Removal of citric acid from water by tributyl amine in octyl acetate: equilibrium and optimization by central composite design

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ABSTRACT

Citric acid is one of the most important natural organic acid and extensively used in pharmaceuticals, foods, beverages, personal care products and mainly manufactured in the form of aqueous solutions by fermentation processes. In this study, the removal of citric acid from aqueous solutions was investigated by reactive extraction using an extractant namely tributylamine (TBA) in octyl acetate. The effects of different parameters on the removal such as initial extractant (TBA) concentration in octyl acetate (0–1.2 mol L^{-1}), initial citric acid concentration (0.26–0.78 mol L^{-1}) and, organic: aqueous phase ratio (0.2–1.0 v/v) were examined. In order to evaluate the performance of reactive extraction operation, extraction efficiencies ($E\%$), distribution coefficients (D) and loading factors (Z) were calculated by using the experimental data. Furthermore, an optimization work was carried out for the reactive extraction process of citric acid. Response surface methodology was used to optimize the effect of input variables on the reactive extraction. In the variables examined, it was determined that the initial TBA concentration in the organic phase was the most effective parameter for the removal of citric acid from aqueous solutions. The optimum extraction conditions were found to be initial TBA concentration in the organic phase of 1.2 mol L^{-1}, the initial citric acid concentration of 0.26 mol L^{-1} and organic: aqueous phase ratio of 1.0 (v/v), respectively. Under these optimum conditions, the predicted and experimental extraction efficiencies were obtained as 86.31% and 82.44%, respectively. The correlation coefficient values (R^2 and adjusted $R^2 > 0.9$) denoted that the obtained model equation represents the experimental data adequately.

Keywords: Citric acid; Reactive extraction; Octyl acetate; Tributyl amine; Central composite design

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