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Sensor equipment for quantification of spatial heterogeneity in large bioreactors

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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.