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Towards Computational Fluid Dynamics Based Methodology to Accelerate Bioprocess Scale Up and Scale Down

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Abstract : Bioprocess development is a time-constrained activity aimed at harnessing the full potential of culture performance in an ambience that is not natural to cells. Even with the use of chemically defined media and feeds, a significant amount of time is devoted in identifying the apt operating parameters. In addition, the scale-up of these processes is often accompanied by loss of antibody titer and product quality, which further delays the commercialization of the drug product. In such a scenario, the investigation of this disparity of culture performance is done by further experimentation at a smaller scale that is representative of at-scale production bioreactors. These scale-down model developments are also time-intensive. In this study, a computation fluid dynamics-based multi-objective scaling approach has been illustrated to speed up the process transfer. For the implementation of this approach, a transient multiphase water-air system has been studied in Ansys CFX to visualize the air bubble distribution and volumetric mass transfer coefficient (kLa) profiles, followed by the design of experiment based parametric optimization approach to define the operational space. The proposed approach is completely in silico and requires minimum experimentation, thereby rendering a high throughput to the overall process development.

Keywords : bioprocess development, scale up, scale down, computation fluid dynamics, multi-objective, Ansys CFX, design of experiment
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