In silico characterization of the flow inside a spinner-flask bioreactor

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Abstract

This study considers the steady, axisymmetric flow inside a generic spinner-flask bioreactor that is used in tissue engineering. Numerical simulation is used to predict the flow field. The spinner-flask bioreactor is idealized as an open-top cylindrical container that is driven by a rotating bottom lid. In this study, the flow is simulated over a Reynolds number range that corresponds to steady axisymmetric flow. The swirling flow consists of two distinct recirculation zones, namely a primary dominant region, and a secondary recirculation bubble that is formed close to the axis of rotation. Of particular interest to tissue engineering is the stress distribution inside the bioreactor. The stress is quantified by the coordinate independent principal stress terms, namely, the positive tensile, intermediate, and negative compressive components. The analysis indicates that there are three main regions of high strain within the bioreactor: at the rotating bottom lid; on the side walls; and at the surface close to the breakdown bubble. Finally, the local flow environment of a suspended scaffold is determined.