CALCIUM MONOALUMINATE CONSTITUENT OF ALUMINOUS CEMENTS

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Abstract. *This works presents information about obtaining and enforcing calcium monoaluminate and compressive strength data of samples of materials.*
Keywords: *calcium monoaluminate, alumina, calcium carbonate, hidratation, strength.*

1. INTRODUCTION

Aluminous cement as main components contains calcium monoaluminate ($CaO \cdot Al_2O_3$) and calcium dialuminate ($CaO \cdot 2Al_2O_3$).

Along with aluminum oxide (alumina fibers) other natural material that can bring the amount of Al_2O_3 necessary to obtain a good quality aluminous cement is bauxite. Bauxite deposits with an appropriate composition, however, are quite common, yet little is required of other major industries such as aluminum and refractory industry. Therefore, aluminous cement has grown into a limited number of countries and not reached amounts comparable to those of Portland cement.

Bauxite of good quality containing between 50 and 55% Al_2O_3, up to 25% Fe_2O_3 and 5% SiO_2.

Apart from bauxite is sometimes used as raw materials zgurele alumina and so-called *red slam*, a waste from alumina production.

The second component of the mixture of raw materials is limestone.

Essential conditions which must correspond material first relates to content in SiO_2 and Fe_2O_3. Silicon dioxide is a harmful component, and feric oxide compounds with properties not so interesting for aluminous cement.

Preparation of mixture of raw materials generally follows the same procedure as for dry Portland cement manufacturing. Depending on the type of oven used, patent or granular mixture is homogenized.

Calcium aluminate, the main constituent of aluminous cement clinker, by reaction with water give hidroaluminate of various compositions. Setting depends on many factors: concetration of Ca $(OH)_2$, the temperature at which hydration occurs, the ratio water / binder.

Calcium hidroaluminate $CaO \cdot Al_2O_3 \cdot 10H_2O$ is formed in aluminate solutions at temperatures between 0 and 12°C. At higher temperatures it decomposes into $2CaO \cdot Al_2O_3 \cdot 8H_2O$ and $Al(OH)_3$. In mortar and concrete decomposition occurs slowly and he can no long even ordinary temperature.

Bicalcium hidroaluminate $2CaO \cdot Al_2O_3 \cdot 8H_2O$ in the form of thin plates belonging to hexagonal crystallization system, depending on the hydration number of water molecules varies between 7 and 9. In dry air loses some water, passing in C_2AH_6. Contact with a solution of Ca $(OH)_3$ passes gradually tricalcium hidroaluminate and even tetracalcic hidroaluminate. Speed of this reaction increases with increasing solution's pH .

Tricalcium hidroaluminate $3CaO \cdot Al_2O_3 \cdot H_2O$ can occur in crystalline diamond and cubic system. Diamond shape corresponds to the formula C_3AH_6 and sometimes is obtain in the laboratory. The system $Al_2O \cdot 3CaO \cdot H_2O$ indicate the presence of metastable phases, hexagonal Composition $3CaO \cdot Al_2O_3 \cdot 10$ ... 12 H_2O, which apparently is a echimolecular mixture of C_2 AH $_8$ and C_4AH_{13}, above 25°C quickly into C_3AH_6, crystallized in cubic form. Tramsformation temperature becomes important. This transformation occurs in the structure is considered cause of the resistance of aluminous cement concretes subjected to that temperature variations.

Tetracalcium hidroaluminate $4CaO \cdot Al_2O_3 \cdot 12$ .. 14 H_2O exists in three modifications: α, β and γ. Modificaţions are quite similar between them and therefore difficult to distinguish, form crystallizes in hexagonal system. In these hidroaluminate, water can be partially substituted by CO_2 in air, resulting in compounds with formula: $Al_2O_3 \cdot 4CaO \cdot mCO_2 \cdot nH_2O$.

Some researchers believe that all calcium hidroaluminate may be represented through a general formula: nec.$(OH) \cdot Al_2(OH)_6 \cdot pH_2O$.

Aluminum hydroxide hydrolysis occurs after aluminate. It forms a gel by aging and drying contribute significantly to increase the strength of cement. Over time, gel $Al(OH)_3$ crystallization.

2. EXPERIMENTAL WORKS

2.1. Synthesis calcium monoaluminate (CA)

The purpose of this work is licensed monoaluminate synthesis and characterization of calcium (Ca). As we said, Calcium monoaluminate is one of the most valuable mineralogical constituents of aluminous cements, which, through hydration to develop hydraulic strengthening of these cements. Calcium monoaluminate may meet accidentally in Portland cement.

Thesis aims to characterize both calcium monoaluminat clinker produced at high temperatures, but also processes and strengthening its hydration.

Table 1

	SiO2	Al2O3	CaO	MgO	Fe2O3	Na2O	K2O	TiO2	P.C.	Total
Alumina Martinswerk	99.8%					0.2%				100%
Calcium carbonate	1.51%	0.53%	54.39%	0.51%	0.33%	0%	0%	0%	42.07%	99.34%

Table 2

Raw material	Dimensiunea granulei, µm.	
	Fischer method (medium dimension)	Fritsh method
Alumina	7.5	under 44
Calcium carbonate	under 0.09mm	

Table 3

Mineralogic compound	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	V_2O_5
CA	0.85%	0.03%	62.55%	0.33%	0.33%	35.47%	0.10%	0.04%	0.20%

To obtain calcium monoaluminatului have used alumina (raw material that brings the system Al2 O3) and calcium carbonate (CaO intake). Chemical characteristics of these materials are presented in Table 1 and Figure 5 and those for grain in Table 2.

Materials by dosing will take into account the atomic masses of each element in part by the following reaction:
$CaCO_3 + Al_2O_3 \cdot CaO \cdot Al_2O_3 + CO_2$
As = 40, C = 12, A = 16 , Al = 26.
so we have: $CaCO_3$ = 100 g. , Al_2O_3=101.8 g

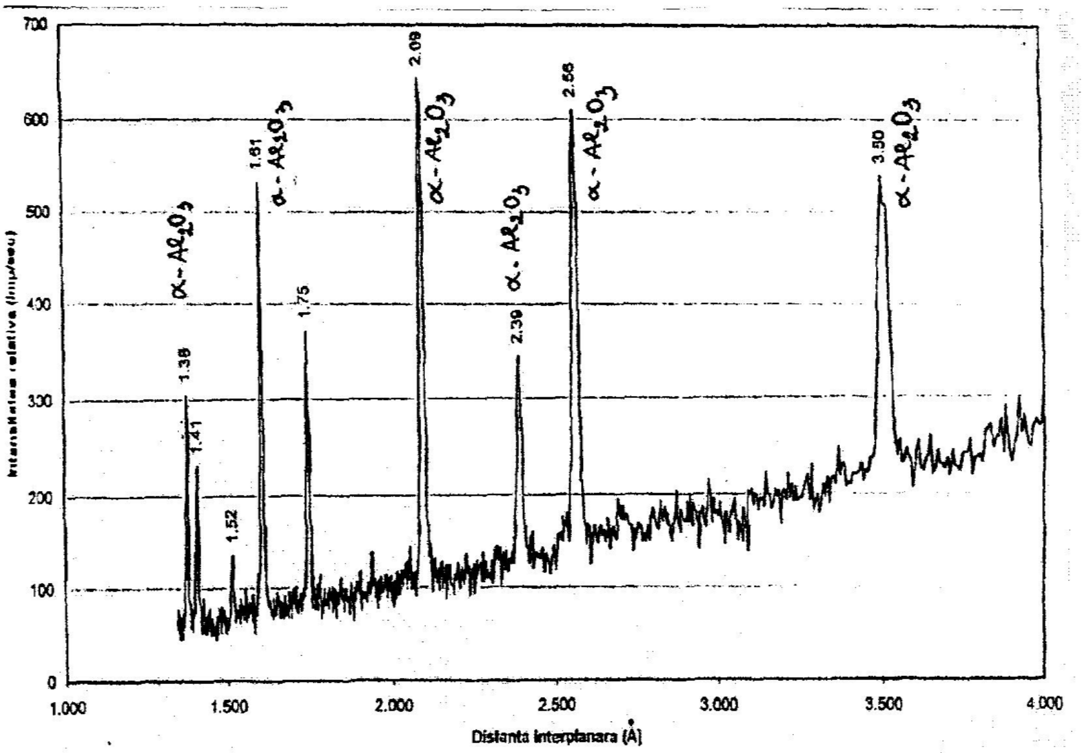

Fig.1 Roentgenogram alumina Martinswerk

Mass resulting from the burning compound CaO $\cdot Al_2O_3$=157.8 g plus a quantity of carbon dioxide amounting to the CO_2 = 44 g.

Given these values of atomic masses, the quantities and proportions do we have this:

- If we use raw materials dosing 100 kg of $CaCO_3$ and 101.8 kg of Al_2O_3 *will result in 157.8 kg of product, ie aluminous cement (CaO* $\cdot Al_2O_3$) *plus the amount of carbon dioxide resulting from burning oven raw material which is discharged by the furnace cart whose*

value is 44 kg. For easier determination of material quantities we calculate the percentage, so we have:
49.5% $CaCO_3$ and 50.5% Al_2O_3.
Mixing materials is done with a rotary mixer. The next step is pressing the materials (briquetting) using a hydraulic press into cylindrical forms with diameter φ=50 mm with pressures up to 60 kg / cm ² (in press using a bonded temporarily to achieve better cohesion between the particles of alumina and limestone and also to facilitate the pressing process).
Next cylindrical drying material resulting from compression. Drying is done outdoors for 24 h then dried at 110°C for 5h.
Samples are then burned in the electric oven supply to 1475°C for 2 h after the first phase are maintained at this temperature for another 2 h (landing).
After that the resulting material is crush in laboratory mills, centrifugal rotary ball three "glasses"
Chemical analysis by x-ray fluorescence showed the chemical composition of cement (Table 3).
Contents of Al_2O_3 and CaO presented in Table 3 show that they correspond monoaluminatului calcium composition.
Mechanical tests were performed on samples of 30 mm side cubic obtained by casting 20% water work. Results of compressive mechanical strengths (1, 2, 3 days of curing free) are presented in Table 4.

Table 4

probe	Fc (kN)	Rc (Mpa)
1 (1 zi)	37.95	42.16
5 (3 zile)	50.45	56
9 (7 zile)	68.15	75.7

Structural characteristics are presented in Table 5.

Table 5

probe	Aparent density g/cm³	Absorbtion capacity %	Aparent porosity %
3Idays	2.05	11.3	23.16
7Idays	2.06	10.3	21.21

3. CONCLUSIONS

- Sintered calcium monoaluminate
- Aimed to strengthen the process of calcium monoaluminate obtained at 1475ºC.
- There have been investigations on qualitative and semiquantitative calcium monoaluminate principal properties of both the synthesis process and to its strengt .
- Originality notes lies in the fact that we obtained a unique composition in limestone that have given 1.51% SiO2, thus placing the material obtained in the quaternary subsystem Second, something unprecedented in Valahia University cements.

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