SUMMARY OF Ph.D. DISSERTATION

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Title

Development of the apparatus for measuring the isobaric specific heat capacity of fluids under high pressure and measurement of methanol-water mixture

Abstract

Recently, global warming and inflating oil prices have been expected to raise awareness regarding energy problems and encourage the development of technology for the efficient usage of energy. The thermodynamic properties of the working fluids used in the equipments of energy systems are one of the essential fields of study for developing such technology. Methanol-water and ammonia-water mixtures are expected to be used as working fluids in the future. The relationships between the pressure, density, temperature, and composition ($P\rho Tx$ relationships) of the mixtures used as working fluids are required for designing the instruments, and calorimetric properties such as heat capacity and enthalpy are required for calculating the system efficiency and evaluating the system performance. Therefore, it is desired to systematically develop the thermodynamic properties of the working fluids by an accurate equation of states so as to calculate these properties at an arbitrary condition. However, few measurement values of these properties exist for developing the equation of states, particularly for fluid mixtures such as aqueous solutions over a wide range of temperatures and pressures. In this study, we developed an apparatus for measuring the isobaric specific heat capacity (calorimeter) of fluids and fluid mixtures with a constant composition over a wide range of temperatures and pressures. The measurements of the isobaric specific heat capacity of methanol-water mixtures were conducted over a wide range of temperatures and pressures by using the developed calorimeter.

Chapter 1 outlines the backgrounds and aims of this study.

Chapter 2 describes the characteristics of some types of calorimeters classified according to the targets of measurement and the structure of the apparatus.

Chapter 3 describes the calorimeter developed in this study. The thermal relaxation method was adopted for the principle of measurement taking into consideration the aims of this study. Bellows was adopted for the sample container of the calorimeter, and the calorimeter filled with the sample was designed as a lumped heat capacity system.

Chapter 4 describes the principle of measurement by the thermal relaxation method, the data processing system, pressure measurement system, temperature measurement system, and measuring procedure.

Chapter 5 describes the operation check and the performance test of the calorimeter. The isobaric specific heat capacity of methanol was measured at 323.15 K and 0.1 MPa. The result was compared with the literature values.

Chapter 6 describes the measurement uncertainties.

Chapter 7 describes the behavior of the isobaric specific heat capacity of methanol-water mixtures based on the measurements of seven components in the temperature range between 280 K and 360 K and pressure up to 15 MPa.

Chapter 8 summarizes the results of this study.