



# Study of local powder mixing in a screw reactor using image processing

Lucas Chatre, Marc Bataille, Tojonirina Randriamanantena, Jérémy Nos, Marie Debacq, Florian Herbelet

## ► To cite this version:

Lucas Chatre, Marc Bataille, Tojonirina Randriamanantena, Jérémy Nos, Marie Debacq, et al.. Study of local powder mixing in a screw reactor using image processing. ECCE/ECAB 2023 - 14th European Congress of Chemical Engineering and 7th European Congress of Applied Biotechnology, European Federation of Chemical Engineering (EFCE); DECHEMA, Sep 2023, Berlin, Germany. pp.42133. hal-04223849

**HAL Id: hal-04223849**

**<https://hal.science/hal-04223849>**

Submitted on 30 Sep 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Study of local powder mixing in a screw reactor using image processing

*Lucas Chatre<sup>a,b</sup>, Marc Bataille<sup>a</sup>, Tojonirina Randriamanantena<sup>a</sup>, Jérémy Nos<sup>c</sup>, Marie Debacq<sup>b,d</sup>, Florian Herbelet<sup>a</sup>*

*<sup>a</sup> CEA, DES, ISEC, DMRC, Université de Montpellier, Marcoule, France*

*<sup>b</sup> Université Paris-Saclay, INRAE, AgroParisTech, UMR SayFood, 91120, Palaiseau, France*

*<sup>c</sup> ORANO Recyclage, 125 Avenue de Paris, 92320, Châtillon, France*

*<sup>d</sup> CNAM, 2 rue Conté, 75003 Paris, France*

## Objectives

Screw reactors are largely used devices in the industry. Few studies focus on the powder hydrodynamic in these reactors and even fewer at a local scale. Knowing the exposure time of the bed to the gaseous atmosphere is crucial to understand gas/solid mass and heat transfer. Therefore, a simple method is proposed to measure this parameter. The heap surface of one pitch is sprinkled with the studied powder colored in blue (Figure 1a). An optical device, moving at the screw speed, was developed in order to focus on the sprinkled heap surface. Therefore, the camera follows the renewal speed of this surface during the screw rotation (Figure 1b and c). Using an image processing code, the blue proportion on the heap surface is determined over time, giving the heap surface renewal speed.

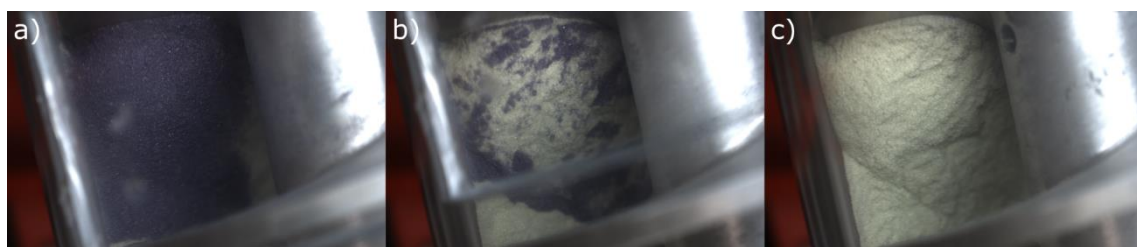


Figure 1: Images of the heap surface a) at the beginning, b) in the middle and c) at the end of the measurement

## New results

The heap surface renewal speed can be estimated by taking the time needed to reach a plateau at the minimum value of the blue proportion. Repeating a measurement with non-cohesive powder (i.e. glass powder and brown corundum) leads to overlapping

curves (Figure 2a), giving a small relative standard deviation. With cohesive powder (i.e. rice flour), the relative standard deviation is higher (Figure 2b).

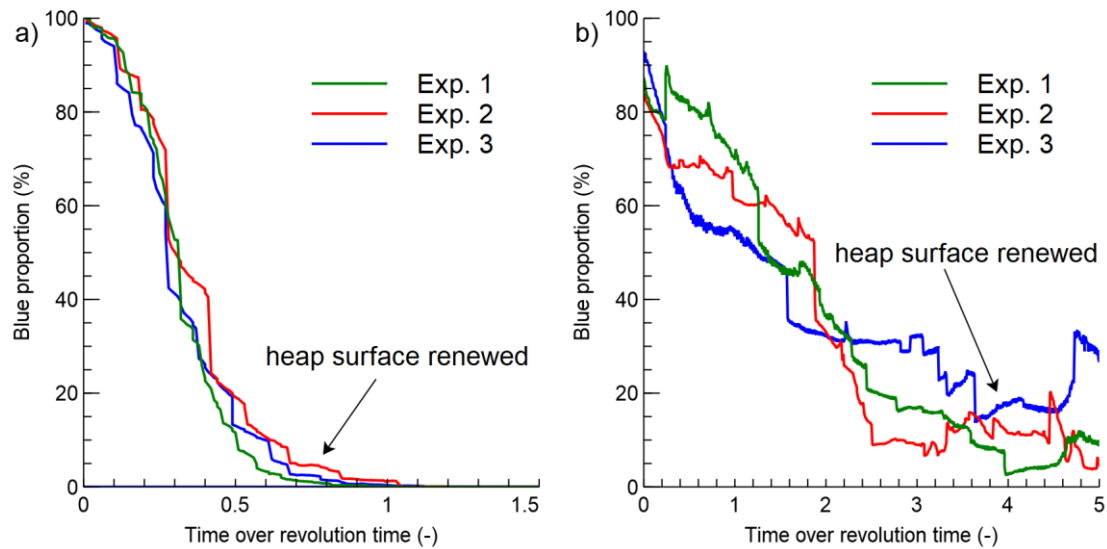


Figure 2: Repeatability of the heap surface renewal speed with a) non-cohesive powder and b) cohesive powder

The heap surface renewal speed was determined for different operating conditions (filling degree, screw rotation speed, powder flowability) and different screw geometries (screw diameter, pitch length). Increasing the filling degree, decreasing the pitch length and having a poorer powder flowability decrease the heap surface renewal speed.

## Conclusions

A simple method has been developed to measure the powder heap surface renewal speed inside a screw reactor. Such parameter is important to characterize the exposure time of the bed to the gaseous atmosphere, thus the gas/solid mass and heat transfer. The heap surface renewal speed was measured for different operating conditions and screw geometries.