Model for Solubility and Solid Phase Composition in High-Temperature Na_2CO_3-Na_2SO_4 Solutions

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Scaling by the double salts of the Na_2SO_4 and Na_2CO_3 system has long been recognized as a problem in pulp and paper industry spent liquor evaporators [1-4]. The two double salts currently identified from this system in black liquor evaporators are burkeite and sodium sulfate dicarbonate. Burkeite is a sulfate-rich species with a nominal formula ($Na_2CO_3 \cdot 2Na_2SO_4$) capable of forming solid solutions with a mole ratio of 1.4-2.2 SO_4:CO_3 at 100 °C [5]. Sodium sulfate dicarbonate is a carbonate-rich species with a CO_3:SO_4 mole ratio of 1.7-2.2 [6]. A limitation of traditional models based on the minimization of the Gibbs free energy is that the chemical composition of the solid species has to be defined so that the chemical potential of the solid species can be calculated. These models lack the flexibility to predict the composition of an equilibrium solid phase which precipitates as a solid solution. We have used a model for the burkeite system that is capable of predicting composition of both the precipitated salt and the solution using published solubility data. The model is based on a thermodynamic definition of a solubility constant with Pitzer ionic activity coefficients in the solution. This model has been fit to solubility data in the 100 to 115 °C range and also to data at 150 °C. Additional solubility data in the 115-150 °C range are being generated to increase the temperature range for which this model can be applied. We are also currently working to produce the solubility data necessary to apply the model to the solution composition range that produces the sodium sulfate dicarbonate phase.

References

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