Lattice Boltzmann method in bioreactor design and simulation

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Microalgae attracts a lot of attention due to its high potential in diverse areas such as renewable fuel, high value compounds, food supplements and others. Industrial-scale utilization is still rather scarce and the field as such is still immature. The relevant biotechnological design processes are one of the issues still to be addressed, especially in case of industrial-scale photobioreactors. These processes are still rather empirical. Modeling in a predictive way the photosynthetic response in the three-dimensional flow field of a photobioreactor seems today unrealistic, because the global response depends on numerous interacting intracellular reactions, with various timescales. This work aims at an alternative approach to microalgae growth modeling and simulation in photobioreactors - namely the Lattice-Boltzmann Method(LBM) for fluid dynamics accompanied by parallel stochastic implementation of the model of Photosynthetic Factory(PSF).

We investigate the applicability and performance advantage of the these methods in case of a Couette-Taylor photobioreactor (CTBR). Both LBM and PSF are very well parallelizable methods and we also investigate the possible performance enhancements to bioreactor simulation on the parallel architecture of CUDA.