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(p, ρ, T) properties, and apparent molar volumes V_ϕ of $ZnBr_2$ in methanol at T = (298.15 to 398.15) K and pressures up to p = 40 MPa

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Abstract

The (p, ρ, T) properties of pure methanol, the (p, ρ, T) properties and apparent molar volumes V_ϕ of $ZnBr_2$ in methanol at T = (298.15 to 398.15) K and pressures up to p = 40 MPa are reported, and apparent molar volumes have been evaluated. The experimental (p, ρ, T, m) values were described by an equation of state. For the solutions the experiments were carried out at molalities m = (0.05772, 0.37852, 0.71585 and 1.95061) mol · kg^{-1} of zinc bromide.

Keywords: Absorption refrigeration machine; Vibration tube densimeter; Methanol + $ZnBr_2$ solution; Equation of state; Apparent molar volume

1. Introduction

The absorption refrigeration machines and absorption heat pumps have received growing attention in recent years from the refrigeration and air-conditioning industry, especially the aspects of energy saving and environmental protection. The absorption cycle is a process by which refrigeration effect is produced through the use of two heat transfer fluids (refrigerant and absorbent) and some quantity of heat input, rather than electrical input as in the more common vapor compression cycle. The efficiency of an absorption refrigeration cycle is largely dependent on the physical and chemical properties of the heat transfer fluids. The heat transfer fluids of these systems should be thermally stable in the whole temperature range [1]. The reaction with metals, crystallization and corrosion of materials should be minimal. These systems widely use aqueous solutions of LiBr, LiCl, $ZnBr_2$, $CaCl_2$, *etc*. The most serious problems by using the conventional aqueous solutions of these salts as a heat transfer fluids are crystallization and corrosion. Moreover, it is impossible to obtain a refrigeration temperature below 277.15 K in these systems, working with the aqueous solutions of above mentioned salts. Using CH_3OH as refrigerant in absorption systems reduces these problems and can replace aqueous solutions at temperatures below the freezing point of water. Methanol shows a high heat

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of vaporization, low values for the density and heat capacity, and a low freezing temperature of 176.15 K. The application of methanol solutions of zinc bromide for absorption refrigerating machines and absorption heat pumps has been studied by Uemura [2].

The main purpose of these investigations was to study of the volumetric properties of new heat transfer fluids of absorption refrigeration and heat pump systems. In the present paper, the (p, ρ, T) properties of pure methanol, the (p, ρ, T) properties and apparent molar volumes V_ϕ of $ZnBr_2$ in methanol at $T = (298.15$ to $398.15)$ K, at pressures up to $p = 40$ MPa are reported. This paper is a continuation of our previous publication of the investigation of methanol solutions with electrolytes [3].

There is only one publication from Uemura [2] with densities of these solutions. Apparent molar volumes results were not found. However, it is necessary to investigate these solutions over a wide temperature and pressure range in order to understand their properties and provide accurate data for the absorption refrigerating machines and absorption heat pumps.

2. Experimental

The (p, ρ, T) properties were investigated using a high pressure – high temperature vibrating tube densimeter installation [4]. The apparatus was tested using density data of methanol, which is known with high accuracy

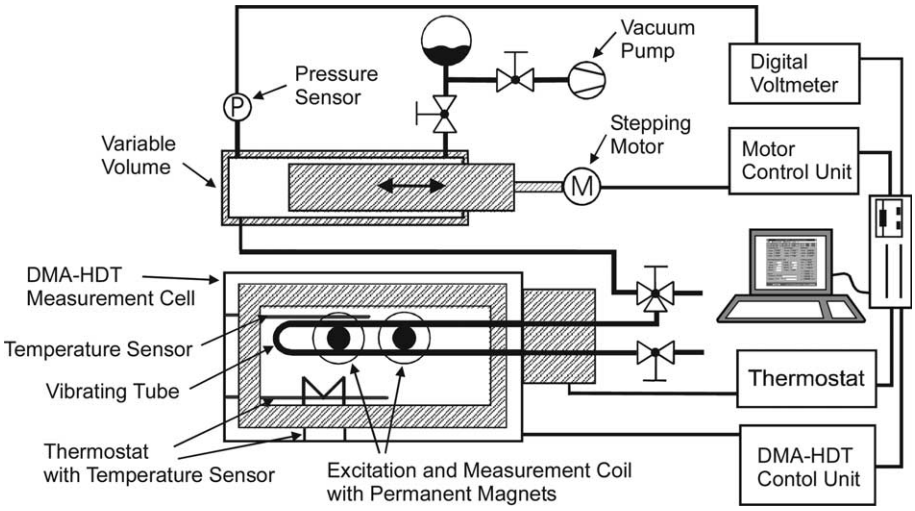

FIGURE 1. Schematic diagram of the computer-controlled density measurement unit.

TABLE 1
Experimental (p, ρ, T) values of CH_3OH

p/MPa	ρ/(kg · m^{-3})	p/MPa	ρ/(kg · m^{-3})	p/MPa	ρ/(kg · m^{-3})
$T = 298.26$ K		$T = 348.25$ K		$T = 398.28$ K	
0.235	785.98	0.366	737.29	0.934	680.93
5.000	790.69	4.987	743.46	4.984	689.00
9.999	795.40	9.986	749.65	9.998	697.91
15.013	799.88	14.991	755.42	14.986	705.88
19.987	804.10	20.004	760.84	19.987	713.16
25.008	808.17	25.020	765.94	24.992	719.87
29.997	812.04	30.013	770.76	29.991	726.11
34.991	815.76	34.989	775.32	35.005	731.99
39.981	819.34	40.000	779.70	40.004	737.47
$T = 323.22$ K		$T = 373.26$ K			
0.270	762.14	0.534	710.55		
4.990	767.53	4.983	717.67		
9.984	772.87	9.990	724.99		
14.982	777.91	14.998	731.69		
19.989	782.69	19.985	737.88		
24.986	787.21	24.994	743.68		
29.995	791.53	29.997	749.13		
34.987	795.64	35.001	754.27		
39.993	799.60	39.996	759.14		