Assessment of water suitability for construction purposes

part 1

1) **Issues to be prepared:**
Mixing water, pH of solutions, water analysis.

2) **Literature:**
– E. Ozimina, K. Sułko „*Laboratorium z chemii budowlanej*", Wyd. Politechniki Świętokrzyskie w Kielcach, 2010 r.
– L. Czarnecki, T. Broniewski, O. Henning, „*Chemia w Budownictwie*", Arkady, Warszawa, 1996 r.

– Philip Maslow „*Chemical Materials for Construction: Handbook of Chemicals for Concrete, Flooring, Caulks and Sealants, Epoxies, Latex Emulsions, Adhesives, Roofing, Waterproofing, Technical Coatings and Heavy Construction Specialties*" McGraw- Hill, Univerity of California,1982.

– Other manuals and scripts covering the topics from p. 1.

3) **Apparatus:**
pH meter with indicator electrode

4) **Laboratory equipment:**
Beakers (50 or 100 cm^3 capacity), test tubes, 2 conical flasks with a capacity of 250cc, pipettes (10cm^3 or 5cm^3), baguettes, spatula, wash bottle, water bath

5) **Reagents:**
0.5M and 0.01 M AgNO3 solution, 5% K_2CrO_4 solution, 1M and 3% NaOH solution, 0.1M and 10% HCl solution, 10% $BaCl_2$ solution, 5% α-naphthol solution, concentrated H_2SO_4, 1M FeSO4 solution, 1M KI solution, paper saturated with $(CH_3COO)_2Pb$ solution.

6) **Performing the exercise**

a) Using the pH meter in exercise 1, measure the pH value of the mixing water obtained for analysis.

b) Detergents - measure approx. 2 cm^3 of water in a test tube, close the stopper and shake vigorously. Leave for approx. 2 minutes. - characterize (absence or presence of foam).

c) Color - the water should be colorless or pale yellow.

d) Humic substances - place 5 cm^3 of water in a test tube and add 5 cm^3 of a 3% NaOH solution, shake and leave for one hour, then observe the color of the sample.

e) Odor of water and presence of hydrogen sulphide - check for the presence of an odor other than the smell of clean water. Check the presence of hydrogen sulphide: pour 5 cm^3 of water into a test tube, add a few drops of concentrated HCl, cover with a paper with a saturated solution $(CH_3COO)_2Pb$ and heat slightly. The blackening of the tissue paper indicates the presence of hydrogen sulphide at a concentration above 20 mg / dm^3. No blackening means no hydrogen sulphide in the tested sample.

f) Chloride ion content - determined by titration of a water sample with $AgNO_3$ solution in the presence of K_2CrO_4. Measure 100 cm^3 of water into a 250 cm^3 conical flask. Add 1 cm^3 of 5% K_2CrO_4 solution and titrate with 0.01 M $AgNO_3$ solution until red-brown color appears. Calculate the chloride ion content using the formula:

$$m_{Cl} = V \cdot C_m \cdot 354{,}4 \text{ mg}$$

where:
V - volume of $AgNO_3$ solution used for titration [cm^3]
Cm - concentration of $AgNO_3$ solution, 0.01 mol / dm^3

g) Content of sulphate ions - pour into a test tube 5 cm^3 of water (if it is cloudy, filter it), 2.5 cm^3 of a 10% HCl solution

and 2.5 cm^3 of a 10% $BaCl_2$ solution and then start the timer. The content of sulphate ions is determined depending on the rate of formation of the barium sulphate (VI) precipitate ($BaSO_4$), using Table 1.

h) Sugar content - measure 50 cm^3 of water into a 100 cm^3 beaker, add 1 cm^3 of 1 M HCl solution, cover with a watch glass and heat for 25 minutes in a water bath with boiling water. After cooling, rinse the clean test tube with water contained in the beaker several times. For the study the water remaining on the walls of the tube is used. To a test tube moistened with test water, add 3 drops of 5% alcoholic naphthol solution and 1 cm^3 of concentrated sulfuric acid (**with glasses, in a hood**). Mix the contents of the test tube and observe the color. Determine the approximate sugar content according to Table 2.

i) Phosphate ion content - place 2 cm^3 of water in a test tube, add 2 cm^3 of 0.5 molar $AgNO_3$ solution. The formation of a yellow precipitate of silver phosphate proves the content of phosphate ions (converted into P_2O_5) greater than 100 mg / dm^3. The lack of sediment indicates that the content of phosphate ions in the tested water does not exceed 100 mg / dm^3.

j) Nitrate content - put 5 cm^3 of water in a test tube, add 1 cm^3 of concentrated sulfuric acid (**in glasses, in a hood**) and 4 cm^3 of 1 molar $FeSO_4$ solution. The formation of a brown sludge - as a result of the formation of the $Fe(NO)^{2+}$ ion - indicates the content of nitrate ions greater than 500 mg / dm^3. The lack of sediment indicates that the content of nitrate ions in the water does not exceed 500 mg / dm^3.

k) Lead content - place 5 cm^3 of water in a test tube, add 5 cm^3 of 1M KI solution and shake. The formation of an abundant yellow precipitate of lead (II) iodide proves the content of lead ions higher than 100 mg / dm^3. The lack of sediment indicates that the content of lead ions in the tested water does not exceed 100 mg / dm^3. l) Zinc content - place 5 cm^3 of water in a test tube, add 5 cm^3 of 1 M NaOH solution and shake. Formation of a white precipitate of zinc hydroxide proves the content of zinc ions higher than 100 mg / dm^3. The lack of sediment indicates that the content of zinc ions does not exceed 100 mg / dm^3.

Compare the results of the determinations with the requirements of the standard, provided in Table 3, and present them in the manner provided in Table 4. Assess the suitability of water for construction purposes.

Table 1. The content of sulphate ions (SO_2) depending on the time of appearance of the turbidity

Fluid turbidity after time [s]	Content of sulphate ions [mg / dm^3]
0 (abundant sediment)	Above 500
1 (turbidity)	500
5	100
20	50
60	25

Table 2. Assessment of sugar content

The color of the solution	Sugar content [mg / dm^3]
Violet-red emerging immediately	500
Reddish pink after a few seconds	100
Light pink after a few minutes	5

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part 2

Table 3. Requirements for mixing water for concretes

Initial assessment of make-up water		
Lp.	Parameter	Equirements
1.	Oils and fats	No more than visible traces
2.	Detergents	Any foam should disappear within 2 minutes
3.	Color	Pale yellow or lighter
4.	Smell	No hydrogen sulfide odor
5.	Suspensions	Not more than 4 cm^3 of sediment in 80 cm^3 of sample
6.	Acids	pH> 4
7.	Humic substances	The color is yellowish brown or lighter when NaOH is added
Chemical properties		
Lp.	Parameter	Maximum content in mixing water [mg / dm^3]
8.	Chlorides (Cl^-)	500 - prestressed concrete or slurry 1000 - concrete containing reinforcement or metal elements 4500 - concrete containing no reinforcement or metal elements
9.	Sulphates $(SO_4)^{2-}$	2000
10.	Alkali (as Na_2O)	1500
11.	Sugars	100
12.	Phosphates (as P_2O_5)	100
13.	Nitrates (NO_3^-)	500
14.	Lead (Pb^{2+})	100
15.	Zinc (Zn^{2+})	100

Table 4. Water test results and evaluation of its suitability as make-up water

Lp.	Substance	Requirement	Test result	Assessment (+/–)
1.	Oils and fats			
2.	Detergents			
3.	Color			
4.	Suspensions			
5.	Odor / presence of hydrogen sulfide			
6.	Acids (pH)			
7.	Humic substances			
8.	Chlorides			
9.	Sulfur			
10.	Sugars			
11.	Phosphates			
12.	Nitrates			
13.	Lead			
14.	Zinc			
Water suitability assessment				