

Continuous fractionation of glycerol acetates. Physicochemical properties glycerol acetates + CO₂ mixtures at high pressure

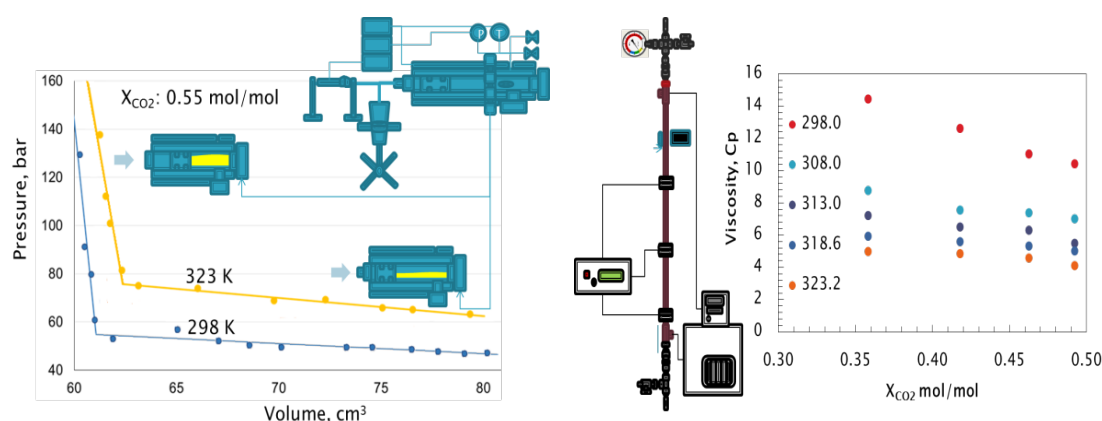
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GRAPHICAL ABSTRACT



ABSTRACT

Glycerol acetates are high-added value biosurfactants that find applications in different industrial sectors. Previous studies show the supercritical CO₂ technology has a great potential for the fractionation of these highly viscous, amphiphilic, and non-volatile products (mono, di, and triacetyl glycerol) according to the quality standards of the food and cosmetic industry [1-3]. A proper design of fractionation columns and their further scale-up to commercial scale requires a robust thermodynamic model for phase equilibrium and PVT predictions [4], as well as proper correlations for physical properties like viscosity to assess the mass transfer and estimate the height of theoretical stages [5]. Physicochemical properties of these multicomponent mixtures are difficult to predict due to the complex nature of this system [6]. Thus, in this work, we determine experimentally the density and viscosity of CO₂ saturated glycerol acetates mixtures at different pressures (30 bar to 150 bar), temperatures (25 °C to 50 °C) and CO₂ concentrations (30 mol % to 70 mol %). Operating conditions were selected based on phase equilibrium predictions with the GCA-EOS of a high-pressure fractionation column [2]. First, a variable volume equilibrium cell is used to measure bubble points and saturated liquid molar volumes of glycerol acetates + CO₂ mixtures. Thereafter, a high-pressure falling ball type viscometer is used to determine the dynamic viscosity of saturated liquid mixtures in the same range of pressure, temperature and CO₂ concentrations.

As it is well known, temperature and CO₂ concentration has a significant effect on both density and viscosity measurements (Figure 1 and 2). The measured molar volumes are between 70 cm³/mol and 130 cm³/mol, while the viscosities are between 5 mPa.s and 20 mPa.S, according to CO₂ concentration and temperature. Molar volume of saturated liquid mixtures increases slightly with temperature at a given CO₂ concentration and it decays drastically with CO₂ concentration at constant temperature (Figure 1). Viscosity of saturated liquid mixtures is significantly affected by both variables. The presence of CO₂ in the liquid mixture reduces the viscosity and this effect is more evident at temperatures lower than CO₂ critical temperature. Viscosity of the saturated glycerol acetates + CO₂ liquid mixtures follows the relationship proposed by Litovitz et al [7], it decays exponentially with temperature wherever the CO₂ concentration in the system.

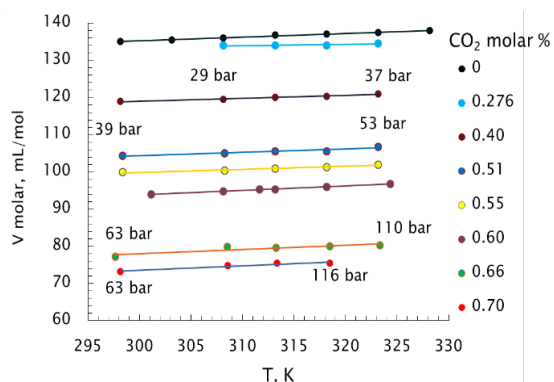


Figure 1. Molar volume of glycerol acetates + CO₂ saturated liquid mixtures. Effect of temperature and CO₂ concentration.

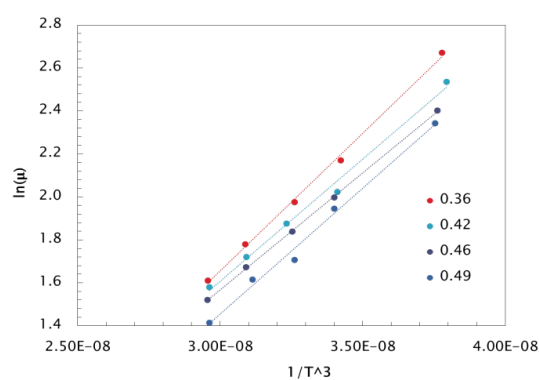


Figure 2. Viscosity of glycerol acetates + CO₂ saturated liquid mixtures. Effect of temperature and CO₂ concentration.

ACKNOWLEDGEMENTS

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REFERENCES

- [1] M. Fortunatti-Montoya, F.A. Sánchez, P.E. Hegel, S. Pereda, *The Journal of Supercritical Fluids*, Vol. 132, 51-64, 2018.
- [2] M. Fortunatti-Montoya, F.A. Sánchez, P.E., Hegel, S. Pereda, *The Journal of Supercritical Fluids*, Vol. 153, 104575, 2019.
- [3] M. Rezayat, H. Ghaziaskar, *The Journal of Supercritical Fluids*, Vol. 55(3), 937-943, 2011.
- [4] E.A. Brignole, S. Pereda, *Phase equilibrium engineering (Vol. 3)*. Newnes, *Supercritical Fluid Science and Technology Series*. Ed (Erdogan Kiran). Elsevier, Amsterdam, The Netherlands, 2013.
- [5] G. Brunner, *The journal of supercritical fluids*, Vol. 47(3), 574-582, 2009.
- [6] B.E. Poling, J.M. Prausnitz, J.P. O'connell, *The properties of gases and liquids (Vol. 5)*. New York: McGraw-hill, (2001).
- [7] A. T. Litovitz, *The Journal of Chemical Physics*, Vol. 20(7), 1088-1089, 1952.