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THE INFLUENCE OF PHOSPHATE BINDER AND ACTIVATOR BINDING TO THE PHYSICAL PROPERTIES OF REFRACTORY CONCRETE

Ilhan Bušatlić, Nadira Bušatlić, Petar Petrovski
University of Zenica, Faculty of Metallurgy and Materials Science
Travnička cesta 1, Zenica
Bosnia and Herzegovina

ABSTRACT
Lately, there are more important chemically bonded refractory materials which have sufficient initial strength after drying and which are important for the installation of thermal plants. After installation of refractory materials in thermal plant gradually warming to certain high temperature is done, where the material achieves the transition from chemical to a ceramic bond. The consequence of this is higher compressive strength of refractory material. Refractory concretes consists of fillers, binders and activator binding sites. It has been shown that role of bonding activator is very important because without it the chemical reaction between the filler and binder will not occure. It is very important activator binding choice as well as its amount in a mixture. In this paper as a filler is used quartz sand, mono aluminum phosphate as a binder and illite-kaolinite clay as activator binding. It is examined the effect of the quantity of binder and activator binding on the compressive strength of refractory concrete.
Keywords: activator binding, chemical binder, concretes.

1. INTRODUCTION
In the industry of refractory materials in recent decades the production of refractory materials that are formed without heat treatment - chemical binding is increased. Representative of these materials are certainly refractory concretes consisting of refractory inert filler (mullite, chamotte, quartz sand, etc.), and the binding agent of mineral or organic origin. These concretes are different from the construction of concrete because they have a high fire resistance (over 1600 ° C) and a specific capacity (strength) at high temperatures, which is a key requirement that is required of structural materials that are exposed at high temperatures. The interest for refractory materials of this type in recent decades has increased, because their production is less complex and more economical compared to classic production of refractory materials, which implies a long process of baking. In industry of refractory materials different phosphates that are typically added to the aggregate as aqueous solutions are used. In the application of: monoaluminijum phosphate (46 - 50% aqueous solution) and ammonium phosphate, chromium-aluminum phosphate, and alkali metal polyphosphates, etc. Hardening by binding phosphate aluminosilicate product is conditioned by forming acid phosphate, their polymerization and polycondensation in the process of heating, and also the formation of insoluble phosphates in the reaction of phosphoric acid with the oxides of the refractory filler.
Production of refractory products based phosphate binding certain advantages are achieved over conventional production: energy saving and improving certain technical characteristics. From the technical advantages of the most important are: high initial mechanical strength and resistance to slag. In the literature devoted of this be noted that the impact of the activator binding decisive when it comes to speed and the degree of hardening of phosphate bonding refractory material, and in that case it offers a range of solutions. But in practice, there are serious problems in selecting activator binding.

Its chemical character to be correlated with the composition of the refractory mass that binds the type of binder. It is very important amount of activator binders to the refractory mass is added.

2. PREPARE SAMPLES WITH MAP AND ILLITE-KAOLINITE CLAY AND TEST RESULTS

In this study were prepared samples based on quartz sand deposits "Bukinje" Tuzla with the addition of binding illite-kaolinite clay deposits "Sočkovac" Gracanica as activator binding. As the binder 50% aqueous solution of Al mono phosphate is used. Addition of a binder is varied in the range of 5, 10, 15 and 20 parts by weight per 100 parts by weight of a mixture of quartz sand + clay while the clay content in a mixture with sand amount: 0, 10, 20 and 30 parts by weight. The aim of this study was to definitively determine the optimal content of the basic components in the refractory mass; quartz sand, then the amount of illite-kaolinite clay in the mass and in the end the amount of phosphate binder that is added refractory mass. The test samples were formed by the primary grain component is well mixed with a certain amount of clay in powder form. Then the solid mixture added a certain amount of binder and (if necessary) water until slightly plastic mass consistency. From thus prepared, well homogenized mass, are formed cylindrical test body dimensions: base diameter d = 50 mm and height h = 50 mm. The draft samples were heated at temperatures of 120 ° C and 1000 ° C for 5 h. After heating the samples are tested physical properties. Table 1. shows the contents of the components prepared samples and expressed in percentages by weight.

Table 1. Contents of components prepared samples

	Label the sample	Quartz sand	Clay	$Al(H_2PO_4)_3$(50 % solution)	Water
I	PGM5	80	20	5	5
	PGM10	80	20	10	2
	PGM15	80	20	15	-
	PGM20	80	20	20	-
II	PM	100	-	10	-
	PG10M	90	10	10	-
	PG20M	80	20	10	2
	PG30M	70	30	10	5

Certain physical properties of the prepared samples shown in Table 2.

Table 2. Physical and mechanical properties of samples with sand and clay with the addition of 50% solution of MAP and annealed at temperatures of 120 ° C and 1000 ° C for 5 h

Label the sample	Density (*g/cm³*)	The apparent porosity (*%*)	Compressive strength (*MPa*)	Linear shrinkage (%)
	1	2	3	4
PGM5	1,62 1,75	28,0 25,3	0,1 4,42	0 0
PGM10	1,63 1,77	25,5 21,8	3,93 5,11	0 0
PGM15	1,67 1,85	21,6 17,7	5,90 11,79	0 0
PGM20	1,78 1,96	15,9 11,5	9,82 17,68	0 0
PM	1,55 1,60	28,2 28,2	3,44 3,93	0 0
PG10M	1,55 1,69	27,5 25,5	0,98 2,95	0 0
PG20M	1,65 1,78	27,0 21,6	2,95 6,88	0 0
PG30M	1,56 1,53	25,7 23,3	3,93 9,82	0 0

Note: The first value refers to the physical size of the samples dried at 120 ° C / 5 hours, and the other on the physical size of the samples annealed at 1000 ° C / 5 hours.
The results are shown in Figures.

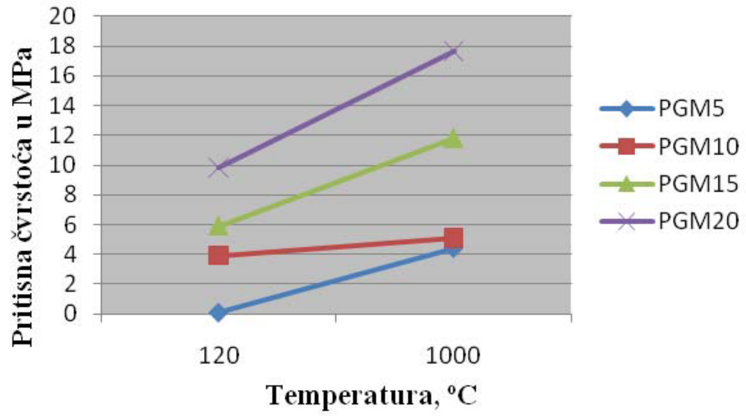

Figure 1. Depending on the compressive strength of the sample temperature labels PGMx

Figure 1. shows that with the increase of MAP and increase in temperature increases the compressive strength of samples.

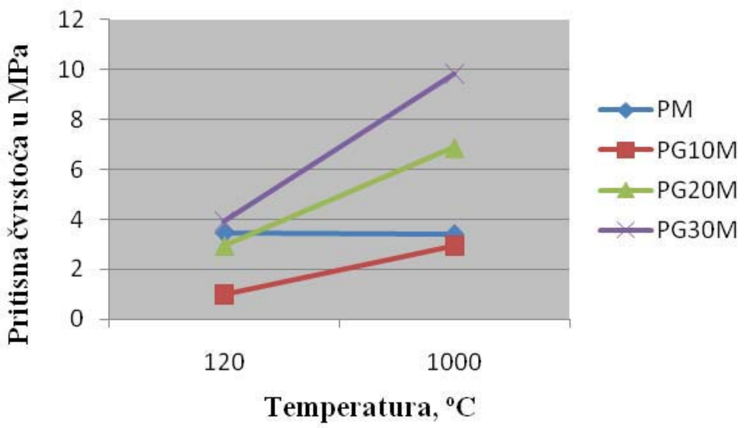

Figure 2. Diagram of compressive strength depending on temperature change test body with the tag PGxM

Figure 2. shows the dependence of the compressive strength when the temperature changes of samples, prepared with the same content of MAP (10%), but with different content of binder clay. From the diagram, it is seen that the sample without the addition of binder clay does not change the strength when the temperature changes. With increasing clay content increases the compressive strength, so that the maximum value of compressive strength has a sample with 30% clay which is about 10 MPa. Addition of binders MAP quartz sand (refractory mass without the addition of activator binding) prepared samples after drying at 120 ° C and heating at 1000 ° C showed a very low strength.

It is obvious that without additional binders (in our case illite-kaolinite clay) basic refractory material is not possible phosphate binding, or due to a lack of creating chemical bonds will occur no ceramic bond during heating. On the other hand, the achieved strength test body (starting after drying the samples at 120 ° C, and after a final heating at 1000 ° C of samples prepared from a mixture of: quartz sand + clay = 80: 20 parts by weight, related to 5,10,15 and 20 parts by weight of binder) are considerably higher. They are close but do not follow completely the expected regularity: increase the strength of samples with increasing participation binders MAP.

3. CONCLUSION

- In this study, the effect of content mono aluminium phosphate and illite-kaolinite clay on the physical properties of phosphate-bonded refractory concrete based on quartz is examined.
- Increasing the binder content (50% solution mono aluminium phosphate), with the addition of clay to quartz, which acts as an activator binding, as well as increasing the heating temperature, the compressive strength of the prepared samples is increases.
- The samples without the addition of clay as activator binding have low initial compressive strength and does not show an increase in compressive strength with increasing temperature.
- With the increasing addition of clay to quartz, and increases the compressive strength of samples. The samples with 70% quartz + 30% clay bounded with 10% of MAP show the highest compressive strength.
- The optimum amount of activator binding is 20% (higher amounts might decrease the refractoriness of concrete), while the optimum amount of binder 50% basic solution of MAP is from 15 to 20% compared to the refractory mass: quartz + clay.

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