Extensional Stress Investigation of Bubble Bursting for Design and Optimization a Bioreactor for Animal Cell Culture

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Abstract: Minimization of cell death rate is the key factor in design and optimization of a bioreactor system for animal cell culture. The extensional stress due to bubble bursting at free surface, in its turn, is the main factor causing cell damage. This study presents the numerical simulation of extensional stress from bubble bursting process in considering the influence of bubble diameter and surface tension.

The wide range of bubble diameter $0.5 \sim 6$ mm and of surface tension $0.030 \sim 0.072$ N/m are considered. Numerical simulations are carried out with CFD commercial software ANSYS Fluent V15 in 2D axisymmetric and transient mode. Coupling between Volume-of-Fluid and Level-Set methods is used to capture the evolution of interface. User-Defined Functions in Fluent are programed for handling huge data in post-processing.

The numerical simulation results show that the maximum extensional stress decreases if bubble size increases. Particularly, the maximum extensional stress is extremely high for small bubble. During bubble bursting process, the large values of maximum extensional stress are recognized at three moments: film receding, just before emerging of jet, and just before releasing the first droplet from emerged jet. These extensional results mainly contribute to the design and optimization picture in bioreactor system.

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