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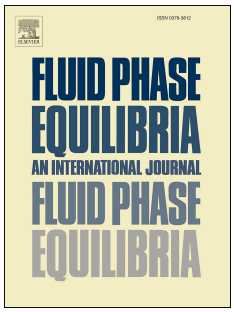

Determination and graphics expression of ice-salt eutectic points of the multicomponent electrolyte solutions

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Determination and graphics expression of ice-salt eutectic points of the multicomponent electrolyte solutions

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A B S T R A C T The eutectic point data of the ternary system Na^+//Cl^-,SO_4^{2-}–H_2O, the quaternary system Na^+//Cl^-,SO_4^{2-},NO_3^-–H_2O, and the quinary system Na^+,K^+ //Cl^-,SO_4^{2-},NO_3^-–H_2O were studied by cooling curves method. Based on the experimental data, the eutectic temperature-solution composition diagrams and projection diagrams were constructed. At the eutectic temperatures, these systems were found to belong to simple types without the formation of the double salts. For the ternary system Na^+ //Cl^-,SO_4^{2-}–H_2O, the eutectic temperature-solution composition diagram could be plotted in the form of a trigonal prism, which exhibited the existence of three eutectic curves of single salt and ice or two salts, and one eutectic point of two salts and ice. For the quaternary homo-ion system Na^+ //Cl^-,SO_4^{2-},NO_3^-–H_2O, the eutectic temperature-solution composition diagram could be drawn as a trigonal prism, which showed three eutectic regions of single salt and ice, three eutectic curves of two salts and ice, and one eutectic point of three salts and ice. Furthermore, for the quinary system Na^+,K^+//Cl^-,SO_4^{2-},NO_3^-–H_2O saturated with $NaCl\cdot 2H_2O$, the relationship between the eutectic temperature and the solution composition could be described based on the solvent-less and Cl-less diagram. This diagram exhibited the presence of four eutectic regions of two salts and ice, five eutectic curves of three salts and ice, and two eutectic points of four salts and ice, and the eutectic temperature was found to be –27.45, –24.75 °C, respectively. The eutectic region of ice-$NaCl\cdot 2H_2O$-$NaNO_3$ was the smallest; however, that of the ice-$NaCl\cdot 2H_2O$-$Na_2SO_4\cdot 10H_2O$ was the largest. The results of this study can offer fundamental data to promote the research and application of crystallization processes at low temperature and further theoretical exploration.

Keywords: multicomponent electrolyte solution; freezing point; eutectic point; phase diagram; crystallization

1. Introduction

The eutectic point is one of the most important thermodynamic properties of electrolyte solution, which allows the accurate prediction of its thermal and physical properties. It is applied widely in the fields of food industries, agriculture, chemical engineering, and so forth [1–6]. For instance, when a saline solution, such as seawater,

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