Abstract

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Transformation of environmentally hazardous slags into mineral resources

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Abstract

Slags generated in pyrometallurgical processes of non-ferrous metals production usually are considered as waste materials and have to be dumped in hazardous waste sites because of high content of heavy-metals (Pb, Zn, Cu, As, Sb, Cd) and leachable in water substances (chlorides, sulfates).

Studies were conducted into transformation of waste slag into mineral resource with recovery of valuable metals by strong reduction process in electric furnace and in oxidation-reduction process in TSL reactor. The tests were performed in IMN Gliwice pilot installations: electric furnace of power rating 80 kW and capacity of 200 kg of slag and in TSL reactor of 200 kg slag capacity, equipped with a lance for introduction of furnace oil and air.

The studies were conducted with polymetallic (Zn, Pb, Cu) and multiphase (sulfides, oxides, chlorides) slags from smelting of lead-bearing materials from copper metallurgy, which contained (wt %): 3-20% Pb, 1,5-5% Cu, 8-15% Zn, 0,3-2% As, 1-14% S, 0,1-1,5% Cl and with slag from EAF dust treatment in Waelz process.

During the strong reduction of slag in electric furnace sedimentation of nonvolatile metals (Cu, Pb, Fe) or their sulfides (Cu_2S, FeS, ZnS, PbS) took place, as well as removal of zinc and volatile substances (PbO, As_2O_3, $PbCl_2$) to dusts.

The oxidising – reducing process of slag treatment in TSL reactor consisted of melting, oxidation of sulfide phase and fuming of zinc and lead. The appropriate process conditions (oxygen excess factor in lance, addition of reducing agent and high process temperature) provided possibilities for extraction of copper into metal or matte form and removal of zinc and lead to dusts.

Both in the electric furnace and in the TSL reactor the unreduced residue was subjected to chemical composition correction to produce vitreous unleachable slag of about 40% SiO_2 and very low heavy metals content, applicable as mineral resource.

The electric furnace provides possibilities for recovery of Pb and Fe in a metal form and for keeping sulfur in stable products. Application of TSL reactor results in lower Zn content in silica slag, and in possibilities of metallic copper production, with transfer of majority of sulfur to gases – and that requires their desulfurization.

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