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Quantitative Determination of the Amorphous and Crystalline Phases of the Ceramic Materials Utilizing the X Ray Diffraction Technique

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Mineral coal is a combustible sedimentary rock formed from vegetable organic matter that has been buried and compacted over geologic time, deposited in shallow, anaerobic sedimentary basins. Fly and bottom ashes are byproducts originating from the combustion of coal in thermoelectric power stations. The fly ash residue has been used in the cement industries, while the bottom ash up to now has no industrial applications. The later residue represents almost 50% of the total generated by the thermoelectric plants. The physical, chemical and mineralogical characteristics of bottom ash are compatible with many raw materials used in the ceramic tiles industry, which indicates the possibility for the partial or total substitution of these raw materials with this byproduct. Ceramic materials have properties defined by their chemical and micro-structural composition. The quantification of the amorphous and crystalline phases is a fundamental stage in the determination of the structure, properties and applications of a ceramic material. Within this context, this study aims is the quantitative determination of the amorphous and crystalline phases of the ceramic materials developed with addition of coal bottom ash, utilizing the X ray diffraction technique, through the methods proposed by Rietveld[1] and Ruland[2]. For the formulation of the ceramic mixtures a {3,3} simplex-lattice design was used, giving ten formulations of three components (two different types of clays and coal bottom ash). The crystalline phases identified in the ceramic materials after sintering at 1150^oC during two hours are: quartz (α-SiO_2 – JCPDS[3] 05-490), polymorph of SiO_2 (SiO_2 - JCPDS[3] 76-912), tridimite (SiO_2 - JCPDS[3] 75-638), mullite ($Al_{2,35}Si_{0,64}O_{4,82}$ - JCPDS[3] 15-776) and hematite (Fe_2O_3 - JCPDS[3] 13-534). The proposed methodology for the use of the Rietveld method for the quantification relating to crystalline phases together with the Ruland method used for the determination of the crystallinity of the materials was shown to be adequate and efficient.

Keywords: Bottom Ash, Ceramic, Amorphous Phase, Crystalline Phase

References

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