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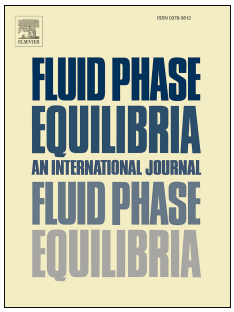

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Separation of Acetonitrile + Ethanol Mixture Using Imidazolium - Based Ionic Liquids as Entrainers

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Abstract:

Three imidazolium-based ionic liquids: 1-methy-3-methylimidazolium dimethylphosphate ([MMIM][DMP]), 1-ethyl-3-methylimidazolium diethylphosphate ([EMIM][DEP]) and 1-butyl-3-methylimidazolium dibutylphosphate ([BMIM][DBP]) were used as entrainers to separate acetonitrile + ethanol mixtures. Isobaric vapor-liquid equilibrium (VLE) data were measured at 101.3 kPa. Addition of ionic liquids (ILs) produced a crossover effect on the VLE of the acetonitrile + ethanol system and the azeotropic phenomenon of acetonitrile and ethanol could be eliminated as the mole fraction of ionic liquids reaches a certain value. The separation performance of the three ILs follows the order of [BMIM][DBP] > [EMIM][DEP] > [MMIM][DMP]. Finally, the experimental VLE data were well fitted with the nonrandom two-liquid (NRTL) model.

Keywords:

Vapor-liquid equilibrium; ionic liquids; acetonitrile; ethanol; NRTL model.

1. Introduction

Acetonitrile and ethanol are extremely important organic solvents and synthesis additives [1–3], which are widely used as fine chemicals in chemical, pharmaceutical and textile industries [4–6]. Acetonitrile and ethanol always coexist in some pharmaceutical and chemical production processes. For example, in the production of acetonitrile using ethanol [7-8], acetonitrile and ethanol are mixed together, which needs to be treated to recycle acetonitrile and ethanol. Unfortunately, it is very difficult for conventional distillation to efficiently separate the mixture of acetonitrile and ethanol due to the minimum azeotrope formed at atmospheric pressure. Several special distillation techniques have been proposed to separate azeotropes. Examples are azeotropic distillation, pressure-swing distillation, reactive distillation, extractive distillation, liquid-liquid extraction, and membrane separation. Among those techniques, extractive distillation is a preferred method in industry as it has the advantages of high separation efficiency, easy operation and high capacity. The key to extractive distillation is the selection of competent entrainers [9–13]. Conventional entrainers such as organic solvents [14] and inorganic salts [15] have been employed to separate azeotropes. However, they cannot be easily recycled and also bring up problems of pollution to environment and corrosion to equipment and pipelines.

In the last few years, ionic liquids (ILs) as entrainers have attracted much attention due to their unique physicochemical properties such as extremely low vapor pressure, being liquid at wide temperature range, and high thermal and chemical stability [16–21]. These make it easy to recycle ionic liquids after separation processes. In addition, the properties of ILs can be adjusted by judicious combination or appropriate modification of cations and anions. Obviously, ILs have unique advantages over classical entrainers. Thus, ionic liquids are increasingly used as entrainers to separate a wide range of azeotropes, such as