Effect of temperature on morphology, phase transformations and thermal expansions of coal fly ash cenospheres

ABSTRACT

Cenospheres are small, hard-shelled hollow spheres with high silica and alumina content. These micron-sized aluminosilicate hollow spheres constitute only a small percentage of the coal fly ash (CFA) obtained from the coal combustion processes. In this study, cenospheres were separated from CFA obtained from a coal-fired power plant located in Kapar, Malaysia. The cenospheres were heated at 1000, 1200 and 1400 °C to study the changes in morphologies, compositions, phase formation and thermal expansion. The sintering temperatures were selected based on the differential scanning calorimetry (DSC) curve results. X-ray diffractometry (XRD), field emission electron microscopy (FESEM), energy dispersive spectroscopy (EDS) as well as thermogravimetry and differential scanning calorimetry analysis (TG–DSC) were used for the characterization study. The study found that the cenospheres have excellent weight stability but are thermally unstable as a result of crystallization and melting. The phase ordering process and devitrification of the amorphous aluminosilicate glass phase at high temperatures lead to the increment and enrichment of the mullite phase in cenospheres. It is suggested that a preheating treatment at 1100 °C could be used to enhance the mechanical properties and thermally stabilize the cenospheres, which make it more suitable for use as a pore-forming agent in ceramics.

Keyword: Coal fly ash; Cenospheres; Mullite crystallites; Phase transformation