Modelling Lead Recycling Processes

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ABSTRACT

Lead is the metal with the highest recycling rate, because of a very efficient collection of the main application, lead acid batteries. Probably because of the smaller plant sizes, the increasing importance of recycling has not lead to matching fundamental research. The thermodynamics of the processes used in recycling, are therefore much less established for secondary smelters then for primary smelting.

Primary production, starting from ores containing a whole range of impurities, including precious metals as well as gangue, consists of an oxidizing roasting step, followed by reduction in a blast furnace. More recent processes combine both in one direct reduction reactor (QSL, Ausmelt or Kivcet). In primary smelting, there is a large concentrated stream of SO_2, and sulphuric acid plants are used to condense the sulphur.

Secondary production starts from products containing Pb, $PbSO_4$, and PbO_2, mainly from batteries. Impurities are now mainly lead alloying elements such as Sb. As in direct reduction, a single pyro-metallurgical step is used for reduction.

However, sulphur is not transformed in SO_2, but is separated from the battery paste hydrometallurgically, or mostly captured in a separate phase during smelting. This phase is generally called a slag, whereas it is sulphide rich and more close to a matte phase.

The matte phase is created using Fe (shaft furnace) and mostly also Na_2CO_3 (short rotary). Unfortunately, the resulting phase diagram system Na_2S-FeS-PbS, in possible combination with metallic lead and iron, iron oxides, sulphates, and liquid oxide slag, is not well understood. It is rather important to understand this system well, in order to model and improve the processes for lead acid battery recycling.

Experimental evidence in well-controlled conditions is difficult to gather, as the formed material is hygroscopic and reacts to hydrates, such as the erdite phase. This presentation discusses the available data, which is scarce and uncertain, as well as some new results.

Then, the present FactSage models for matte are compared and our own model is discussed. Finally, we discuss the use of SimuSage to use thermodynamics for process modelling efficiently.