Characterization of solid samples with flame emission spectroscopy and artificial neural networks

Flash smelting is a pyrometallurgical process used to extract base metals, such as copper, from finely pulverized sulphide mineral ores called concentrates. The process runs continuously and can be fully automized by adjusting the oxygen enrichment and temperature within the furnace to accommodate the changing concentrations of minerals like $CuFeS_2$, FeS_2, SiO_2 and other minerals. However, process control is limited due to the constant variation in feedstock composition and challenges in determining the feedstock composition in real time. The analysis is complicated since mineralogical measurements have to be conducted every few seconds, the environment is extremely hostile, there is no opportunity for sample preparation, and the sample is highly heterogeneous. Previous attempts to measure spontaneous emission from a flash furnace were limited to temperature and brightness due to insufficient thermal excitation of heavy elements such as copper and iron[1].

Here, we demonstrate a flame emission system using a high-temperature acetylene burner that is gravity-fed with concentrates obtained from a Cu-smelter. By recording the flame emission every few seconds, spectral features can be correlated to the composition of the concentrate as obtained using conventional methods. However, conventional spectroscopic analysis is complicated by the blackbody background, the many short-lived species in the flame, and inner-filter effects that prevent the extraction of quantitative information from conventional spectroscopic analysis. Instead, an Artificial Neural Network algorithm, appropriately trained on known samples, provides a robust prediction of the elemental and mineralogical composition of concentrate composition with an approximate accuracy of less than 2% [2] [3].

References

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