



## Sensor equipment for quantification of spatial heterogeneity in large bioreactor

Nørregaard, Anders; Formenti, Luca Riccardo; Stocks, Stuart M.; Madsen, Brian; Woodley, John; Gernaey, Krist

*Publication date:*  
2014

*Document Version*  
Early version, also known as pre-print

[Link back to DTU Orbit](#)

*Citation (APA):*

Nørregaard, A., Formenti, L. R., Stocks, S. M., Madsen, B., Woodley, J., & Gernaey, K. (2014). *Sensor equipment for quantification of spatial heterogeneity in large bioreactor*. Poster session presented at 3rd BioProScale Symposium on Inhomogeneities in large-scale bioprocesses, Berlin, Germany.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

## Sensor equipment for quantification of spatial heterogeneity in large bioreactors

Anders Nørregaard<sup>1</sup>, Luca R. Formenti<sup>1</sup>, Stuart M. Stocks<sup>2</sup>, Brian Madsen<sup>3</sup>, John M. Woodley<sup>1</sup>, Krist V. Gernaey<sup>1</sup>

<sup>1</sup> Department of Chemical and Biochemical Engineering, Technical University of Denmark, Building 229, DK-2800 Kgs. Lyngby, Denmark

<sup>2</sup> Novozymes A/S, Krogshoejvej 36, DK-2880 Bagsværd, Denmark

<sup>3</sup> Novo Nordisk A/S, Hallas Allé, DK-4400 Kalundborg, Denmark

Suspension cultivation in large stirred tank reactors suffers from imperfect mixing and pressure gradients due to the large size of the liquid column in the bioreactors. This leads to gradients of substrate concentrations and in turn cell population heterogeneity. The processes in large scale cannot be directly compared to laboratory scale experiments due to these reasons, and thus, in order to understand the large scale processes, experimental data has to be collected at large scale.

The cost of acquiring data at large scale is high. The bioreactors are usually run with a limited array of sensors and in order to apply more sensor equipment the bioreactor has to be modified which is both costly and results in production downtime. The presence of three phases (gas, liquid, and solid), and the opaque nature of the fermentation broth together with the necessity of heat sterilization further increases the requirements to the sensor equipment. In order to address these issues this study aims to make an investigation into freely floating, battery driven sensor particles that can follow the liquid movement in the reactor and make measurements while being distributed in the whole volume of the bioreactor. The method leaves a minimal footprint and can be applied to running production to gather large scale fermentation data, without the need of dedicated experimental cultivations.

Ultimately, data describing the spatial heterogeneity can be used to enhance existing process models and to create better scale-down strategies for lab-scale experiments. Accurate process models and lab-scale experiments could in turn lead to a more scientific approach to scaling of biotechnological processes.