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Characterization of Steel Production Dusts: Mössbauer Spectroscopy Study

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Extended Abstract

Steel production involves processes and alloys based on iron. Metallurgy is one of the most energy-intensive branches of industry and it also generates a lot of harmful emissions (gases and dusts resulting from steelmaking in the electric arc furnaces) and wastes (e.g. slag, mud). The dusts and wastes produced vary in terms of their chemical and mineral composition caused by raw material used for steel production, a process which involves a combination of primary resources (iron bearing ores), metal scraps and metallurgical wastes. The general worldwide trend is evaluation of technologies which re-use the metallurgical wastes and apply recycling routes as the source of furnace charge. Therefore, the determination of physical and chemical properties of the dusts arisen during the metallurgical process, mainly their phase composition, is the subject of many studies of application character.

The aim of the research was to recognize magnetic properties, mineral composition and phase content of dusts from de-dusting station, steel mill, sinter strand and filter press located in steel metallurgical foundry in Upper Silesia, the most urbanized, industrialized and also, the most polluted region of Poland. The following methods were applied: X-ray fluorescence (XRF), magnetic susceptibility and X-ray diffraction (XRD) measurements. In practice, each particular type of dust is unique, which requires application of many different research techniques. Especially, in the case where the dust is rich in the iron bearing phases, the application of routine analytical methods does not always lead to unambiguous results. Therefore, these results were correlated with the spectroscopic data, which was Mössbauer spectroscopy.

Chemical analysis indicated that the analyzed material contained a significant amount of heavy metals: Cd (~0.01 Mass%), Pb (0.09-0.31 Mass%), Zn (0.02-4.08 Mass%), Cu (0.01-0.04 Mass%), Ti (0.02-0.17 Mass%) and others, accompanied by large amounts of Fe (13-54 Mass%). The average magnetic susceptibility values were high and varied in range from 9 to 146 × 10^{-6} m^3kg^{-1}. The X-ray diffractograms of dust samples revealed that the dominant components were some spinels, hematite, calcite, and portlandyt. Wüstite, hematite and pure iron dominated in samples of muds. Mössbauer spectra confirmed these results. Additionally, Mössbauer measurements clearly identified the content of Fe-bearing phases and oxidation state of iron. Due to the changeable mineralization and chemical composition metallurgical slags are one of the most diverse groups of wastes.

Due to the complicated microcrystalline structure of metallurgical wastes the application of the Mössbauer spectroscopy provided a unique, clear and consistent characterization of the iron bearing compounds and their relative abundances.

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