Thermodynamic analysis of the role of chlorine and sulfur environments during combustion and incineration processes

Abstract

In order to control the emission of trace metals from combustion and incineration systems, sorbents and filters are sometimes used. However, the effectiveness of these methods is greatly affected by the volatility of the metals and the way in which they speciate during combustion, and afterwards during condensation, and physical or chemical sorption.Although there has been a lot of research into the mechanisms by which trace metals speciate and subsequently appear in submicron particles, the details of these mechanisms are not yet thoroughly understood. In this study, a chemical equilibrium approach was used to qualitatively determine the speciation of lead, cadmium, and chromium in Cl and S environments. The reaction conditions of sorbents were also tested numerically in order to understand the reaction behavior of metals with sorbents. This article reports the influence of different concentrations of Cl and SO2 on Pb, Cd, and Cr speciation, as representatives of other trace elements. The partitioning behavior of metals during combustion was also examined for Cl and S. The results obtained indicate that most metals exist in the vapor phase, even at low temperatures, when chlorine is present. However, the addition of SO2 enhances the formation of the condensed phase, except at extremely high temperatures. This observation was not significant for Cd or Cr. The higher the concentration of Cl the higher the retention of trace metals in the vapor phase, even at low temperatures. Results from comparisons of the reactivities of mixed metals with Cl indicate that the presence of Fe limits the reactivity of most trace metals with Cl except at higher concentrations. In the presence of Fe, alkali metals are the first to react with Cl. If Fe is not present, most trace metals react