PRODUCTION OF CONSTRUCTION MATERIALS FROM POWER INDUSTRY WASTE

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***ABSTRACT*:** The ongoing development of power industry involves drawbacks as well, among which the most important are accelerated exhaustion of primary resources and generation of waste materials. Ash resulting from coal combustion in coal fired power plants is an industrial waste which generates major soil pollution effects. Physical and chemical characteristics of ashes correspond to light granulary agregates class (bulk density, dry 0,8 – 1,0 g/cm^3). The utilization potential is ensured by a high chemical inertia, which is caused by the generating technology itself (oxydic solid residue heated at temperatures higher than 1100 °C). The article presents results of the experimental works, which justify the opportunity of using this waste as alternative raw material. The activities developed within the frame of the research project co-funded by EU consisted of investigation of concrete fabrication incorporating ash as unique granulary aggregate or combined with other light agregate.

***KEY WORDS*:** ash, waste, coal

1. INTRODUCTION

Clay and ashes from the burning fuel is drained hydraulic pumping in a single step, the storage plant to disposal.

In general, there are three types of furnaces used coal boiler energy industry. They are diverting, collecting wet and cyclone outbreaks. The most common is the focus of diverting [3].

When pulverized coal is burned in a furnace with diverting about 80% of all ash leaves the furnace as fly ash entrained in the flue gas. When pulverized coal is burned in a furnace with wet collection, 50% of the ash is retained in the bottom of the furnace, and the remaining 50% is entrained in the flue gas [3].

In a cyclone furnace, where crushed coal is used as fuel, 70 ÷80% of the ash is retained as the bottom of the furnace slag and 30% leaving only 20 focus as dry ash flue gas channel. A general diagram of the production of boiler ash in a dry collection is shown in Figure 1 [3].

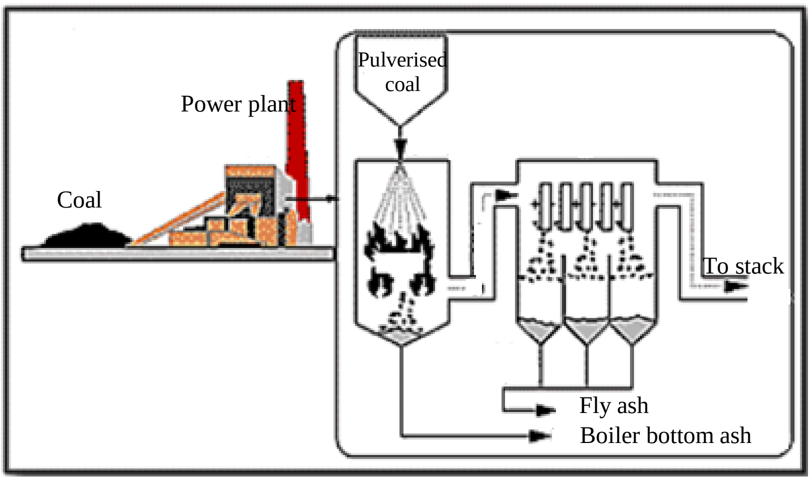

Fig. 1. The ash generated by a power plant

2. INDUSTRIAL WASTE MATERIALS USED FOR OBTAINING BUILDING MATERIALS

Using power plant ash mixtures obtained molding for construction materials expeller is mentioned in the literature worldwide, where they are shown positive results by including ash as a raw material in plastic molding mixtures with a mass weight 15 to 20% [3], [4], [5].

Experimental work on the use of industrial waste to products studied by methods of pressing, aimed at establishing possible recovery from power plant ash and slurry flows drilling established manufacturing bricks, taking into account this molding technique products used in industry, namely, suction and pressing the press - snail plastic molding mixture, followed by cutting rectangular blocks continuously extruded section blank.

The development of resistance in the product structure is achieved by heat treatment of drying and firing at high temperature.

For work performed as reference material plasticizer was used clay feldspar Rovinari, natural raw resulting in the work of stripping the exploitation of lignite quarrying and commonly used in flow manufacturing building bricks in the enterprise profile MACOFIL SA Targu-Jiu. Clays are set to point sintered at about 1180 °C to about 1220 °C melting point [1]. Table 1 shows the chemical composition of the oxide specify it.

Table 1. Chemical composition of the feldspathic clay Rovinari [1]

Oxide based compounds (%w)										P.C.
SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	
65,8	0,68	15,97	5,4	0,11	1,64	0,85	1,86	2,37	0,12	5,35

Considering the wide range of technological processes expected to be experienced in industrial flow within experimental recipes clay content ranged from 40-90% for situations that are unique plasticizer and between 20-60% when the amentecul of trimming occurs and oil drilling slurry. Using very high content of clay in some mixtures of trimming is justified by the fact that the current production on stream MACOFIL SA, it is unique raw material used, on the grounds sufficiently high grease content in the native state, which is likely to give the benefit of simple technologies and higher mechanical resistance manufactures, and disadvantages of higher densities and higher risk discarded after firing.

In all experimental variants was performed gravimetric dosing components so that all references, mixture composition expressed in weight percent.

Table 2 shows the components of the solid dosage prescriptions applied to the molding mixture obtained in the experimental work.

Table 2. Recipes metering components for experimental ceramics obtained by hot pressing and bonding

No	Sample		Mixture composition (% w)			
	Symbol	ID	Clay	Ash	Oil slurry	
1	AC1	1	90	10	-	
2	AC2	2	80	20	-	
3	AC3	3	70	30	-	
4	AC4	4	60	40	-	
5	AC5	5	50	50	-	
6	AC6	6	45	55	-	
7	AC7	25	88	12	-	
8	AC8	26	85	15	-	
9	AC9	27	82	18	-	
10	ASC1	10	60	20	20	
11	ASC2	11	40	20	40	
12	ASC3	12	20	20	60	
13	ASC4	13	50	30	20	
14	ASC5	14	35	30	35	
15	ASC6	15	20	30	50	
16	ASC7	22	25	50	25	
17	ASC8	23	20	60	20	
18	ASC9	24	22,5	55	22,5	

3. MANUFACTURING OF CERAMIC ITEMS

Table molding mixtures ranged from 2-2.5 kg, depending on the weight and bulk density of the materials, so as to ensure the possibility of achieving a minimum of eight samples of each test recipe. The mixtures were homogenized manually pursue an advanced degree as uniformity and avoiding the formation of agglomerates with high clay content. The pellet is increasing trend with increasing clay content and the addition of water occurs at the time of working.

The molding mixtures were homogenized kept for 24 hours at ambient temperature and humidity storage conditions, in order to ensure a uniform distribution of the water so advanced in the total weight of the mixture.

This process is known as maturation, is determined by the rate of application than the clay particulates which absorb excess moisture.

Forming the products was accomplished by pressing the metal mold to give cylindrical ceramic pieces with a diameter of 50 mm and a height of 0.2 mm 50 mm 0.5 mm (Figure 2).

Fig. 2. Parts raw ceramic obtained by compression molding

After trimming, raw ceramic pieces were marked with paint resistant, measured and weighed, then stored in the free atmosphere at room temperature at least 72 hours and then subjected to heat treatment. Drying was performed in the specimens electric oven at 105 °C to 2°C, the approximation bearing 5 hours at the maximum temperature.

Once removed from the oven a valuable samples after their cooling operations were repeated measuring and weighing.

Fig. 3. Drying of the samples in an oven at 105 °C

The dried sample was heat-treated at a high temperature electric furnace.

The heat treatment was done at a temperature of 970 °C, 1000 °C, 1030 °C, with a heating rate of 5 °C per minute and holding the bearing 3 hours and cooling in the furnace chamber for about 16 hours.

After burning were obtained ceramic pieces, which were then subjected to laboratory tests.

Fig. 4. Burning samples in a furnace at temperatures of 970 °C, 1000 °C, 1030 °C

Compressive strength was determined in accordance with the application of compressive force applied to the test specimen at a constant speed corresponding to a pressure gradient of 0.2 MPa / sec until damage as a result of the determination and recording the maximum force attained during the test.

Determination of density, absorption capacity and porosity of test specimens was carried out by weighing dry boiling water for 2.5 hours in total for the replacement of water in the pores of the open air and then immersed in water and weighed in the wet state into the air, resulting parameters required for the calculation.

Sample density, porosity and absorption capacity are determined by the following relations:

$$d = \frac{m_s}{m_u - m_h} \cdot \rho \quad \left[g / cm^3 \right]$$

$$P = \frac{m_u - m_s}{m_u - m_h} \cdot 100 \quad [\%]$$

$$A = \frac{m_u - m_s}{m_s} \cdot 100 \quad [\%]$$

in which:
d - sample density in g / cm ^{3},
P - porosity in%
A - absorption capacity in %
m_s - mass of dry sample, g,
m_u - wet mass of the sample immersed in water in g,
The density of the immersion liquid (water) in g/cm^3.

These measurements were made with an accuracy of 0.1g.

Table 3. Content of ash, combustion temperatures and results of laboratory tests performed on cylindrical specimens having clay and ash composition

	Components (%)		Firing temperature	Compressive strength		Density	Absorption capacity	Porosity
	Clay	Ash	(^{o}C)	Force (kN)	RC (MPa)	g/cm^3	%	%
AC1	90	10	970	65,90	35,61	1,74	17,50	30,37
AC2	80	20	970	60,60	31,63	1,70	18,66	31,69
AC3	70	30	970	41,00	21,40	1,78	22,97	40,88

	Components (%)		Firing temperature	Compressive strength		Density	Absorption capacity	Porosity
	Clay	Ash	(^{o}C)	Force (kN)	RC (MPa)	g/cm^3	%	%
AC4	50	50	970	32,75	17,03	1,49	26,84	40,02
AC5	40	60	970	23,40	11,93	1,38	32,19	44,43
AC6	45	55	970	26,35	13,56	1,70	17,62	29,94
AC7	88	12	970	52,40	28,56	1,75	18,65	32,66
AC8	85	15	970	48,95	26,35	1,72	19,55	33,59
AC9	82	18	970	55,30	29,22	1,70	19,92	33,95
AC1	90	10	1000	47,45	25,80	1,79	16,20	29,05
AC2	80	20	1000	61,53	32,39	1,70	17,62	29,94
AC3	70	30	1000	42,43	22,24	1,78	22,13	39,32
AC4	50	50	1000	39,00	20,28	1,49	26,31	39,15
AC5	40	60	1000	30,60	15,71	1,39	30,92	43,03
AC6	45	55	1000	30,90	16,03	1,67	17,50	29,22
AC7	88	12	1000	55,30	30,38	1,79	17,48	31,34
AC8	85	15	1000	52,25	28,41	1,75	18,69	32,70
AC9	82	18	1000	56,95	30,78	1,74	18,65	32,51
AC1	90	10	1030	deformed	deformed	1,88	16,54	31,02
AC2	80	20	1030	34,30	17,78	1,67	17,50	29,22
AC3	70	30	1030	37,85	19,79	1,57	21,88	34,45
AC4	50	50	1030	41,20	21,08	1,48	24,46	36,08
AC5	40	60	1030	40,30	20,70	1,37	29,35	40,26
AC6	45	55	1030	42,20	21,50	1,49	26,31	39,15
AC7	88	12	1030	53,85	30,03	1,84	15,64	28,81
AC8	85	15	1030	52,60	29,56	1,78	17,69	31,58
AC9	82	18	1030	59,90	32,51	1,78	17,37	30,90

Table 4. Content of ash, combustion temperatures and results of laboratory tests performed on cylindrical specimens having compositions clay, oil slurry and ash

	Components (%)			Firing temperature	Compressive strength		Density	Absorption capacity	Porosity
	Clay	Oil slurry	Ash	(^{o}C)	Force (kN)	RC (MPa)	g/cm^3	%	%
ASC1	60	20	20	970	29,40	16,15	1,57	23,90	37,49
ASC2	40	40	20	970	35,75	18,81	1,54	25,58	39,48
ASC3	20	60	20	970	20,80	10,97	1,43	30,98	44,40
ASC4	50	20	30	970	36,15	18,64	1,52	25,94	39,51
ASC5	35	35	30	970	31,70	16,31	1,54	25,08	42,24
ASC6	20	50	30	970	24,75	12,44	1,45	29,06	38,67
ASC7	25	25	50	970	17,85	9,10	1,37	32,90	45,14
ASC8	20	20	60	970	15,15	7,72	1,45	29,68	43,17
ASC9	22,5	22,5	55	970	15,10	7,69	1,27	37,94	48,20
ASC1	60	20	20	1000	31,50	18,24	1,59	22,01	34,92
ASC2	40	40	20	1000	37,50	19,86	1,57	23,74	37,31
ASC3	20	60	20	1000	26,33	14,08	1,45	29,68	43,17
ASC4	50	20	30	1000	40,75	21,14	1,53	24,74	37,89
ASC5	35	35	30	1000	39,70	20,39	1,55	24,12	37,30
ASC6	20	50	30	1000	34,05	17,56	1,46	28,47	41,45
ASC7	25	25	50	1000	20,30	10,21	1,37	31,81	43,53

	Components (%)			Firing temperature	Compressive strength		Density	Absorption capacity	Porosity
	Clay	Oil slurry	Ash	(^{o}C)	Force (kN)	RC (MPa)	g/cm^3	%	%
ASC8	20	20	60	1000	17,40	8,70	1,48	28,16	41,65
ASC9	22,5	22,5	55	1000	18,45	9,36	1,30	35,20	45,87
ASC1	60	20	20	1030	26,40	14,46	1,58	19,97	31,56
ASC2	40	40	20	1030	39,80	20,69	1,57	22,12	34,65
ASC3	20	60	20	1030	29,60	16,10	1,48	28,16	41,65
ASC4	50	20	30	1030	40,95	21,29	1,52	23,31	35,34
ASC5	35	35	30	1030	46,60	23,50	1,54	22,61	34,94
ASC6	20	50	30	1030	42,20	22,03	1,48	26,94	39,81
ASC7	25	25	50	1030	27,50	14,07	1,35	30,81	41,68
ASC8	20	20	60	1030	23,30	11,92	1,52	23,31	35,34
ASC9	22,5	22,5	55	1030	23,75	12,15	1,30	34,02	44,13

4. CONCLUSIONS

Experimental work micropilot allowed to define the practical conditions of use of industrial waste to obtain ceramic composites studied in the category of building materials.

The fly ash aggregate granules having the characteristics of light in the core can become an alternative raw material for manufacturing press molded product at a high temperature binder.

There is a possibility of using this waste to various mixtures of trimming weight, from 10% for the need to maintain their plasticity and advanced up to 70% when participating as granular aggregate concrete mixes exclusively to obtain.

Slurry oil drilling presents to confer plasticity property / workability granular mixtures of aggregate, its use is recommended to obtain mixtures molding or stamping press as partial replacement of natural clays. Compositional similarity and common features with feldspathic clays is demonstrated by the fact that to ensure the product development of the resistance structure by solid-phase reaction heat treatment is required at the same level with the recommended maximum temperature for common technologies.

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