Optimal design of continuous crystallizers

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Scope of the project IMPROVISE

Closing the gap between offline and online use of rigorous process models in daily operation of chemical plants.

www.ISPT.eu/media/PSE-20-01-IMPROVISE.pdf

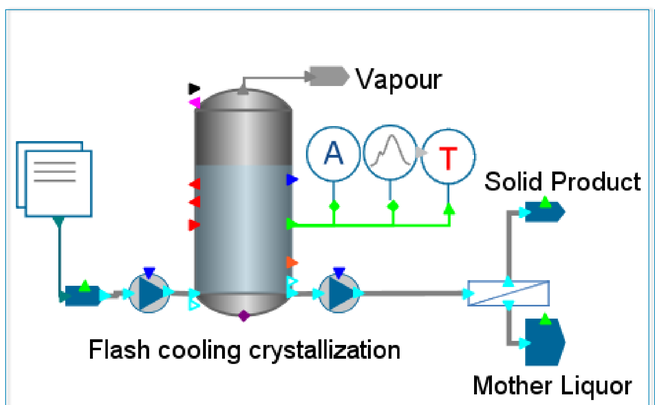
Project goals with respect to crystallization

- Batch crystallization operation and modelling studies.
- Online model-based monitoring and control.
- **Optimal design of continuous crystallizers.**

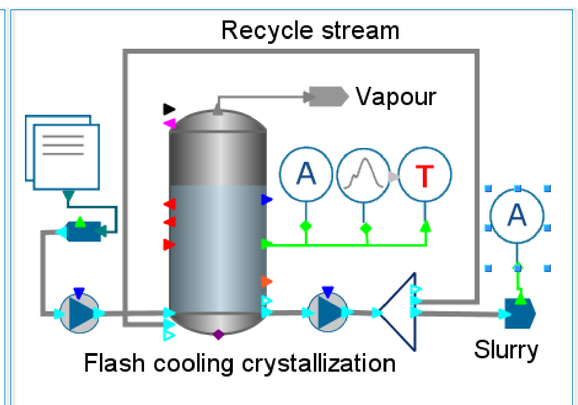
Motivation

Overcome typical drawbacks of the (semi) batch operation (low batch to batch reproducibility, controllability, observability, and scale up problems).

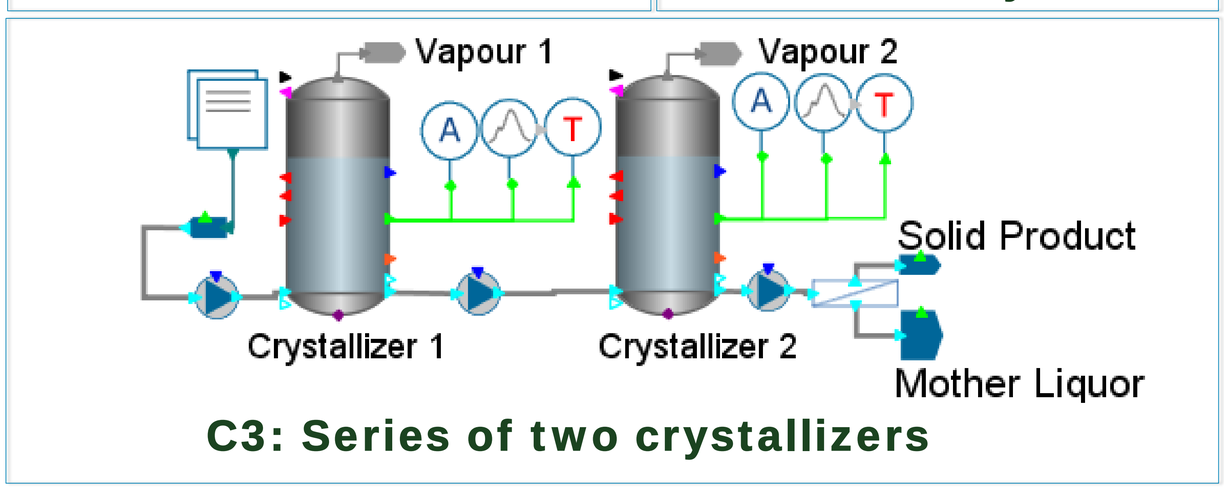
Process configurations under study



C1: Single MSMPR

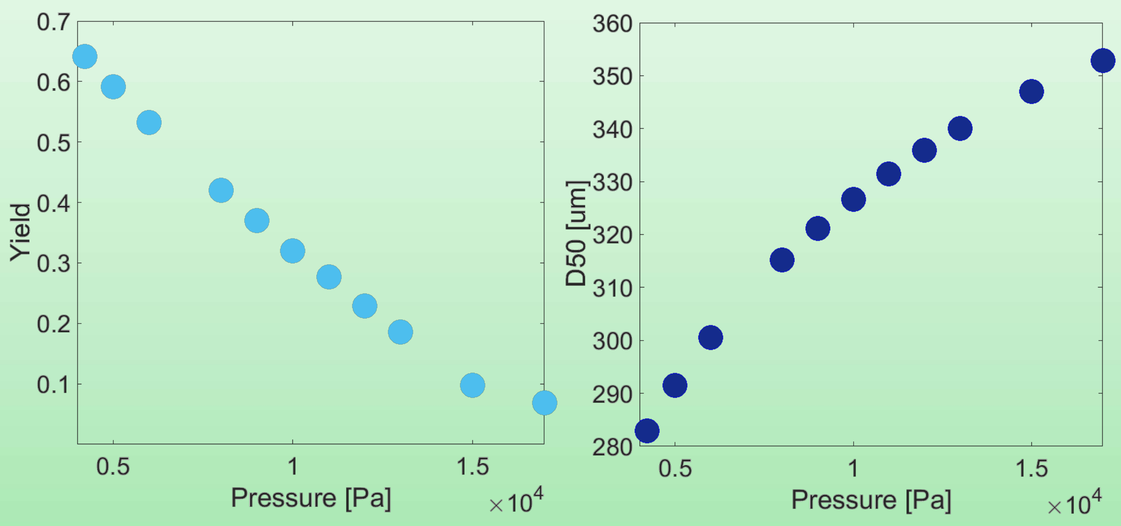


C2: Single MSMPR with recycle



C3: Series of two crystallizers

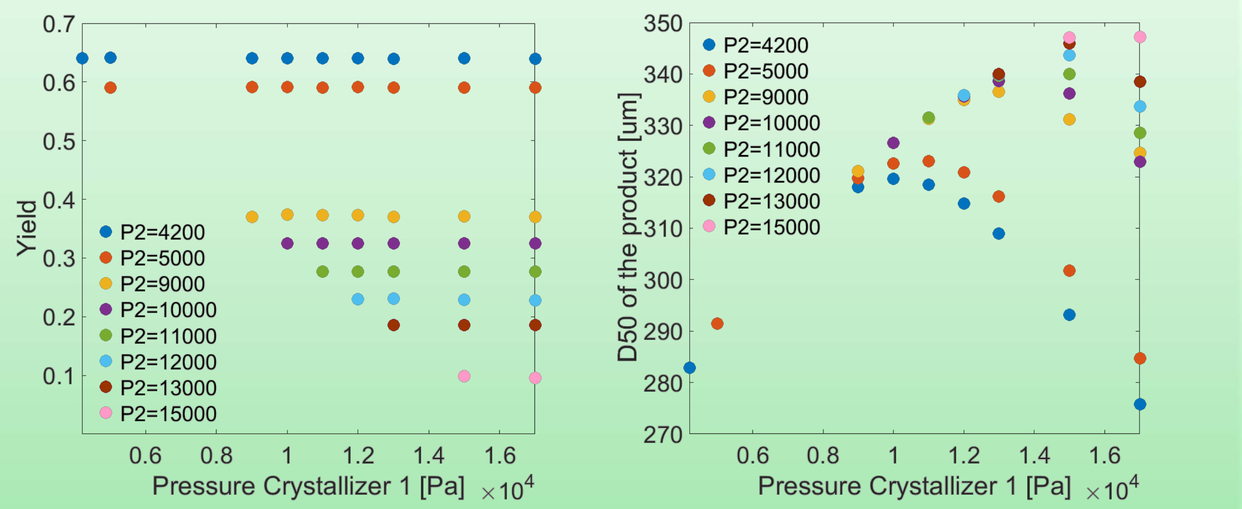
Analysis of C1 through simulations



Analysis of C2 through simulations

The recycle ratio does not have influence on yield and PSD.

Analysis of C3 through simulations



Optimization problem

C1

$$\underset{\text{Pressure}}{\text{maximize}}\ Yield$$

subject to: $D50 > \varepsilon_{D50}$

model

Yield penalized if large crystals are desired

C2

$$\underset{\text{Pressure, Recycle}}{\text{maximize}}\ Yield$$

subject to: $D50 > \varepsilon_{D50}$

model

No solution

C3

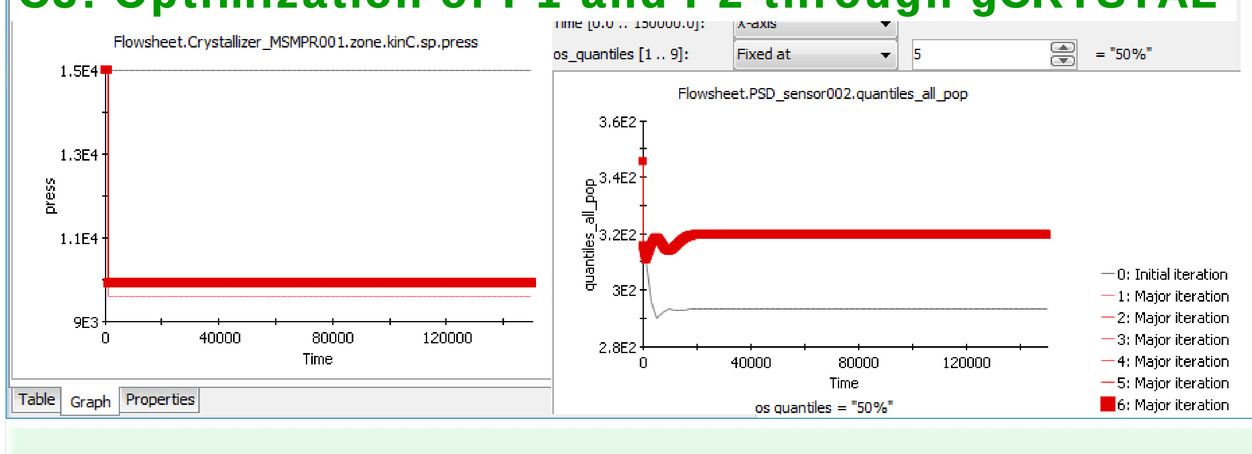
$$\underset{\text{Pressure P1}}{\text{maximize}}\ D50$$

subject to: $\max_{P2} Yield$

model

At high yields there is margin to improve the dimension of the crystals

C3: Optimization of P1 and P2 through gCRYSTAL



Conclusion and future work

- **C1:** The optimal pressure for the single MSMPR is the result of a compromise between high yield and large D50.
- **C2:** The addition of a recycle stream does not improve the crystallization performance.
- **C3:** Optimal setting of pressures of the first and second crystallizer allows to operate at the maximum yield and obtain larger crystals compared with the use of a single unit.
- Cost estimation under study to evaluate the costs/profits associated with the addition of a second crystallizer.