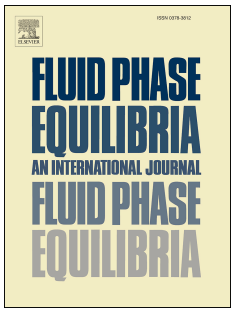
Accepted Manuscript



Vapour pressure measurements of ammonia/ionic liquids mixtures as suitable alternative working fluids for absorption refrigeration technology

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PII: S0378-3812(18)30005-0

DOI: 10.1016/j.fluid.2018.01.006

Reference: FLUID 11717

To appear in: *Fluid Phase Equilibria*

Received Date: 25 October 2017

Revised Date: 4 January 2018

Accepted Date: 5 January 2018

Please cite this article as: A. Cera-Manjarres, D. Salavera, A. Coronas, Vapour pressure measurements of ammonia/ionic liquids mixtures as suitable alternative working fluids for absorption refrigeration technology, *Fluid Phase Equilibria* (2018), doi: 10.1016/j.fluid.2018.01.006.

Vapour pressure measurements of ammonia/ionic liquids mixtures as suitable alternative working fluids for absorption refrigeration technology

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Abstract

In the present paper, we report new data on the vapour pressure of ammonia with 1-(2-hydroxyethyl)-3-methylimidazolium tetrafluoroborate [EtOHmim][BF_4], 1-(2-hydroxyethyl)-3-methylimidazolium bis(trifluoromethylsulfonyl)imide [EtOHmim]-[Tf_2N], choline bis(trifluoromethylsulfonyl)imide [$N_{111(2OH)}$][Tf_2N], and trimethyl-N-propylammonium bis(trifluoromethylsulfonyl)imide [N_{1113}][Tf_2N]. The vapour pressure of the ionic liquid (IL) mixtures with ammonia was measured from 293.15 to 373.15 K at five compositions (from ~0.219 to 0.954 mol of ammonia) using a static method. The presence of a hydroxyl group in the cation structure of the ILs enhances the ammonia solubility. Experimental measurements of vapour pressure for ammonia/IL mixtures were correlated using an Antoine type equation and the Non-Random Two-Liquids (NRTL) model. Estimated values using both models presented root mean square deviation values lower than 10%. Excess Gibbs energy was calculated from the activity coefficients and the results were analysed as criteria for selecting the most suitable IL as absorbent for ammonia. Also, to evaluate the suitability of the studied binary mixtures as a working fluid, their vapour pressure (calculate using the Antoine equation) was compared with the most common salts used for this application to observe their deviation from Raoult's law. The data obtained from the analysis of the g^E–x relationship and the deviation from Raoult's law for each system suggests that the most suitable absorbent for ammonia is [EtOHmim][BF_4].

Keywords: Ammonia, Ionic liquids, Vapour pressure, NRTL, Absorption Refrigeration Technology

1. Introduction

Absorption refrigeration is a technology that is undergoing continuous growth, because it allows the recovery and upgrading of thermal wastes, the use of renewable sources, and the reduction of CO_2 emissions [1-3]. One of the most frequently used working fluid mixtures (refrigerant/absorbent) in absorption refrigeration is ammonia (NH_3)/water (H_2O) [4]. Nevertheless, low relative volatility of the compounds requires the use of a rectification column to separate the two components to prevent the passage of water into the refrigerant circuit, which could decrease the performance of the system. Many works have been dedicated to solving this significant limitation of NH_3/H_2O and various strategies have been proposed. One of them consists of the replacement of water by another non-volatile absorbent, which could eliminate the need to use a rectifier column. In this sense, two of the most common salts proposed as absorbents to replace the water in binary mixtures with ammonia are lithium nitrate