NO.2 DETERMINATION OF Ca^{2+} IN WATER

- **CHEMICALS:** Chelatone III (c = 0,05 mol/l), NaOH (c = 2 mol/l), murexide (mixture with NaCl at the ratio of 1:100), samples of water (from a water tap and from a well)

- **AIDS :** titration flasks, pipette, burette, graduated cylinder, scales, volumetric flask, weighing boat, spoon

- **PROCEDURE**: Measure out 100 ml of the water sample into the titration flask by means of the volumetric flask. After adding 5 ml of NaOH (c = 2 mol / l) and 0.3 g of murexide, titrate by the standard solution of chelatone III (c = 0,05 mol / l) up to a blue-violet colouring. Titrate all samples.

- **APPARATUS:**



- **CALCULATIONS:**

where Ft = 1 and it is a factor of titration
V1 (Ch III) = consumption of chelatone in the titration in litres
c (Ch III) = 0.05 mol/l
M (Ca2 +) = 40g/mol

- **CONCLUSION:** Calculate the amount of Ca2 + in water samples.

TASK NO.3 DETERMINATION OF THE TOTAL HARDNESS OF WATER

- **CHEMICALS:** Chelatone III (c = 0,05 mol/l), ammoniacal buffer (Schwarzenbach buffer with pH = 10 (mixture of NH_4Cl + NH_4OH)), Eriochrom black T (mixture with NaCl at the ratio of 1:100), water from a water tap and from a well.

- **AIDS:** titration flasks, pipette, burette, graduated cylinder, scales, volumetric flask, weighing boat, spoon

- **PROCEDURE:** Measure out 100 ml of water sample into the titration flask by means of the volumetric flask, add 5 ml of ammonia buffer and 0.3 g of Eriochrome black -T and titrate by the standard solution of Chelatone III up to a blue colouring. Titrate all water samples.

- **CALCULATIONS:**

1 ml of chelatone III corresponds with 2.8 ° N.

The total hardness of water (in German degrees) = V_2(Ch III) x 2.8

Water is divided according to the total hardness (in German degrees) into:

<5	Soft Water
5-15	Slightly hard water
15-30	Hard water
> 30	Very hard water
> 50	Bad Water

Water with hardness over 5 °N must be softened for industrial purposes.

- **CONCLUSION:** Calculate the water hardness in the samples of water.

TASK NO.4 Determination of Mg^{2+} in water

- **PROCEDURE:** Magnesium is not determined individually. The content of Mg^{2+} is calculated from the different consumptions of chelatone III into the Eriochrome black T ($Mg^{2+} + Ca^{2+}$) = V_2 and into the murexide (Ca^{2+}) = V_1.

- **CALCULATIONS:**

where Ft = 1, c (Ch III) = 0.05 mol/l, M (Mg^{2+}) = 24g/mol, V_1 and V_2 are in litres.

- **CONCLUSION:** Calculate the amount of Mg 2 + in water samples and compare the results with the Regulation No. 252/2004 of Digest. dated April 22, 2004 which you have at your disposal.

STUDENT ´S SHEET no. 13
PHYSICAL AND CHEMICAL ANALYSIS OF DRINKING WATER

1. Vocabulary:
Match the Czech names with their English equivalents:

1. slightly hard water	A. měkká voda	1….
2. consumption	B. tvrdá voda	2….
3. water solution	C. středně tvrdá voda	3….
4. unboiled	D. vodný roztok	4….
5. soft water	E. spotřeba	5….
6. turbidity	F. poměr	6….
7. drinking water	G. zákal	7…..
8. rate	H. nepřevařená	8…..
9. hardness	I. pitná voda	9…..
10. hard water	J. tvrdost	10….

2. Fill in the missing words in this crossword:

a) titrovat

b) počítat

c) an agent

d) property of water

e) good water

3. Choose the correct answer - T/F questions:

A.

1. Permanent hardnes is caused by bicarbonate. T/F
2. Permanent hardnes is caused by sulphate. T/F
3. Permanent hardnes is caused by chloride. T/F
4. Permanent hardnes is caused by sulphite. T/F
5. Permanent hardnes is caused microbiologically. T/F

B.

1. As standard solution we use Chelaton I. T/F
2. As standard solution we use Chelaton II. T/F
3. As standard solution we use Chelaton III. T/F
4. As standard solution we use Chelaton IV. T/F

4. Choose the correct indicators for Chelatometric method:

methylorange, kongo red, litmus, murexid, phenolphtalein, eriochrom black T, malachit green, bromothymol blue

5. **Complete the missing letters of the <u>words:</u>**

co-d-ct-met--

ha-d-es-

t-rbi-ity

s- - sta-ce

mu-e-i-e

e- -o-h-ome b-ac- T

wa- er s-pp-y

Ge- m - n de- - ee

te- p – ra- y

p- rm- n- nt