



Enhanced separation of benzene and cyclohexane by homogeneous extractive distillation using ionic liquids as entrainers



Miguel Ayuso^a, Andrés Cañada-Barcala^a, Marcos Larriba^a, Pablo Navarro^b,
Noemí Delgado-Mellado^a, Julián García^{a,*}, Francisco Rodríguez^a

^a Department of Chemical Engineering, Complutense University of Madrid, E-28040 Madrid, Spain

^b Department of Chemical Engineering, Universidad Autónoma de Madrid, 28049 Madrid, Spain

ARTICLE INFO

Keywords:

Cyclohexane/benzene separation
Extractive distillation
Ionic liquids
Vapor-liquid equilibria
NRTL

ABSTRACT

The worldwide production of cyclohexane is mainly carried out through the hydrogenation of benzene. Unreacted benzene is separated from produced cyclohexane, being one of the most challenging processes in the petrochemical industry due to their extremely close boiling points and the presence of an azeotrope. In this work, an experimental screening of seven ionic liquids has been done in order to check the suitability of the extractive distillation with ionic liquids. The vapor-liquid or vapor-liquid-liquid equilibria (VLE/VLLE) of {cyclohexane/benzene + ionic liquid} binary systems and {cyclohexane + benzene + ionic liquid} ternary systems have been determined by Headspace-Gas Chromatography technique. The Non-Random Two Liquids (NRTL) thermodynamic model has been used to fit the experimental VLE/VLLE accurately. Although all the selected ionic liquids enhanced the cyclohexane/benzene relative volatility ($\alpha_{1,2}$) in comparison with conventional solvents, the [4bmpy][TCM] was chosen and implemented in Aspen Plus to simulate the extractive distillation process of benzene from cyclohexane with ionic liquids. The associated operating costs and the energy savings in comparison with conventional process, using *N*-methyl-2-pyrrolidone (NMP) as solvent, show that the extractive distillation with the [4bmpy][TCM] ionic liquid improves the conventional process, standing as an enhancer technology in the field.

* Corresponding author.

E-mail address: jgarcia@quim.ucm.es (J. García).

<https://doi.org/10.1016/j.seppur.2020.116583>

Received 18 October 2019; Received in revised form 8 January 2020; Accepted 16 January 2020

Available online 17 January 2020

1383-5866/ © 2020 Elsevier B.V. All rights reserved.