Plasma Processing of Dusts and Residues

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Abstract

Thermal plasmas find increasing attention in materials processing for their high energy densities, low gas flow rates, ease of installation, and free choice of chemical potentials. Drawbacks are the costs for torches and power supplies, for plasma gases and electric energy. Industrial applications of thermal plasmas therefore depend on the balance between plasma-specific benefits and costs. This balance may change with time and location and cause plasma processes to emerge and disappear again.

In dust and residues processing, numerous attempts have been made to make use of thermal plasmas. In cases where Ar plasma of atmospheric pressure competes with high vacuum processes, plasma has been successful, as in titanium metal recovery. The treatment of aluminium dross with plasma to avoid the use of salts has been partially successful, but oxy-fuel burners are considered as an alternative. Platinum group metals are being recovered from spent automobile catalysts with plasma heaters since 1984. Stainless steel dust is processed in a plasma-fired shaft furnace. Recycling of chips and turnings into the cupola furnace has been improved by superheating the cupola blast with plasma torches.

In steelmaking, electric arc furnace dust has to be recycled under newly passed environmental regulations in many countries. For that purpose, DC arc furnaces with hollow graphite electrodes seem to be well suited. They have proven feasible for chromite fines reduction (Krugersdorp, 40 MW), for EAF dusts, for stainless steel dusts, and for residues from the ferronickel production.

Thermal plasmas have been tested to process solid residues from municipal waste and from sewage sludge incineration. The aim is to produce an inert slag, a condensate containing salts to be treated and re-used, and a relatively small gas volume. Municipal waste being known to contain chlorine, the de novo synthesis of dioxins and furans must be avoided in the off-gases by creating oxidizing conditions in and downstream the plasma furnace. Then, inert or oxidizing plasma flames are preferable to graphite electrodes.

With chlorine-free residues, a reducing melting process has the advantage to minimize heavy metal contents in the slag. Volatilization processes depend strongly on the oxygen potential in the furnace. Pilot test results are reported on plasma melting of waste incineration residues under reducing and oxidizing conditions. The benefits of a substantially inert plasma heating system and the free choice of the oxygen potential in the furnace are discussed.