Fluid Flow Modeling in a Bioreactor Applied to Wine Production

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Abstract

Wine quality is strongly dependent on the operation parameters of the production process. In batch or fed batch reactors, the rotating velocity should be carefully controlled to avoid cellular stress and ensure adequate mixing of the mixture. Moreover, precise control of substrates concentration evolution and cellular growth, as well as efficient heat transfer, allows the production of high quality varietal wines. Modeling can be applied in all steps of the wine production process for the design of the equipment, definition of operation ranges and optimization of new and existing facilities. In this work, the COMSOL Multiphysics® software was applied for fluid flow modeling in a multipurpose fermenter in order to assess its performance for varietal wine production in San Juan province, Argentina. A three-dimensional geometry based on all real features of the equipment installed at Universidad Nacional de San Juan was built using COMSOL. The CFD Module, through the Rotating Machinery, Laminar Flow Interface, was applied, taking the "Laminar Flow in a Baffled Stirred Mixer" COMSOL's model gallery application as reference. In particular, the model allowed the visualization of the flow pattern inside the device at different instants (50, 100, 150, 250 and 300 s). Slices of velocity contours (Figure 1), three-dimensional velocity isosurfaces (Figure 2) and three-dimensional vector plot (Figure 3) were obtained at different time intervals. These results represent the first step towards the full implementation of non-isothermal varietal wine production modeling in COMSOL Multiphysics, which will be completed soon by the addition of reaction kinetics and heat transfer effects in the computations.

Figures used in the abstract

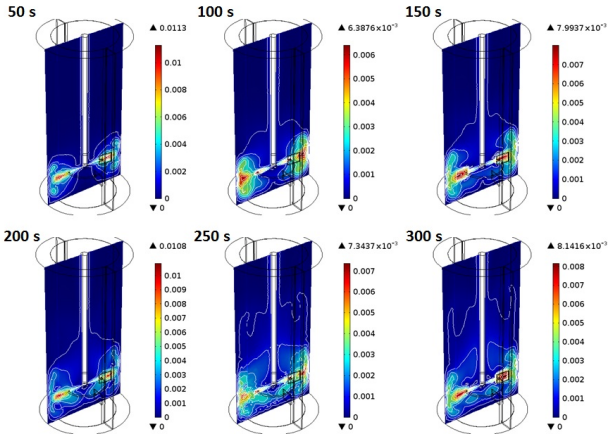

Figure 1: Slices of velocity contours at different instants.

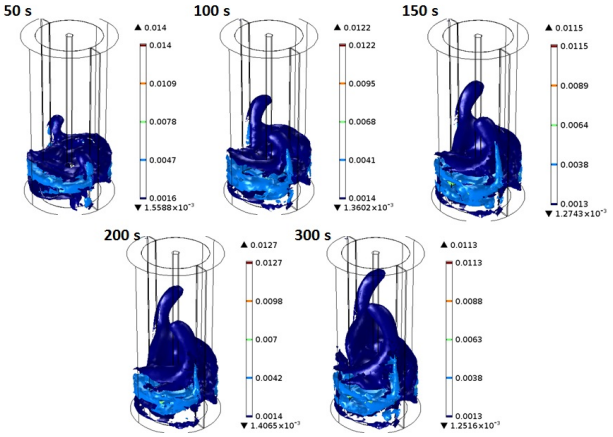

Figure 2: Velocity isosurfaces at different instants.

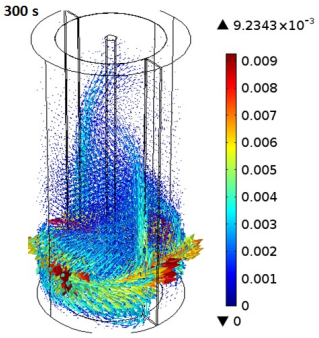

Figure 3: Three-dimensional vector plot at t = 300 s.