

## ENERGY ECONOMY THROUGH USING INDUSTRIAL WASTE IN THE PRODUCTION OF NON-FIRED REFRACTORIES

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### ABSTRACT

*The results from experimental investigations in obtaining of non-fired aluminosilicate refractories, including an industrial waste – polyester resin (dust coloring paint) are presented. The possibility of replacing the firing process of the investigated refractories for thermal treatment at 180°C is proved. Thus, a huge energy and raw materials economy will be realized.*

*The obtained non fired articles have characteristics, conforming to the requirements of the specifications.*

*Keywords: energy economy, non-fired refractories, wasted polyester resin.*

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### INTRODUCTION

Increasing requirements for a living standards and the economical development are connected with increasing of the energy needs, that force the production of heat and thermal energy to rise. At the same time the energy sector is accountable for a significant part of the noxious gas emissions to the atmosphere.

Technological processes in the ceramic industry, and mainly the firing process, involve large energy consumption.

Different components can be used in the ceramic product compositions, especially industrial wastes. That may diminish environment pollution and decrease the raw materials needs. The production of non-fired refractories will be more profitable, if the use of the above components leads also an energy economy.

The main aim of the present work is an investigation of the possibility for energy and raw materials economy through using of an industrial waste from dust coloring paint (polyester resin) in the production of non-

fired refractories. Obtaining of the above production articles with equal or improved parameters and a replacing their production at temperatures over 900 -1000°C with a thermal treatment at 200°C will be consequential results of the fulfillment of the main project aim.

A set of technological problems has been solved in order to obtain the above aim.

### EXPERIMENTAL

#### An object of the investigation

Non fired aluminosilicate refractories with low carbon content, prepared according several recipes were chosen for the present investigation (Table 1). These compositions and samples have been made according to standard methods.

#### Evaluation criteria

The below criteria are chosen for comparative evaluation of the properties of the received fired and non-fired refractory masses and models:

- apparent density;
- water uptake;
- opened porosity;
- mechanical pressure strength;
- linear changes.

The experimental results, from the investigations are given in Table 1.

## RESULTS AND DISCUSSION

### Apparent density

1. The first composition apparent density after thermal treating at 180°C is lower than after forming (1,41 g cm<sup>-3</sup>), but after firing at 1150°C significantly decreases (1,13 g cm<sup>-3</sup>).

2. After firing at second composition, including chamot, the apparent density is higher after forming as well (1,73 g cm<sup>-3</sup>), decreases after the thermal treatment at 180°C to 1,54 g cm<sup>-3</sup> and reaches to 1,30 g cm<sup>-3</sup>.

3. For the third composition (including perlite), the apparent densities are equal after the forming and

Table 1. Physicomechanical indicators of the compositions including waste thermoplastic polymer.

Compositions	Apparent density g.cm <sup>-3</sup>	Water uptake %	opened porosity %	Pressure strength MPa	Linear changes %
1. Washed kaolin -75 % Waste (paint) -25 % Make-up water - 5 %	After forming average 1.57	#	#	After forming 0.6; 0.6	#
	After 180 °C x 2 h 1.4; 1.36	After 180 °C x 2 h 26.38; 26.28	After 180 °C x 2 h 37.30; 37.12	After 180 °C x 2 h 15.0; 16.0	After 180 °C x 2 h +0.79 / +1.58 +0.79 / +1.47
	After 1150 °C x 2 h 1.13; 1.13	After 1150 °C x 2 h 50.74; 50.62	After 1150 °C x 2 h 57.42; 57.37	After 1150 °C x 2 h 1.0; 1.0	After 1150 °C x 2 h -0.99 / -0.59 -0.99 / -0.59
2. Washed kaolin -40 % Chamot (0÷5)mm -30 % Waste (paint) - 25 % Benton - 5 % Make-up water - 5 %	After forming average 1.73	#	#	After forming 0.6; 0.6	#
	After 180 °C x 2 h 1.54; 1.60	After 180 °C x 2 h 19.52; 17.74	After 180 °C x 2 h 30.08; 28.38	After 180 °C x 2 h 19.0; 20.0	After 180 °C x 2 h +0.40 / +0.56 +0.40 / +0.19
	After 1150 °C x 2 h 1.33; 1.30	After 1150 °C x 2 h 37.47; 38.65	After 1150 °C x 2 h 49.72; 50.45	After 1150 °C x 2 h 0.8 ; 0.8	After 1150 °C x 2 h -1.59 / -1.84 -1.59 / -1.72
3.1 Washed kaolin -45.7 % Perlite - 14.7 % Waste (paint) - 35.0 % Benton - 4.6 % Make-up water - 39 %	After 110 °C x 24 h 0.96; 0.95	After 110 °C x 24 h 44.50; 43.10	After 110 °C x 24 h 42.70; 43.10	After 110 °C x 24 h 7.0; 7.0	#
	After 180 °C x 2 h 0.95; 0.96	After 180 °C x 2 h 45.60; 43.60	After 180 °C x 2 h 43.20; 42.10	After 180 °C x 2 h 18.0; 7.0	After 180 °C x 2 h 0 / 0 0 / 0
	After 1150 °C x 2 h 0.71; 0.70	After 1150 °C x 2 h 90.15; 93.28	After 1150 °C x 2 h 64.48; 65.45	After 1150 °C x 2 h 1.0; 2.0	After 1150 °C x 2 h -1.42 / -1.43 -1.42 / -1.23
3.2 Washed kaolin -35.7 % Perlite - 30 % Waste (paint) - 28.7 % Benton - 3.8 % Make-up water -50.7 %	After 110 °C x 24 h 0.83; 0.84	After 110 °C x 24 h 59.90; 55.30	After 110 °C x 24h 42.70; 46.30	After 110 °C x 24 h 5.0; 5.0	#
	After 180 °C x 2 h 0.84; 0.84	After 180 °C x 2 h 55.10; 54.30	After 180 °C x 2 h 46.30; 45.50	After 180 °C x 2 h 6.0; 6.0	After 180 °C x 2 h -0.2 / -0.2 -0.2 / -0.2
	After 1150 °C x 2 h 0.66; 0.66	After 1150 °C x 2 h 94.50; 93.96	After 1150 °C x 2 h 62.19; 62.04	After 1150 °C x 2 h 3.0; 3.0	After 1150 °C x 2 h -1.01 / -1.46 -1.01 / -1.46
4. Washed kaolin -70 % Waste (paint) - 25 % Benton - 5 % Make-up water - 25 %	After forming average 1.76	#	#	After forming 0 ; 0	#
	After 110 °C x 24 h 1.55; 1.55	After 110 °C x 24 h 15.5; 15.10	After 110 °C x 24 h 24.20; 23.40	After 110 °C x 24 h 17.0; 19.0	After 110 °C x 24 h -5.69 / -6.15 -6.09 / -5.39
	After 180 °C x 2h 1.55; 1.57	After 180 °C x 2h 13.68; 12.34	After 180 °C x 2h 21.30; 19.40	After 180 °C x 2h 22.0; 21.0	After 180 °C x 2h -6.49 / -5.40 -5.93 / -5.73
	After 1150 °C x 2 h 1.20; 1.20	After 1150 °C x 2 h 45.30; 45.39	After 1150 °C x 2 h 54.51; 54.60	After 1150 °C x 2 h 5.0; 4.0	After 1150 °C x 2 h -7.55 / -7.30 -7.74 / -7.86

after the thermal treatment at 180°C, and decrease after the 1150°C treatment to 0,70 g cm<sup>-3</sup>.

4. The apparent densities after treating at 110°C and 180°C are also equal - 0,84 g cm<sup>-3</sup> and decrease after 1150°C to 0,66 g cm<sup>-3</sup> with the increase of the perlite percent contents.

5. The apparent density is within the limits of 1,76 - 1,55 - 1,2 g.cm<sup>-3</sup> for the fourth composition.

The highest apparent densities after thermal treatment at 180°C are established for compositions 1 and 4, including kaolin and waste, and the lowest – for composition, including perlite.

#### **Water uptake**

1. The water uptake after thermal treatment at 180°C is the lowest for composition 4 (13,68 %; 12,34 %) and becomes higher values for the composition, including perlite (55,10 %; 45,60 %), according to expectations.

2. The water uptake is very high (90 %) after firing at 1150°C

#### **Opened porosity**

1. The opened porosity after thermal treatment at 180°C is lowest again for compositions 4 - 21,30 %, 19,40 %.

2. A lower opened porosity, (and a water uptake) is observed for the composition, including chamote - 30,08 %, 28,38 %.

3. The opened porosity is high for the compositions 3.1 and 3.2, including perlite. The porosity increases from 42,10 % to 46,30 % when the perlite content rises.

4. The opened porosity after firing at 1150°C reaches a value of 62,19 % (composition 3.2), according to the logical expectations.

#### **Mechanical pressure strength**

1. The mechanical pressure strength is very high after thermal treatment at 180°C for composition 4 (22 MPa; 21MPa), composition 2, including chamote (19 MPa, 20 MPa), and composition 1. The possible reason for that is the good homogenization in the plastic forming and the chamote participation.

2. The mechanical pressure strength is low for compositions 3.1 and 3.2 - 8 MPa and 6MPa respectively, due to the perlite participation.

3. The mechanical pressure strength after forming and firing at 1150°C is low for all compositions.

#### **Linear changes**

1. The linear changes after thermal treatment at 180°C are higher comparatively for composition 4 - 6,49 % and 5,93 % contractibility due to the plastic forming of that composition.

2. The linear changes are very slight for the rest of the compositions.

The results, obtained from the experimental investigation and their analysis allow us to formulate the following

#### **INFERENCES**

1. Every kind of aluminosilicate refractories, containing carbon (or carbon waste), including low-refractory and high-refractory materials, depending on the raw materials can be produced. The carbon increases their slag steadiness to a great extent.

2. Some of the investigated compositions (3.1, 3.2) are suitable for the porous heat-resisting refractories, produced by low density (perlite) raw materials or others foamers.

3. The compositions, for which are registered some linear changes under heating, can be used and respectively produced also, if the construction of the thermal aggregate permits that.

4. A thermoplastic resin firing process occurs, when the resin low-temperature bonding possibility is replaced by a ceramic bond due to the high temperature in the thermal aggregate during the produce and the application of the above compositions articles under the thermal processes.

#### **CONCLUSIONS**

The thermoplastic resin application (introduced by the waste from dust coloring paint in the present investigation) is suitable for the production of aluminosilicate refractories, including carbon.

An energy economy, decrease of the fuel gas emissions because of the low temperature production of this kind of refractories, industrial waste utilization and a reduced quantity of the necessary raw materials will be realized.

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