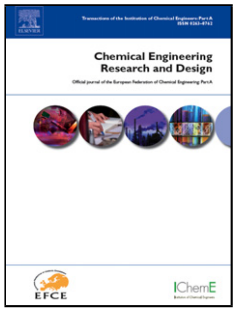

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PII: S0263-8762(18)30046-7
DOI: https://doi.org/doi:10.1016/j.cherd.2018.01.036
Reference: CHERD 3010

To appear in:

Received date: 28-6-2017
Revised date: 9-11-2017
Accepted date: 15-1-2018

Please cite this article as: Timm Steffen Severin, Andreas Apel, Thomas Br*ddotu*ck, Dirk Weuster-Botz, Investigation of Vertical Mixing in Thin-Layer Cascade Reactors using Computational Fluid Dynamics, *<![CDATA[Chemical Engineering Research and Design]]>* (2018), https://doi.org/10.1016/j.cherd.2018.01.036

Investigation of Vertical Mixing in Thin-Layer Cascade Reactors using Computational Fluid Dynamics

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Abstract

In current research microalgae are considered as an important source for food, chemicals or bioenergy. To enable economically viable production of bulk chemicals such as biofuels from microalgae, however, very low operational costs have to be achieved. In this respect, thin-layer cascade (TLC) reactors provide the advantage of enhanced cell concentrations and hence biomass yields over the conventional raceway ponds. While TLC reactors have been developed half a century ago, this reactor design still offers multiple aspects for optimisation. This study focuses on the evaluation of the main cultivation area of the reactor, the thin-layer channel, with respect to vertical mixing. Therefore a three dimensional representation of the channel was simulated using computational fluid dynamics. The resulting model was validated against theoretical and experimental data. Having a valid simulation, different geometric and operational parameters could be modified to investigate the effects on the channel's mixing properties. To allow a direct comparison of distinct channels, stream tracers were used and evaluated to generate a dimensionless characteristic for each channel, which allowed an easy comparison. This method can be applied without effort to a multitude of reactor types of similar flow regimes. For the current reactor design, variations of the channel's slope, volume flow and the fluids viscosity have been analysed by simulation, covering operation modes published in literature. Evaluating the simulations for the suggested mixing index, different reactor setups with very similar mixing properties were found, which allow to transfer reactor knowledge gathered on pilot plants to real systems.

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