Mineral binders II

The exercise aims to: a) analyze the corrosion phenomenon of concrete in an acidic environment (in the environment of HCl and CH_3COOH acids of different concentrations) and b) to investigate the influence of admixtures on the course of binding of gypsum binders

Theoretical issues for self-study:

- ✓ classification of mineral binders (air and hydraulic),
- ✓ examples of silicate and aluminosilicate structures,
- ✓ binding processes of mineral binders,
- ✓ corrosion of concrete.

Laboratory equipment:

laboratory balance, beakers, measuring cylinder, baguettes, spatulas, and wash bottle.

Reagents:

2%, 4% and 6% HCl, 2%, 4% and 6% CH_3COOH, construction gypsum, sodium chloride (NaCl), sodium hydrogen phosphate (Na_2HPO_4), citric acid.

Methodology:

a) Cement concrete samples, stored in water should be thoroughly dried and weighed. Fill 6 beakers (marked with inscriptions) with the appropriate acids: 2%, 4% and 6% hydrochloric acid (HCl) and acetic acid (CH_3COOH), also with concentrations of 2%, 4% and 6%. Then place the concrete samples simultaneously in appropriate acid solutions. After 50 minutes, remove the samples from the solutions, rinse with running tap water, dry with blotting paper and weigh again. Tabulate the obtained results in Table 1 and present them in the form of a graph. On the ordinate (Y-axis), place the weight loss of the sample in weight percentage and on the abscissa axis (X-axis) - the percentage concentration of the acid solution.

b) Prepare the gypsum slurries according to the recipes given in Table 2. Pour into a given evaporator a calculated amount of distilled water with a measuring cylinder and dissolve the appropriate admixture in it. Then, while stirring, pour it into the previously weighed gypsum. The total pouring and mixing time should not exceed 0.5 minutes. At the same time, while pouring the gypsum into the water, turn on the second meter to determine the setting time. The setting time of the binder is simply known as the period from the mixing of the binder with water until the mass loses its plastic properties and therefore, cannot be molded.

Note: Start the exercise by making slurry 3 with sodium hydrogen phosphate or citric acid. While this sample is set, carry out slurries 1 and 2.

Set the results of the measurements in Table 3.

Literature:

- ✓ R. M. E Diamant, The chemistry of building materials, Business Books, 1970
- ✓ R. J. Naumann, Introduction to the Chemistry and Physics of Building Materials, Taylor&Francis, 2008
- ✓ L.E. Czarnecki, P. Łukowski, A. Garbacz, B. G. Chmielewska, J. Kuziak, Building Chemistry. Laboratory Exercises, Oficyna Wydawnicza Politechniki Warszawskiej, 2016
- ✓ E. Ozimina, K. Sułko „Laboratorium z chemii budowlanej”, Wyd. Politechniki Świętokrzyskiej w Kielcach, 2010 (Polish)
- ✓ L. Czarnecki, T. Broniewski, O. Henning, „Chemia w Budownictwie”, Wyd. Arkady Warszawa, 1996 (Polish)

Table 1. Concrete acid corrosion

Acid concentration [%]	Sample mass before test m_1 [g]	Sample mass after the test m_2 [g]	Sample weight loss Δm [g]	Sample weight loss Z [%]
HCl 2 %				
HCl 4 %				
HCl 6 %				
CH_3COOH 2 %				
CH_3COOH 4 %				
CH_3COOH 6 %				

The weight loss of a sample is calculated according to the formulas:

$\Delta m = m_1 - m_2$ $Z = (\Delta m / m_1) \cdot 100\ \%$

Table 2. Preparation of gypsum slurries

Components	**Recipes**		
Construction gypsum	30 g	30 g	30 g
Admixture	–	NaCl – 1 g	Na_2HPO_4 – 0.15 g or Citric acid – 0.15 g
Distilled water	20 g	20 g	20 g

Table 3. Gypsum slurries research results

Sample number	Admixture (substance name/chemical formula)	Admixture mass [g]	Binding time [min]	The admixture action