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# The molar surface Gibbs energy and its application to the binary mixtures of *N*-butylpyridinium dicyanamide [C<sub>4</sub>py][DCA] with alcohols

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## ABSTRACT:

The density and surface tension for the binary mixtures of ionic liquid (IL) [C<sub>4</sub>py][DCA] with ethanol, 1-propanol and 2-propanol were measured across the entire range of mole fraction ( $x_1 = 0.0000$  to  $1.0000$ ) at  $T = (288.15 \text{ to } 318.15)$  K. The average molar volume and the thermal expansion coefficient of the binary mixtures were calculated from the experimental density. The excess molar volumes,  $V^E$ , of the binary mixtures were also calculated and well fitted by Redlich–Kister equation. The obtained  $V^E$  are negative values over the whole composition range. The values of  $V^E$  are related to the alcohol chain length and temperature. In order to predict the surface tension of the mixtures, the new function — the molar surface Gibbs energy of mixtures was obtained from Li's model improved by us in this work. So, the molar surface Gibbs energy,  $g_s$ , and its excess function,  $g_s^E$ , of mixtures for [C<sub>4</sub>py][DCA] with ethanol, 1-propanol and 2-propanol were calculated. The excess molar surface Gibbs energy,  $g_s^E$ , was well fitted by Redlich–Kister equation. In terms of the Redlich–Kister's parameters, a new method for predicting the surface tension,  $\gamma$ , of the mixtures is proposed and the predicted values,  $\gamma$  (pre.), are in good agreement with the corresponding experimental ones,  $\gamma$  (exp.). On a basis of molar surface Gibbs energy of mixtures, a new Eötvös equation was obtained and applied to binary mixtures of [C<sub>4</sub>py][DCA] with alcohols. The absolute value of the slope of the new Eötvös equation is the mole surface entropy,  $s$ , and the intercept is the molar surface enthalpy,  $h$ , which is temperature-independent.

**Keywords:** *N*-butylpyridinium dicyanamide; Ionic liquid; Binary mixture; Molar surface Gibbs energy; Excess function

## 1. Introduction

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