Separation and purification of high-value products by melt crystallization

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Introduction

The potential advantages of melt crystallization as a separation method make it a suitable candidate as a downstream purification technique in bioprocesses. To successfully implement this method, this work aims to evaluate potential modification and optimizations required according to system's fundamental thermodynamics and kinetics.

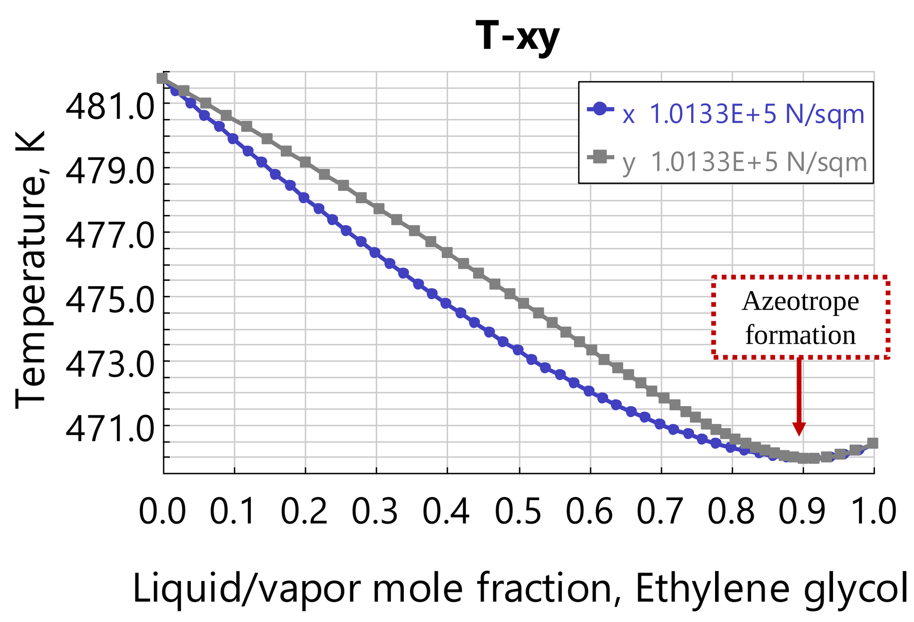
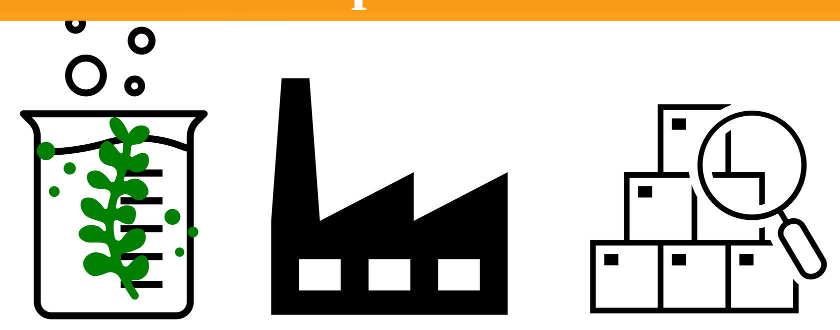


Figure 1. Predicted VLE diagram of ethylene glycol/1,2-pentanedol mixture using Aspen plus V12.1

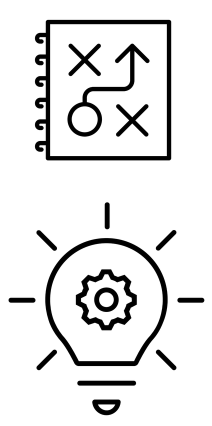
Conversion of biomass to plant-based products



Plant-based non-food material

Glycols, glycerol and sugar alcohols with co-produced impurities

Downstream purification



Challenges and limitations of individual techniques

Developing new complementary techniques

Approach

- The overall efficiency of the process was evaluated in both solvent-free and solvent-aided case studies by examining the effect of the solvent on non-ideal behavior of the system and crystal growth kinetics.
- Predictive UNIFAC Dortmund model and semi-empirical NRTL model were used to calculate thermodynamic driving force for crystallization

$$\frac{\Delta\mu}{RT} = \ln\left(\frac{a}{a^*}\right) = \ln\left(\frac{x_i\gamma_i}{x_i^*\gamma_i^*}\right)$$

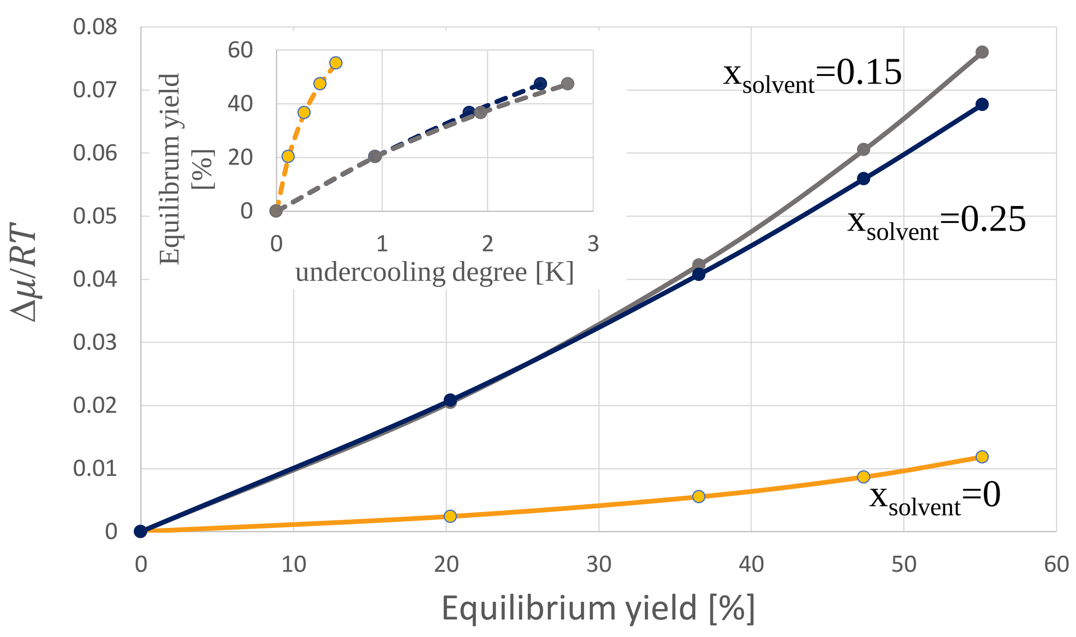
- Crystallization kinetics were measured in **layer melt crystallization** method as a suitable technique for relatively high viscosity melts

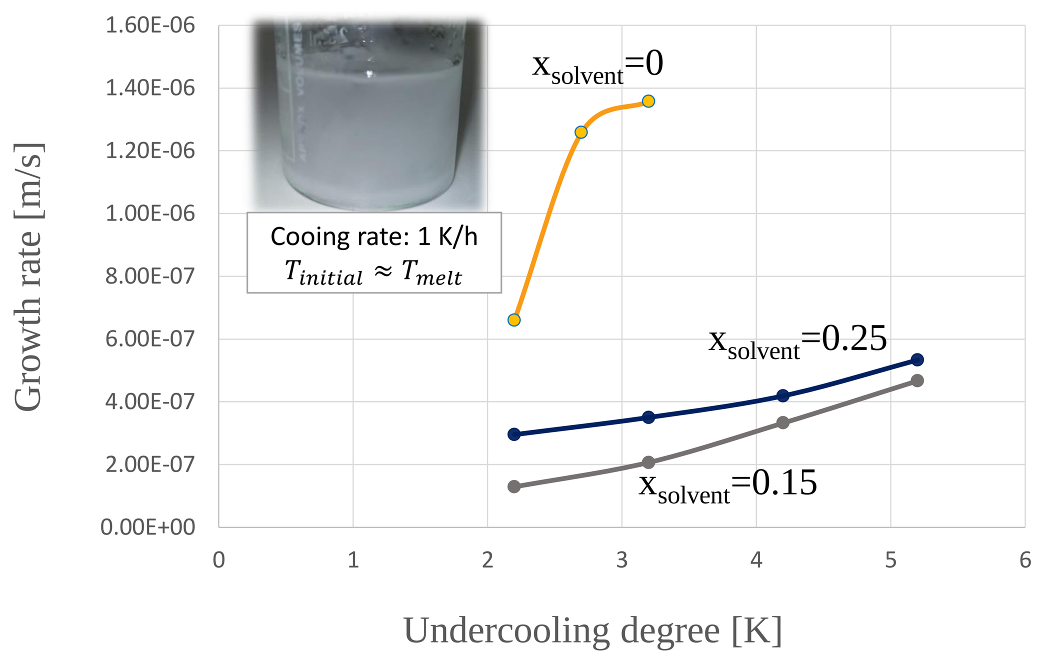
Thermodynamics: effect of solvent on required driving force to obtain same equilibrium yield

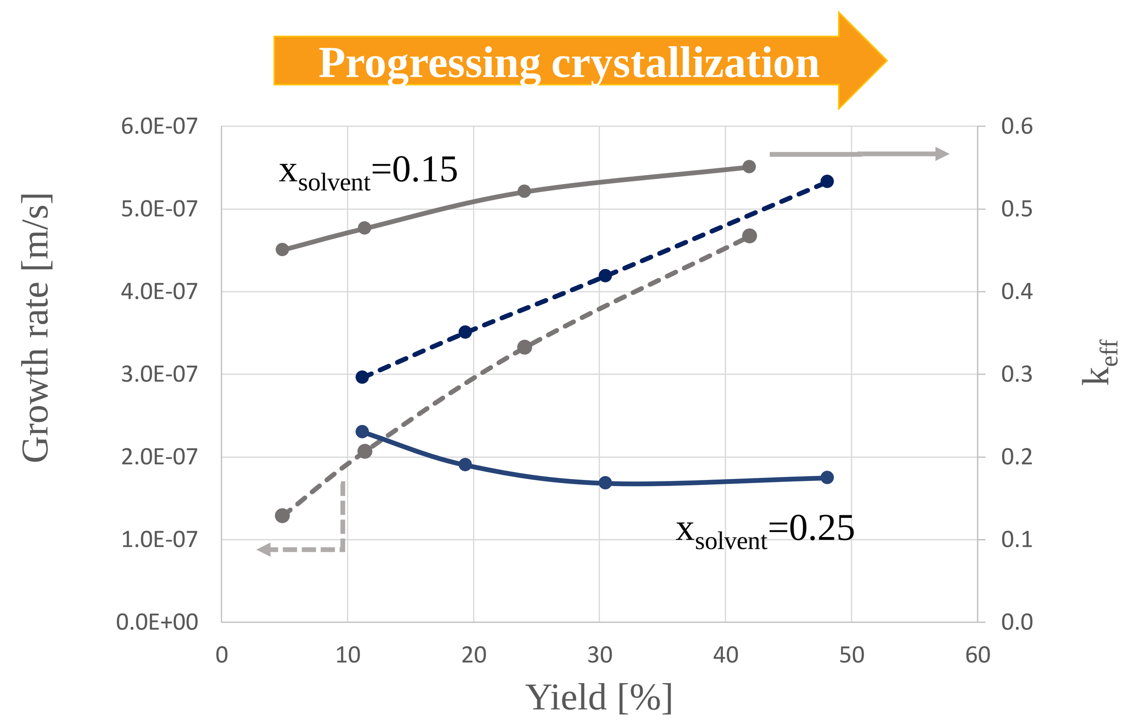
Different kinetic responses to additives

Maintaining purity level at high yield (solvent-aided)

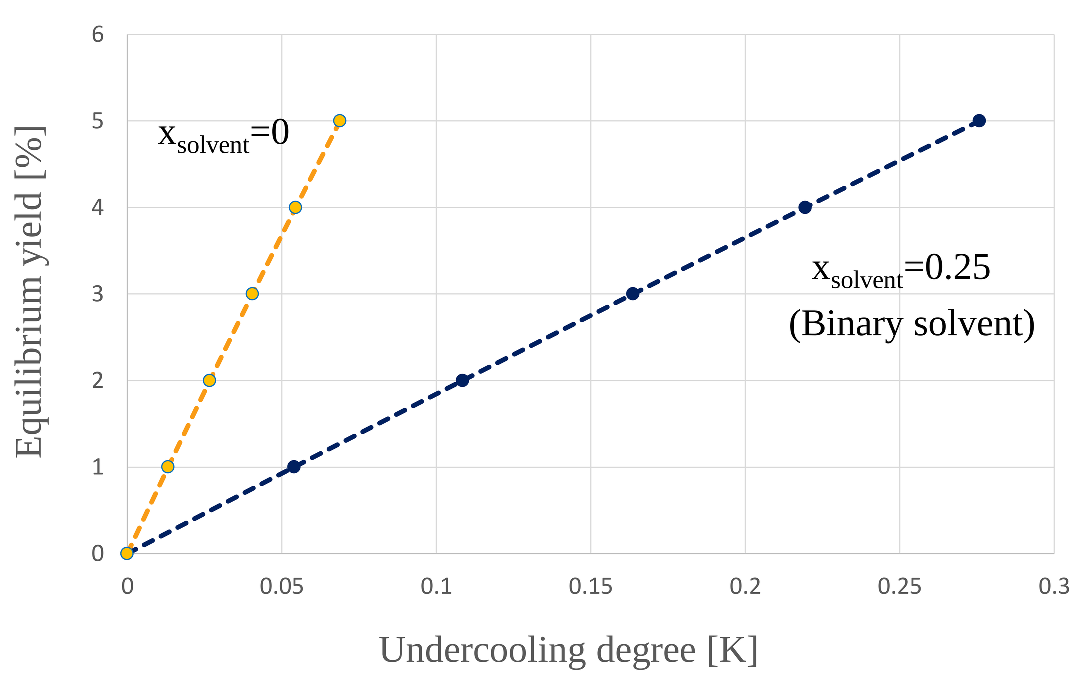
MEG

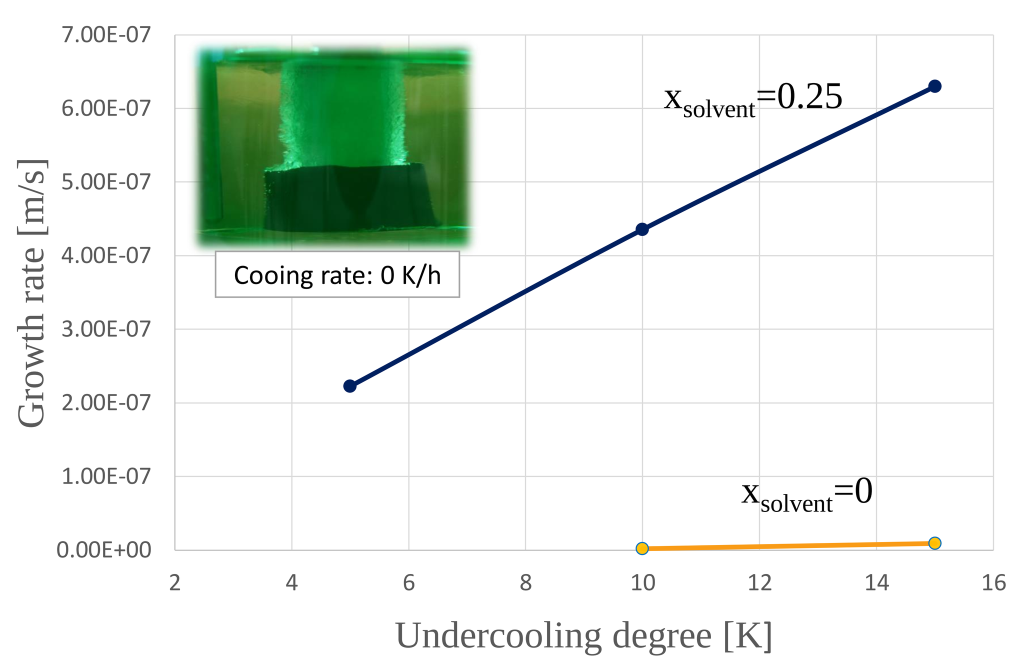


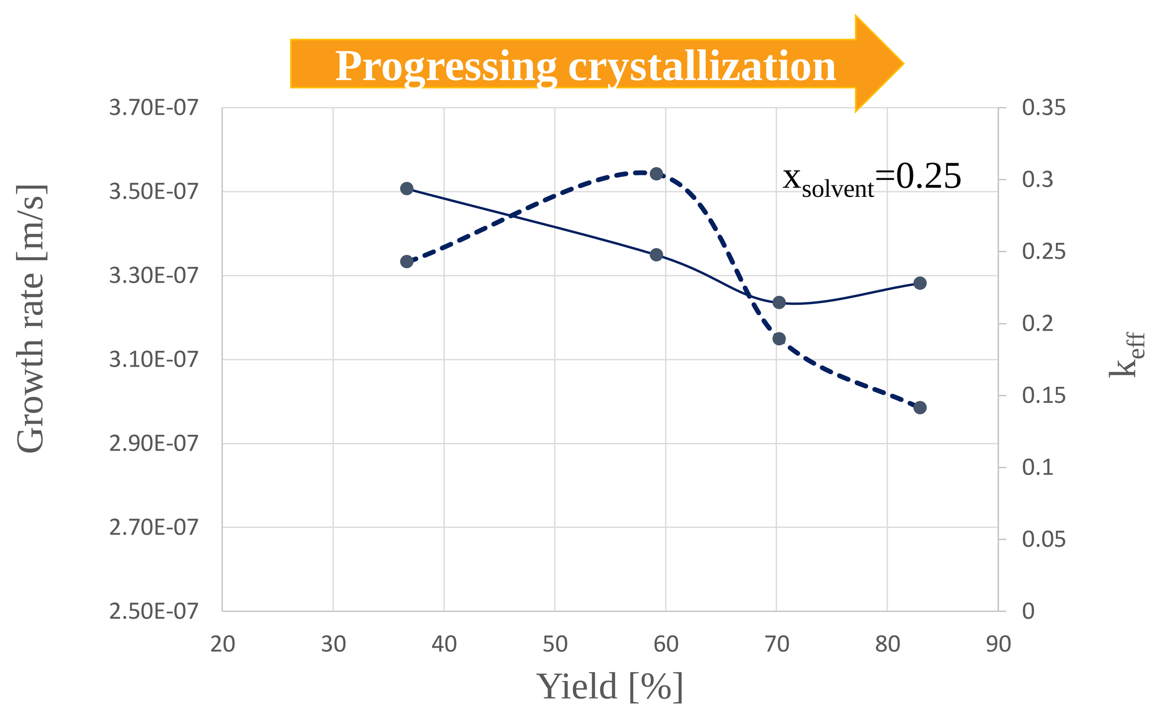




Glycerol







Conclusion

- Solvent-aided layer melt crystallization shows high separation efficiency in purification of relatively high viscosity polyols and diols.
- The addition of solvent in both systems increased the driving force required to obtain the same equilibrium as the solvent-free melt.
- The effect of the solvent on crystal growth rate varies depending on the studied system. This may imply that the interfacial kinetics plays an important role in the crystal growth rate.
- Higher concentration of solvent enhances the purification efficiency and maintains the purity level at high crystallization yield.

Aknowledgment

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