THE IMPACT OF BAFFLES AND PROBES ON FLOW AND POWER CONSUMPTION IN SINGLE-USE BIOREACTORS

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In upstream processing single-use bioreactors (SUBs) are used in for the production of 66% of biopharmaceutical products due to high flexibility and reduction of time to market[1]. Even though SUBs offer economic feasibility for cell culture, there are limitations on the selection of optimal scale-up criteria which ensure that the cultivation process is adequately translated to larger scales. Therefore, rigorous hydrodynamic analysis is essential in novel SUBs, for the understanding of flow dynamics and energy consumption characteristics and secures that the equivalency of critical quality attributes (CQAs) across different scales is met[2]. To date scaling procedures have been mainly limited to pilot and larger scale systems but this must be extended and tested to smaller scales, where probes and baffle dimensions relative to the reactor size can greatly affect the overall flow and mixing performance. In this framework, a systematic characterisation of engineering features in small-scale SUBs is particularly important for the development of valid scale-down models (SDMs) and a thorough understanding of the flow field at that scale is essential to evaluate the way critical design parameters affect the fluid dynamics, assisting in the optimisation of mixing and cell growth[3].

The aim of this work is to assess the flow patterns and power consumption in different stirred tank bioreactor geometries, with working volumes ranging between 200 mL - 1L, actively used in mammalian and stem-cell cultures, in fed-batch and perfusion modes. The bioreactors are equipped with different baffle and probe sizes focusing on the optimisation of probe design. For fluid flow experiments the Reynolds number ranges from Re=2500-7000 with mixtures of water and glycerol being the working fluids. Flow hydrodynamics and power consumption have been characterised via computational fluid dynamics (CFD) and validated experimentally via Particle Image Velocimetry (PIV). The impact of design parameters is assessed with particular focus on baffle and probe number and size in order to evaluate the dependency of bioreactor hydrodynamics and power consumption on key geometrical features. Preliminary results indicate that the presence of probes highly impact the flow dynamics and impeller power number with the latter acting equivalently to baffles. The computational and experimental analysis of the flow dynamics in the current work, verifies the accuracy of CFD simulations and emphasises that the investigation of small-scale reactors is essential, highlighting the sensitivity of mixing features on bioreactor design parameters.

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