Exergetic efficiency analysis of a pyrometallurgical zinc recycling process

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ABSTRACT

The exergy content of a process stream is a thermodynamic value, indicating the maximum amount of work the stream can perform in a reference environment. It can be calculated for energy streams as well as for mass streams, allowing an unambiguous comparison between the two. Starting from an exergy balance the global efficiency of any thermodynamic process can be quantified by comparing the exergy in the useful output streams to the exergy provided by the in-put streams. This is an advantage over traditional process analyses based on separate mass and energy balances. From an ecological point of view, exergy analysis thus provides a powerful tool for the evaluation and optimization of industrial processes. In this presentation, first the thermodynamic principles behind an exergy analysis are elaborated. Next, it is illustrated that the outcome of an exergy calculation can be substantially influenced by the choice of a reference state, a thermodynamic database and a description method for the stream. The latter is of particular importance for pyrometallurgical process streams with complex compositions and phase structures. Due to these effects, comparisons between different exergy analyses should be ap-proached with care. However, when the analyses are performed systematically and consistently, they can be very useful for the optimization of process efficiencies. This is shown by a case study on a recently developed zinc recycling process. In this study well adapted solution models are used for an accurate and consistent description of the involved pyrometallurgical process streams. An analysis of a base case scenario shows that the process efficiency is limited by the production of low exergetic zinc oxide and highly exergetic waste streams. Based on the outcome of this analysis, appropriate modifications are suggested to improve the overall process efficiency.