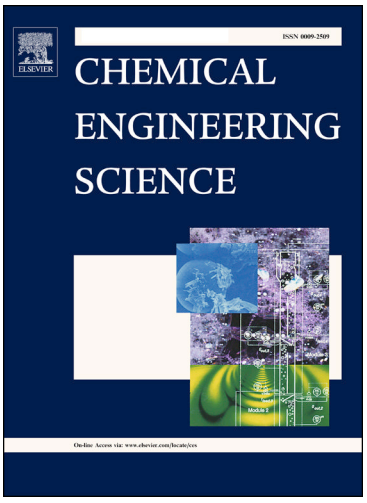

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Study of hydrodynamics in Wave Bioreactors by Computational Fluid Dynamics reveals a resonance phenomenon

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Abstract

Culture of mammalian or human cells in Wave bioreactor is widely used for cell expansion or for biologics manufacturing. Wave bioreactor cultivation of sensitive cells such as stem cells, immune cells or anchorage-dependent cells, is recognized as an attractive option for culture in suspension or adherently on microcarriers. A systematic optimization of the mixing, oxygen transfer rate and shear stress, most favorable for the cells requires a deep understanding of the hydrodynamics inside the Wave bioreactor bag, i.e. cellbag. Numerical simulation by Computation Fluid Dynamics (CFD), is considered as an inexpensive and efficient tool for predicting the fluid behavior in many fields. In the present study, we perform numerical simulations by Ansys-FLUENT to characterize the flow conditions in a 10L cellbag. The numerical simulations are carried out to investigate the fluid structures for nine different operating conditions of rocking speed and angle. The influence of these operating parameters on the mixing and the shear stress induced by the liquid motion are studied. We find that the mixing and shear stress increase with the cellbag angle from 4˚ to 7˚ but that increasing rocking speeds are not systematically associated with increasing mixing and shear stress. It is concluded that a resonance phenomenon is responsible for the fact that the lowest studied rocking speed, 15 rpm, generates the highest fluid velocity, mixing and shear stress compared to the higher speeds of 22 and 30 rpm.

Keywords: Wave bioreactor, Computation Fluid Dynamics (CFD), volume of fluid (VOF), hydrodynamic, resonance

1. Introduction

The interest in single-use equipment has tremendously increased since the introduction of the disposable bioreactors. This technology reduces the procedures of cleaning and sterilization, the cross-contamination validation, the risk of contamination, and enhances the process safety (Eibl *et al*. 2009). It has been estimated that the cost savings are larger than 60% with single-use systems compared to stainless-steel based equipment in biopharmaceutical manufacturing (Morrow 2006). An ideal bioreactor should be perfectly mixed however with shear stress not