Abstract

This dissertation presents a review of literature pertaining to critical raw materials in energy waste (fly ash) generated in various coal combustion technologies. Among the dozen or critical raw materials being metals, the dissertation focused on rare earth elements, due to the increase in their demand on world markets. Based on a detailed analysis of the research results, an assessment of the impact of coal combustion technology on the concentration of rare earth elements in polish fly ash was conducted. Characteristic of fly ash (physical and chemical) and a large amount of their production allow for their extensive use as raw materials in many areas of the economy.

As part of the dissertation laboratory tests were conducted. For this purpose, tests were carried out for 29 polish fly ash. The samples came from conventional dust boilers where the fuel was hard coal and brown coal, as well as from fluidized bed boilers where the fuel was hard coal. In the samples, the full chemical composition, the content of critical raw materials, including the content of rare earth elements, as well as the phase composition were determined. An own research procedure was developed to determine the forms of REE occurrence by scanning electron microscopy.

The results of the research allowed to assess the effect of coal combustion technologies on the concentration of rare earth elements in polish fly ash, which was aimed at demonstrating the relationship of rare earth elements content in polish fly ash with phase composition.

In the tested fly ash, there is a clear impact of combustion technologies and the type of fuel on their main chemical components and phase composition. In conventional boilers fired with hard coal, the main phases in fly ash are glaze, mullite, quartz, iron oxides and an unburnt organic substance. In fly ash from conventional boilers, fired with brown coal, the main phases are glaze and quartz. In fly ash from fluidized-bed boilers fired with hard coal, the phase composition differs significantly from the composition of fly ash from conventional boilers. In fly ash from fluidized bed boilers the main phases are: quartz, illite, anorthite, anorthocyte, anhydrite, portlandite, lime, calcite, hematite, magnetite, maghemite and periclase.

The highest concentrations of REE are observed in fly ash from conventional boilers fired with brown coal, while in fly ash from conventional boilers fired with hard coal, higher concentrations of REE occur than in ash from fluidized boilers firing with hard coal. In fly ash from conventional boilers fired with hard coal, REE concentrates in glaze and glaze granules with crystalline phases. In order to evaluate the tested samples of fly ash from conventional boilers fired with hard and brown coal and fluidized ashes and bottom ash from fluidized coal

boilers, as an alternative REY source it was found that the value of the perspective coefficient (Coutl) allows to include all analyzed samples for REY perspective raw materials.

The diversity of phase and chemical composition, including critical raw materials (REE), results mainly from the quality of the fuel burned, including the presence of mineral components in it, REE carriers, which mainly depends on geological processes forming and shaping the organic substance in the hard coal bed and brown coal bad and conditions, mainly temperature, prevailing in the boiler which is essential for the formation of the phase composition of produced energy waste and the binding of rare earth elements in these components.