SUMMARY OF Ph.D. DISSERTATION

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Title

Development of the Helmholtz Type Equation of State for Binary Mixtures of Methane and Hydrogen Sulfide

Abstract

Recently, energy problems have been discussed along with the consideration of environmental problems. Thermodynamic properties for fluids and fluid mixtures with high accuracy are essential for the efficient usage of energy. Natural gas has been given attention and its thermodynamic properties are also required. Natural gas is a multicomponent system whose primary component is methane, and it is very difficult to predict the properties of natural gas because the components are different depending on the source. Therefore a high accurate equation of state for natural gas is required for providing its properties. Binary mixtures of methane and hydrogen sulfide, which are mixtures of natural gas components, show vapor-liquid-liquid equilibrium and divergence of the critical curve. The binary mixture which shows such a complicated behavior is classified as Type III according to the classification of Scott and van Konynenburg. Although the phase behavior of Type III on the P–T–x plane is well known, other properties have not yet discussed even for $P\rho Tx$ property. The Helmholtz type equation of state for binary mixture of methane and hydrogen sulfide was developed in this study. The property behavior was discussed for entire fluid region using the equation of state. This study was performed to provide natural gas properties and to make contributions to further development of multicomponent thermodynamics.

Chapter 1 summarizes the aims of this study, the background of natural gas property researches, and classification of binary fluid mixtures.

Chapter 2 describes the state of the art in equations of state for fluids and fluid mixtures.

Chapter 3 describes the way to develop the present equations of state. In addition, the calculation methods of vapor-liquid-liquid equilibria and complicated critical curves are discussed.

Chapter 4 describes the Helmholtz type equation of state for hydrogen sulfide developed in this study. There have been no good equations of state for hydrogen sulfide until now.

Chapter 5 describes the Helmholtz type equation of state for binary mixtures of methane and hydrogen sulfide developed in this study. The equation of state for methane by Setzmann and Wagner and that for hydrogen sulfide by this study are adopted in the present equation of state. The functional forms of Helmholtz type equation of state were analyzed and it was made clear that the Helmholtz type equations of state with the proposed mixing rules can represent the complicated behavior of Type III.

Chapter 6 describes the behavior of the binary mixture of methane and hydrogen sulfide not only for the phase equilibrium and the critical curve but also $P\rho Tx$ property, heat capacity, speed of sound, and so on in the entire fluid region in comparison with the binary mixture of methane and ethane, which is classified as Type I.

Chapter 7 summarizes the results of this study.