

BYPRODUCT FROM THERMAL POWER PLANTS AS A PROMISING MICROAGGREGATE FOR REFRACTORY MATERIALS

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The present research focuses on the investigation of the thermal power plants byproduct generated during coal combustion and known as cenospheres (CS). CS are micro-sized, lightweight, spherical, hollow fly ash particles consisting mainly of silica and alumina. The specific morphology and properties of CS make them useful for production of various materials, mainly as lightweight fillers and non-sacrificial pore-forming agent (for example, in lightweight concrete, geopolymeric composites, mullite ceramics, high-density polyethylene composite). Based on the research data available in the field for the moment, one may assume CS could also be valuable in development of lightweight refractory materials, manufactured using calcium aluminate cement (CAC). However, the interaction of CS with CAC matrix and their behaviour at high temperatures are not studied sufficiently for the moment. Moreover, the properties of CS from different plants can vary in a wide range, influencing structure formation process and final properties of the composite. Therefore, the detail characterization of CS is of high importance.

In the present work, the properties of cenospheres of three different types (here named CS1, CS2 and CS3, see Table 1) were investigated in details in aim to evaluate the viability to use them for the production of lightweight refractory materials.

Table 1. Chemical composition of the initial CS

	C	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	K ₂ O	CaO	TiO ₂	Fe ₂ O ₃	Other
CS1	4.838	0.551	0.255	34.8	51.9	0.784	1.12	1.28	2.12	2.352
CS2	4.805	0.758	1.97	27.7	52.8	3.17	2.31	1.17	4.19	1.127
CS3	7.144	0.864	1.18	29.9	47.8	4.50	0.797	0.956	4.84	2.019

The elemental and phase compositions, morphology, granulometry, microstructure, thermal stability of initial cenospheres were investigated along with their properties after treatment at high temperatures.

It was determined that the size of all the CS investigated varied in a quite wide range with prevailing particle size ~80–100 µm. The particles are spherical with porous walls having from 1–2 µm up to ~10–15 µm in thickness. The bulk density of CS1 is slightly bigger (414 kg/m³) as compared with CS2 and CS3 (357 and 350 kg/m³, respectively). According to XRD phase analysis, CS2 and CS3 are mainly amorphous with low amount of crystalline mullite while CS1 consist mainly of crystalline mullite. The amount of amorphous phase in CS2 and CS3 decreased significantly after thermal treatment at high temperatures (above 1100 °C). In all the CS investigated, XRD analysis revealed the formation of mullite and then, at higher temperatures, tridymite. Summarizing these results along with other findings of present work one may state the CS are promising material for development of CAC-based lightweight refractory composite.

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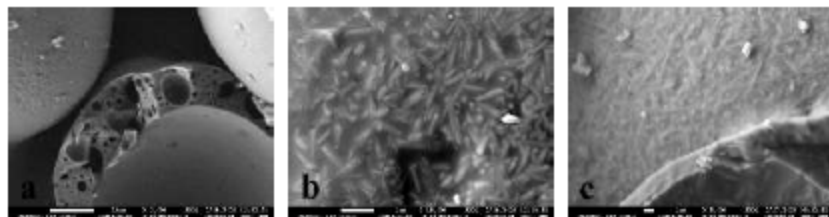


Fig. 1. Morphology of initial CS1 (a); microstructure of CS1 and CS3 surface after thermal treatment (b), (c)