CONTINUOUS SEMI-SOLID STATE BIOREACTOR OPTIMIZATION THROUGH MODELING THE INTERNAL MULTIPHASE FLOW

Paulo Seleghim Júnior
São Carlos School of Engineering / University of São Paulo (USP)
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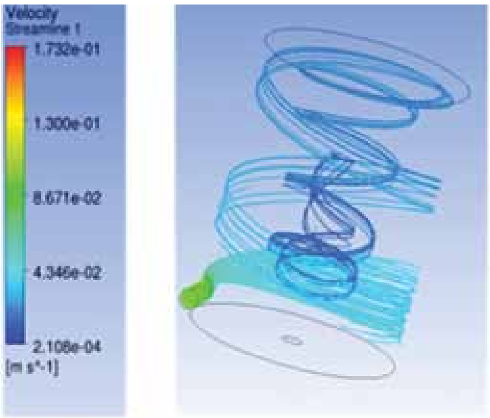
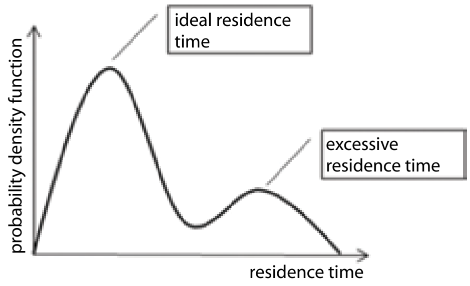
The substitution of fossil fuels by biofuels is pioneered by Brasil since the release of the Proalcool in the mid seventies. Today, around 48% of the Brazilian energy matrix is based on renewable sources: bio-ethanol, bio-diesel, hydro and bio-electricity. Despite this favorable scenario, further increases in biofuels production is strongly limited by technological bottlenecks, mainly associated to the up-scaling of new production methods developed at laboratory scales. The efficiency of biomass conversion in large scale bioreactors (hundreds or thousands of cubic meters) is a consensual issue among industrials. In a sugar cane juice fermentation tank for example, the distribution of residence time affects the efficiency of biochemical reactions: very little time result in an incomplete conversion (high sugar content in wine) and excessively long time results in loss of the ethanol by evaporation. The numerical optimization of this type of equipment produces an inverse problem which is, therefore, intrinsically ill conditioned. The solution of this problem by minimizing an error functional, although extremely interesting because there is no need for rough simplifications, is not possible through traditional numerical methods. Furthermore, the computational effort involved is extremely huge, if not impracticable, because of the complexity of the fluid and the geometry involved as well as the scale of the problem. The development of techniques capable to arrive to an optimization with sufficient accuracy in reasonable computational time will have a major impact on the design and operation of high performance industrial bioreactors and, consequently, increasing their operational efficiency. The main objective of this research project is to contribute to the development of integrated optimization methods, combining the characteristics of deterministic and random search strategies. Particularly, multiphase flow and bio-chemical reaction equations are numerically modeled and iteratively solved within a multi-objective optimization scheme, combining a genetic algorithm and Newton's method. With this, we intend to develop the bases of a new methodology for optimal design and operation of industrial scale bioreactors.

Figure 1. Continuous sugar cane juice fermentation bioreactors

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

We have finished implementing the multiphase flow model in CFX. Some preliminary simulations are being carried out in order to construct temperature, residence time (the amount of time that a particle spends inside the bioreactor and shear stress histograms. These histograms will generate performance parameters which will be used to determine the pareto frontier associated to the multi-objective optimization problem.





Paulo Seleghim Júnior

Escola de Engenharia de São Carlos
Universidade de São Paulo (USP)
Departamento de Engenharia Mecânica
Av. Trabalhador Sãocarlense, 400
CEP 13566-590 – São Carlos, SP – Brasil

+55-16-3373-9416
seleghim@sc.usp.br