# The Mixing of a Viscous Xanthan Solution: Measurements and Modeling

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**Abstract**

Poor mixing and oxygen transfer limitations are common in large aerated bioreactors, especially in shear thinning mixtures that exhibit a yield stress. Computational Fluid Dynamics (CFD) and multiblock reactor models (Bezzo et al. 2005, Laakkonen et al. 2006) together with phenomenological gas-liquid hydrodynamics, mass transfer and reaction kinetic models allow the detailed investigation of agitated bioreactors. However, experimental model validation is needed to obtain reliable simulation tools for reactor scale-up at varying geometries.

In this study, gas-liquid hydrodynamics was measured from aerated xanthan dispersions in a 40 $dm^3$ laboratory vessel agitated by two Rushton impellers at varying xanthan concentrations and stirring speeds. The measured quantities include liquid viscosity, power consumption, mass transfer, mixing time and gas holdup. The measurements were compared to simulations with Computational Fluid Dynamic (CFD) and multiblock stirred tank models.

The measurements were done with water and at xanthan concentrations ranging from 0.25 w-% to 4 w-%. Gas holdup was measured as a time dependent variable at the start of aeration and after the aeration and mixing was stopped. The existence of a static or residual holdup was noted. This is caused by the shear thinning nature and yield stress of the liquid as bubbles are unable to overcome the shear needed to rise from the liquid. Small bubbles stay in the liquid longer than it takes for the mass transfer to happen and they can be assumed at equilibrium with the liquid. Therefore it is proposed that computationally only the dynamic holdup is responsible for the mass transfer between the phases. In order to calculate the vessel average mass transfer rate, mass transfer was measured with the gassing in gassing out method (van't Riet, 1979) with a polarographic oxygen probe. Probe lag times were also tested at different xanthan concentrations in order to make subsequent calculations more reliable.

CFD was used to simulate the system. According to CFD results of turbulent energy dissipation, the vessel was split up into zones. These zones were then used as the ideally mixed blocks within a previously developed multiblock model (Laakkonen et al., 2006). Furthermore, the mass transfer was modeled with the multiblock model to examine the holdup hypothesis.

**References:**

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