EPSRC
Centre for Innovative Manufacturing
in Continuous Manufacturing and Crystallisation

EPSRC
Engineering and Physical Sciences Research Council

On the effect of oscillation method on the nucleation mechanism of sodium chlorate in an oscillatory baffled crystallizer

Craig Callahan and Xiong-Wei Ni
School of Engineering and Physical Science, Heriot-Watt University, United Kingdom

Introduction

In our previous work [1], we have reported the comparison of nucleation mechanism in both the oscillatory baffled crystallizer (OBC) and the stirred tank crystallizer (STC). In order to provide insight into the scale up from batch to continuous processing, this current work focuses on the different methods of oscillation: the OBC with moving baffles (OBC-MB) and the OBC with moving fluid (OBC-MF).

Motivation for work

In the batch OBC, the baffles are oscillated through a stationary fluid phase. In a COBC, the reactor geometry prohibits movement of the baffles. Instead, the baffles are fixed and the fluid is pulsed by a bellows or piston system. Recent CFD work suggests that the different devices have subtle differences in fluid dynamics [2]. The aim is to investigate what effect, if any, this has on nucleation.

Strategy

- Maintain a constant set of process conditions (ΔT, c_{sat}, seeding, P/V).
- Vary only the fluid dynamics.
- Continue working with sodium chlorate, which allows insight into nucleation mechanism [1].

Experimental setup

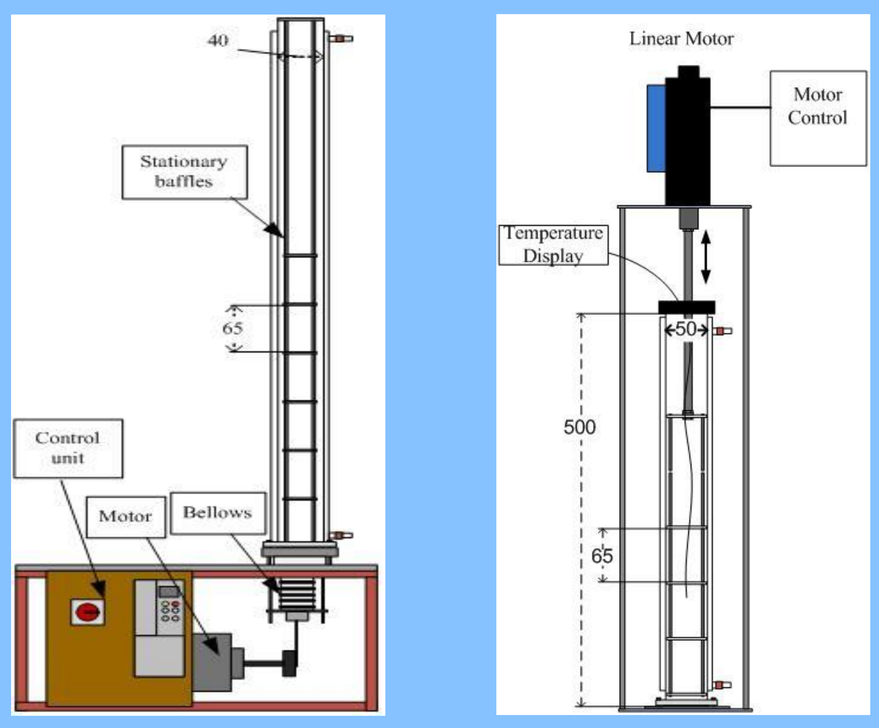

Figure 1 – Schematic setup of the stationary baffle (left) and moving baffle (right) OCBs – not to scale

- In OBC-MF, a nitrile sheath is sandwiched between the column and the bellows.
- Amplitude fixed to 15 mm.
- Varied power densities by changing the oscillation frequency:

Table 1 – Mixing conditions for both OBCs with a fixed amplitude of 15 mm

P/V (Wm^{-3})	f (Hz)
12	0.8
187	2
766	3.3

Results

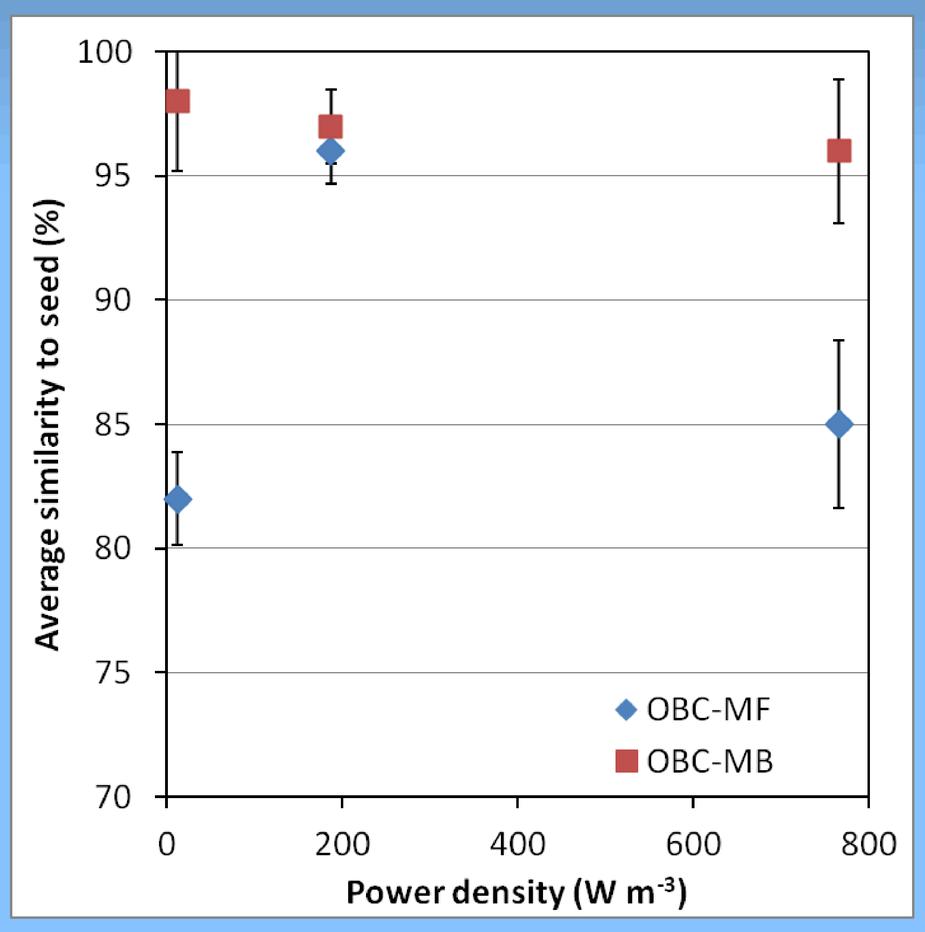

Figure 2 – Similarity of product crystals to seed at various mixing intensities

- OBC-MB gives fairly constant results as P/V increases.
- OBC-MF seems to go through a maximum at medium mixing intensity.
- No mixing in both systems yields products with 100 % similarity to seeds.
- OBC-MF system seems to be more prone to spontaneous nucleation.

Key questions

- Why does the OBC-MF go through a maximum in the similarity, while the OBC-MB does not?
- Could surface renewal play a role in this difference?
- Could we utilise the OBC-MF to provide more nucleation?

Future research

- Conduct experiments with different baffle materials, e.g. stainless steel, PTFE, a combination of the two.
- Examine primary nucleation in the various crystallizers.
- Explore if either OBC could act as a nuclei generator.

References

[1] Callahan, C. J. and Ni, X., Cryst. Growth & Des., 2012. 12 (5): p.2525-2352
[2] Ni, X. *et al.* J. Chem. Tech. BioTech., 2012. Submitted work