Simulations of mother liquor and crystal suspension flows in baffled stirred tank crystallizer

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Introduction

•**Tank Dynamics:** Industrial crystallization employs baffled stirred tanks, where fluid and particle flow hinges on rheology. Mixing conditions directly impact crystallization kinetics and crystal size due to factors like geometry, impeller speed, and rheology.

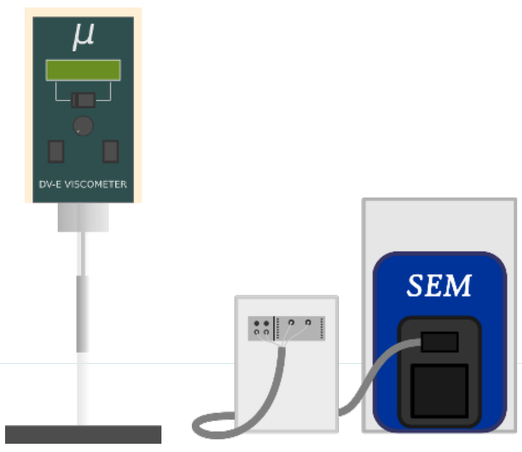
•**Mixing Insights:** VisiMix software calculates key mixing attributes like energy dissipation, crystal collision energy, power numbers for mass transfer, enabling process optimization and up-scaling simulations.

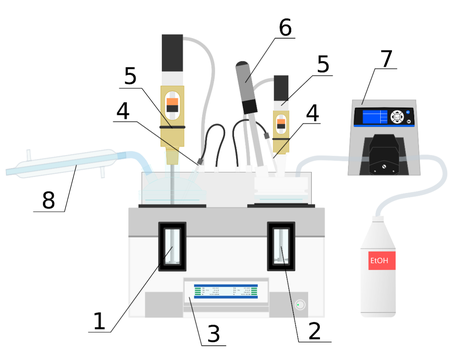
•**Scaling Study:** Investigating erythritol and xylitol cooling crystallization from 40 °C to 20 °C, maintaining tip speed and energy. Xylitol's solubility leads to higher viscosities. Comparison of suspension mixedness during nucleation and crystallization end.

Research methodology

1) Empirical laboratory-scale studies:

Viscosity, solubility, density, PSD measurements and crystallization trials





EasyMax 402 crystallization system: 1 – 400 mL reactor, 2 – 100 mL reactor, 3 – control panel, 4 – thermocouples, 5 – stirrers, 6 – FBRM, 7 – peristatic pump, 8 – condenser

2) **Simulations at stirred tank**

VisiMix software was used for:

Up-scaling Simulations from 100 mL to 1 L, 1 m^3, and 100 m^3

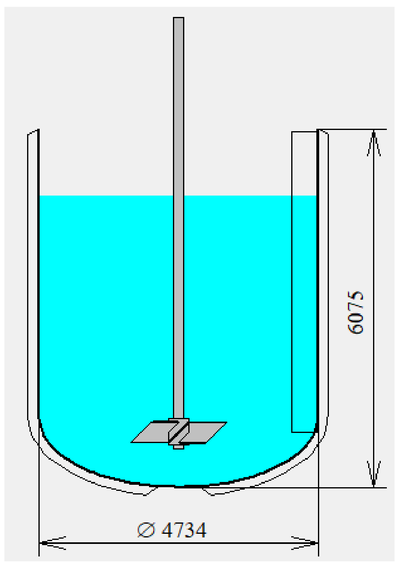
Process optimization;

Calculations that include:

-Energy Dissipation

-Crystal Collision Energy

-Mass Transfer

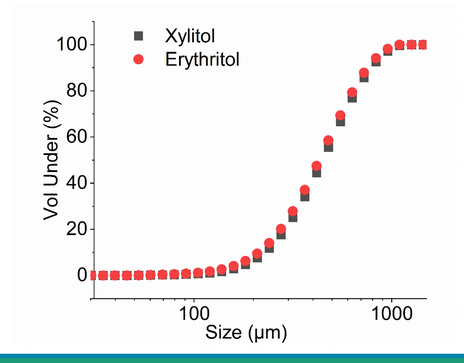


Results and discussions

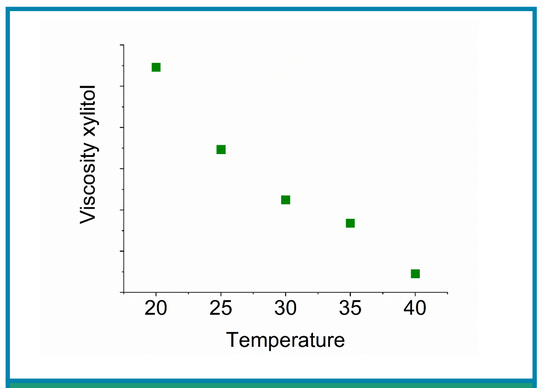
•Xylitol highly soluble, leading to high viscosity in saturated solutions

•Erythritol solutions remain non-viscous when saturated

•Viscosity played a crucial role in mass and heat transfer efficiency, affecting crystal growth kinetics.



PSD measurement results

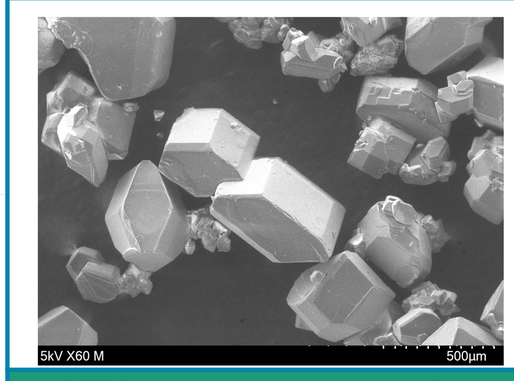


Apparent viscosity of xylitol during crystallization

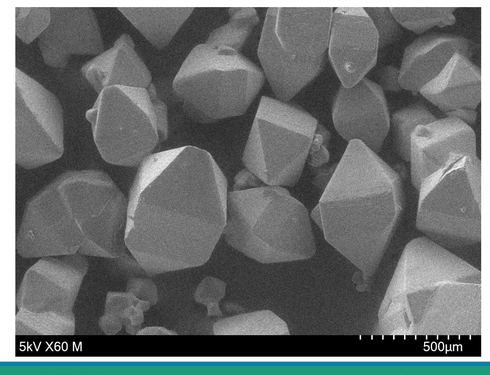
•Studied scaling-up erythritol and xylitol batch cooling crystallization from 40°C to 20°C

•Maintained constant tip speed/energy dissipation

•Used VisiMix software to calculate mixing characteristics (dissipation energy, TIP speed, etc.)



SEM measurement results - erythritol



SEM measurement results - xylitol

An example of an up-scaling calculation:

Tank volume, m^3	**1**	**100**
Rotation speed, rpm	100	26.1
Impeller tip velocity, m/s	1.83	1.83
Average energy dissipation, W/kg	0.189	0.0410
Maximum local energy dissipation rate, W/kg	7.62	1.60
Turbulent shear rate near the impeller blades, 1/s	1620	750
Micromixing time, s	9.60	21
Impeller Reynolds number	69800	3200000

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