6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Investigating fluid-particle interactions in expanded beds using CFD-DEM

Victor Koppejan[1], Guilherme Ferreira[2], Dong-Qiang Lin[3], Haibin Wang[4], Marcel Ottens[1]

[1] Delft University of Technology, Department of Biotechnology , Van der Maasweg 9, 2627 HZ Delft, The Netherlands
[2] DSM Biotechnology Center, Center of Integrated BioProcessing, Alexander Fleminglaan 1, 2613 AX Delft, The Netherlands
[3] College of Chemical and Biological Engineering, Zhejiang University, Hangzhou 310027, China
[4] Zhejiang Hisun Pharmaceutical CO, 318000, Jiaojiang, Taizhou, Zhejiang, China

Key Words: *Multiphase flow, Liquid-solid fluidization, Bioseparations*

The purification of high value products such proteins produced via fermentation typically involves a cascade of unit operations such as membrane filtration and chromatography columns. Expanded bed adsorption (EBA) creates an opportunity for process intensification by combining cell removal with a product capture and initial purification step. By mildly fluidizing a bed of adsorbent particles, the inter-particle void space is increased, which allows cells and other particulate matter to move through the bed in a relatively unhindered manner. The bed is stabilized through the use of a particle size and density distribution, which cause bigger/heavier particles to remain in the bottom while smaller/lighter particles reside higher up in the column. This results in a gradient in particle size, particle density and particle volume fraction along the height of the bed which reduces particle movement and thereby reducing unwanted back mixing in both phases.

To successfully scale up this technology to production scale, a more fundamental understanding of the mechanisms behind fluidization in EBA columns is required. Research into expanded beds using experimental techniques yields different conclusions based on whether the solid or liquid phase is examined [1, 2]. Given the nature of expanded bed systems (dense, opaque multiphase flows), non-intrusive measurements of the fluid-particle interaction at the particle scale are highly challenging. As an alternative to experimental measurements, computational fluid dynamics (CFD) can be combined with a discrete element model (DEM) for the particle phase. This work will present the results of CFD-DEM simulations on lab scale columns and compare them with experimental data. It will be demonstrated how this approach can be used to link the mesoscopic behaviour of the particles to macroscopic phenomena such as bed expansion, fluid phase dispersion and velocity. Based on the insights obtained from the simulations, resin properties such as density and size distribution can optimized to ensure bed stability and separation performance. The overall goal is to understand, optimize and scale EBA technology which then can be used for various business applications, like bio-pharmaceuticals, natural products and enzymes.

REFERENCES

[1] Souquet J, Liu HY, Fan XF, Theodosiou E, Thomas O. Exposing expanded beds to PEPT. J Biotechnol. 2007;131(2):S191-S.
[2] Lin DQ, Shi W, Tong HF, van de Sandt EJ, Boer P, Ferreira GN, et al. Evaluation and characterization of axial distribution in expanded bed: II. Liquid mixing and local effective axial dispersion. J Chromatogr A. 2015;1393:65-72.