Study the possibilities for using of clays from coal overburden for bricks production

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Introduction

Bulgarian energy industry is characterized by broad using of lignite coal as a source for an electricity production. Most of lignite reserves of the country are located in East-Marishki coal basin which is exploited by „Mini Maritsa Iztok" EAD Mines. The company manage three open pits with total annual mining of lignite – 35.5 million tons and overburden from 80 to 100 million m^3, Euracoal statistics (2022) and Karacholov (2020).

Maritsa East deposit is built of Pliocene clays, clayed sands lying directly on a variegated substrate of Palaeozoic and Triassic rocks. The waste from lignite mining is presented by deposit's overburden. It consists from soil layer and different types of clays - black to grey-black highly organic clays with coal inclusions, grey-green, blue-green to grey-yellow and yellow-brown coloured clays, Marica Iztok mine (2023).

The study of possibilities for using of clays from coal mining for bricks production has performed for decreasing of ecological effect upon a nature.

Experimental

Two types of clays (labeled C_1 and C_4 respectively) mined on different mine's horizons are object of the research.

The chemical compositions of the clays were evaluated by XRF analysis (Zetium Spectrometer – Malvern Panalytical). The phase compositions were evaluated by powder XRD analysis by automatic powder diffractometer system Philips, generator PW1830 and goniometer PW1050.

The batch for the brick sample was prepared by mixing 50 Wt% of clay 1 and 50 Wt% of clay 4. It was humidified (6 Wt%) and pressing at 40 MPa using a uniaxial hydraulic press (Mignon C, Nannetti, Italy) to obtain bar samples (50x5x3 mm), suitable for firing in horizontal optical dilatometer (Expert System Solutions, Misura HSML ODLT 1400) at 10°C/min and 1 hour holding at 1000°C.

The open porosity of the sample was estimate by the water absorption, while the close porosity by pycnometric measurement.

Powder XRD patterns of the studied samples were recorded on Empyrean Powder X-ray diffractometer in the 3°-100° 2θ range and overall scanning time 35 min. Phase identification was carried out using the HighScore Plus program, Degen et al (2014). The microstructure of the final sample (both surface and fracture) were observed by Scanning Electron Microscopy (JEOL JSM 6390).

Results and discussions

The results from chemical XRF analysis of main elements of C_1, C_4 and corresponding ceramic are given in Table 1. The results from XRD analysis shows that the clays are kaolinite types.

Table 1. Results from chemical analysis of the clays (Wt.%)

Powders Elements	Unit	Sample 1 Yellow-brown clay C_1	Sample 4 Yellow-brown clay with organic remains C_4	Ceramic sample
SiO_2	%	53,4	54,6	54
Al_2O_3	%	18,9	18,7	18,8
Fe_2O_3	%	8,9	5,9	7,4
K_2O	%	2,4	2,7	2,55
MgO	%	1,2	1,1	1,15
CaO	%	1,0	0,9	0,95
Other	%	1,8	2,4	2,1
LOI*	%	12,4	13,7	

*Losses after heat-treated at 1000°C

Hot Stage Microscope had applied for evaluation of the thermal behaviour of the clays for the purpose of the study. The sintering plot is reported on Fig.1 and demonstrates starting of sintering at about 850°C. The shrinkage at 1000°C is about 1% and after 1 hour riches about 4,5 %, which is typical value for ceramic industry.

The results of the performed study demonstrate that the close porosity of the baked sample is 1 ± 0,2 % while the open porosity is 17 ± 2 %. The obtained values are typical for the production of facing bricks.

The XRD results presented in Fig.2 shows a typical pattern for similar products as residual quartz, hematite and anorthite.

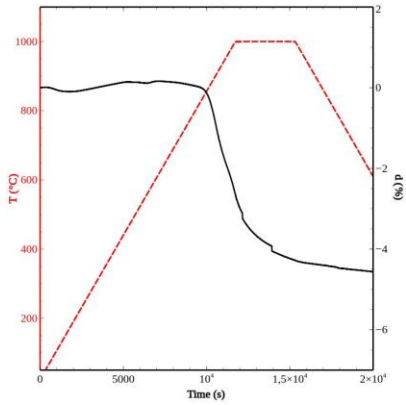

Figure 1. Dilatometric sintering curve of brick sample

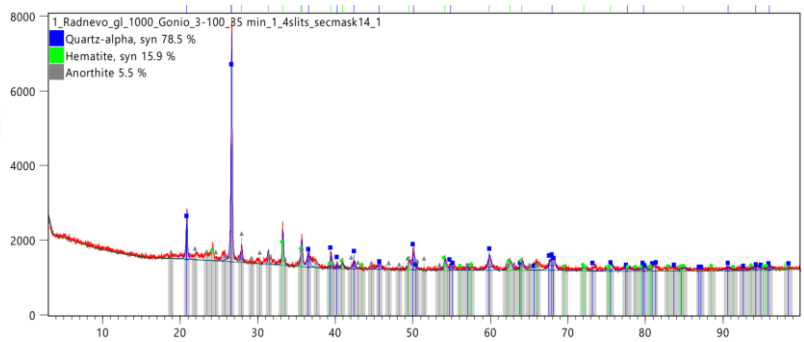

Fig. 2. Phase analysis of sample

The satisfactory degree of densification is confirmed by the SEM images, presented in Fig. 3 and 4, showing a typical bricks structure with high percentages of open porosity. Obviously, the porosity in the surface (Fig. 3) is lower than one in the volume (Fig. 4).

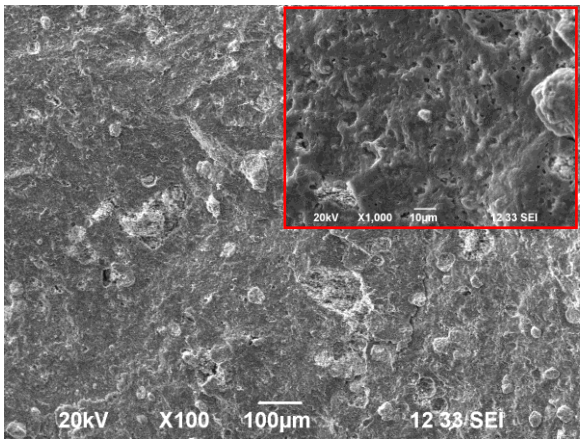

Fig 3.

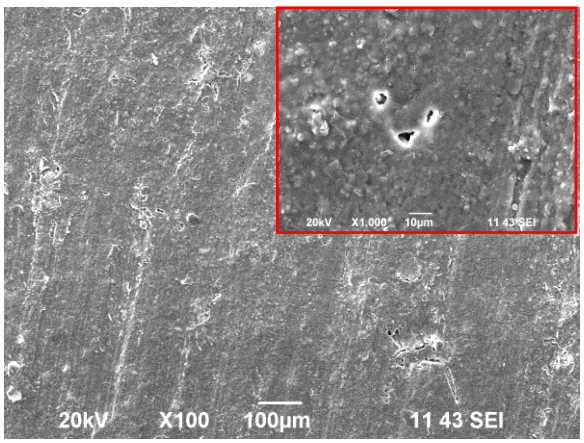

Fig. 4.

Conclusions

The results of chemical analysis and mineral composition of the studied clays in „Mini Maritsa Iztok" EAD Mines as well as their thermal behaviour, show that they can probably be used in the synthesis of bricks.

The sintering shrinkage and the final moderate porosity as a result of 1 hour holding at 1000°C corresponds to values typical for facing brick production.

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- KP-06-N77-9 "New geopolymeric and ceramic energy efficient materials and composites"

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