OP 06

Controlling the CO_2-lipid liquid phase separation via process tuning and lipid structural design

Authors and affiliation

Ying-Chieh Hung[1], Yuna Tatsumi[1], Chieh-Ming Hsieh[2], Shiang-Tai Lin[3], and Yusuke Shimoyama[*,1]

[1] Department of Chemical Science and Engineering, Tokyo Institute of Technology, S1-33 2-12-1 Ookayama, Meguro-ku, Tokyo, 1528550, Japan

[2] Department of Chemical and Materials Engineering, National Central University, Taoyuan 32001, Taiwan

[3] Department of Chemical Engineering, National Taiwan University, Taipei 10617, Taiwan

*E-mail: yshimo@chemeng.titech.ac.jp

Key Word

Volume expansion, Supercritical CO_2, Thermodynamics modeling

Abstract

The volume expansion of organic solvent at near critical and supercritical CO_2 ($ScCO_2$) is a critical property for designing and optimizing $ScCO_2$-mediated process. The lipid expansion behavior in the $ScCO_2$ is found to be a dominant factor toward $ScCO_2$ ani-solvent precipitation process, liposome capsule production using $ScCO_2$, and $ScCO_2$ assisted lipid extraction process[1-5]. In this work, the oleic acid, linoleic acid, and 1-octadecene are selected to perform measurement of liquid volume expansion during CO_2 pressurization at a pressure–volume–temperature (PVT) cell with visible window, to investigate the role of carboxyl group and double bond to CO_2 dispersion behavior in the lipid at pressure range of 5 MPa to 20 MPa, temperature range of 308 K to 338 K.

It is found that the dispersion behavior of CO_2 in the liquid phase is dominated by the carboxyl group on the lipid. The temperature and pressure dependent liquid expansion in CO_2 environment is reasonably fitted by Peng-Robinson equation of state combining with Wong-Sandler mixing. From analysis of molecular σ-profile, carboxyl group and double bond shows strong and weak hydrophilic character, respectively. Both functional groups are disadvantage of CO_2 dispersion into liquid lipid, leading to CO_2-lipid phase separation at high pressure region (P > 15MPa).

References

[1] C. Dejoye, M.A. Vian, G. Lumia, C. Bouscarle, F. Charton, F. Chemat, Combined Extraction Processes of Lipid from Chlorella vulgaris Microalgae: Microwave Prior to Supercritical Carbon Dioxide Extraction, International Journal of Molecular Sciences, 12 (2011) 9332-9341.

[2] C. Pando, A. Cabañas, I.A. Cuadra, Preparation of pharmaceutical co-crystals through sustainable processes using supercritical carbon dioxide: a review, RSC Advances, 6 (2016) 71134-71150.

[3] C. Brandenbusch, B. Bühler, P. Hoffmann, G. Sadowski, A. Schmid, Efficient phase separation and product recovery in organic-aqueous bioprocessing using supercritical carbon dioxide, Biotechnology and Bioengineering, 107 (2010) 642-651.

[4] A. Tabernero, E.M. Martín del Valle, M.A. Galán, Supercritical fluids for pharmaceutical particle engineering: Methods, basic fundamentals and modelling, Chemical Engineering and Processing: Process Intensification, 60

(2012) 9-25.
[5] I. Pasquali, R. Bettini, F. Giordano, Supercritical fluid technologies: An innovative approach for manipulating the solid-state of pharmaceuticals, Advanced Drug Delivery Reviews, 60 (2008) 399-410.