Using solvent additives in melt crystallization of high-viscous organic mixtures

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The increasing demand for energy efficiency, food security and global warming related issues are leading to move globally towards renewable resources. Employment of biorefinery strategies can provide the opportunity of a more sustainable global development along with economic values[1]. The present work focuses on the development of a separation method in the general downstream processing of biorefinery products.

Separation and purification processes contribute significantly to the production of high quality, renewable raw material and overall performance of biorefineries. Various separation technologies are utilized to obtain high product purities of organic substances. Distillation is one of the most widely used purification methods. However, in case of azeotropic forming compound systems, required high purity levels cannot be obtained by distillation. The alternative hybrid distillation/melt crystallization technique offers the advantages of separating such mixtures to any required product purity with low energy consumption[2].

Crystallization from melts is usually conducted as cooling crystallization. The corresponding design of such a process as a chemical unit operation requires deep knowledge about mass and heat transfer in order to achieve optimal overall efficiency and product yield. Although melt crystallization is usually governed by heat transfer, also the effect of mass transfer resistance on crystal growth rate can be significant when mixtures exhibit high viscosities. Former publication have shown that the best crystallization product quality is obtained when the mass transfer rates are at an appropriate level related to the crystal growth rate[3]. Hence, a proper additive may aid

the process by reducing the viscosity of the mixture without considerably changing the melting point depression.

The aim of the present study is, therefore, to assess the role of mass and heat transfer on crystal growth kinetics. The experiments were performed to evaluate the possible solvents of low concentrations, which likely influence crystal growth rate by reducing the viscosity of binary glycol mixtures. The melting temperature of the system at different compositions were estimated by using a UNIFAC thermodynamic model. The viscosity was measured with Anton Paar Physica MCR 301 rheometer at shear rates ranging from 60 to 100 s^{-1}. General operation parameters of layer melt crystallization and their impact on the separation of the targeted component were investigated based on lab-scale experiments.

The obtained data for viscosity reduction of the potential solvents contribute to further development of the proposed process by studying influencing factors of the solvent attributed to the separation efficiency of melt crystallization such as melting point depression of multicomponent systems, crystal growth rate and distribution coefficient of impurities under various growth conditions.

References

(1) Motola, V.; Bari, I. de; Pierro, N.; Giocoli, A. *Bioeconomy and biorefining strategies in the EU Member States and beyond*.

(2) Li, C.; Zhou, Y.; Su, W.; Wang, H. Research Progress of Hybrid Distillation/Crystallization Technology. *Chem. Eng. Technol.* 2018, *41* (10), 1894–1904. DOI: 10.1002/ceat.201700675.

(3) Eisenbart, F. J.; Ulrich, J. Solvent-aided layer crystallization—Case study glycerol–water. *Chemical Engineering Science* 2015, *133*, 24–29. DOI: 10.1016/j.ces.2014.12.060.

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