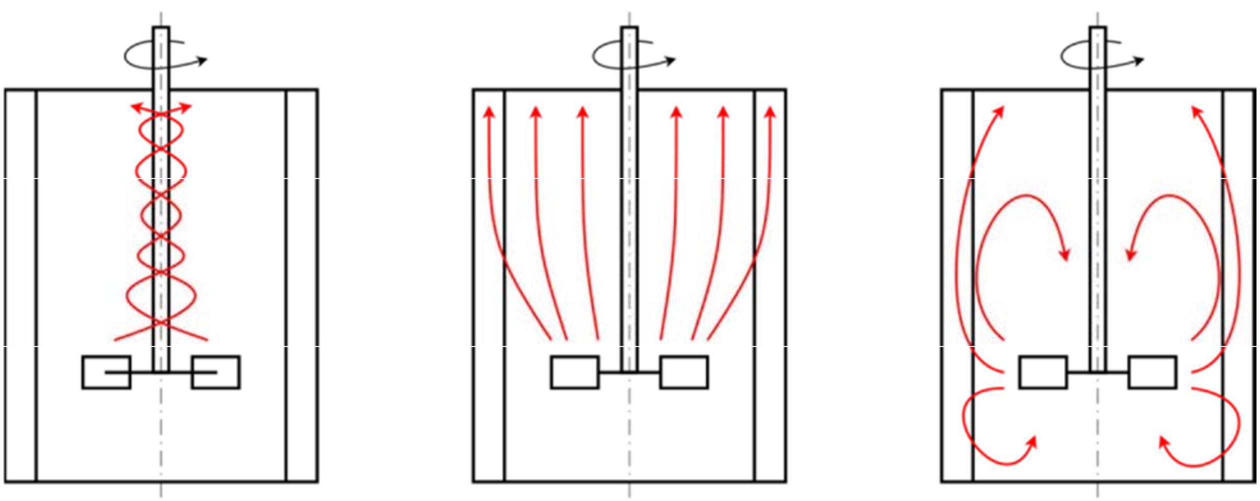
Simulation of a Stirred Tank with Rushton Impeller with OpenFOAM

Gerhard Holzinger

Johannes Kepler University, Department for Particulate Flow Modelling, Altenberger Straße 69, 4040 Linz, Austria

Stirred tanks are a widely used appliance in process engineering and have been a subject of investigation for decades. Thus, there is a vast body of literature available on this matter. This makes the stirred tank an interesting test object. The baffled stirred tank with Rushton impeller has turned out to be a popular test case with a largely standardized geometry.
In this study we created a parametric structured mesh of a baffled stirred tank with a Rushton impeller with the native meshing tool blockMesh. The stirred tank was simulated by using the MRF method, as this method is available in the single phase and the two phase solvers that have been used. Single and two phase simulations were conducted and results have been compared with published measurement and simulation data.
The single phase simulation was compared to published data with respect to the power number and velocity profiles near the impeller (Wu and Patterson, 1989). In case of the aerated stirred tank the flow regime within the tank was compared against an empirical correlation (Lee and Dudukovic, 2014).
The simulation results show good agreement with published measurement data. This shows that OpenFOAM is able to predict the flow regime in a stirred tank. However, due to the use of the MRF method accuracy is limited in the region close to the impeller.



Flooding Loading Recirculating

Figure 1: Flow regimes in an aerated stirred tank. The red arrows indicate the trajectory of the gas bubbles. Adapted from Lee and Dudukovic 2014.

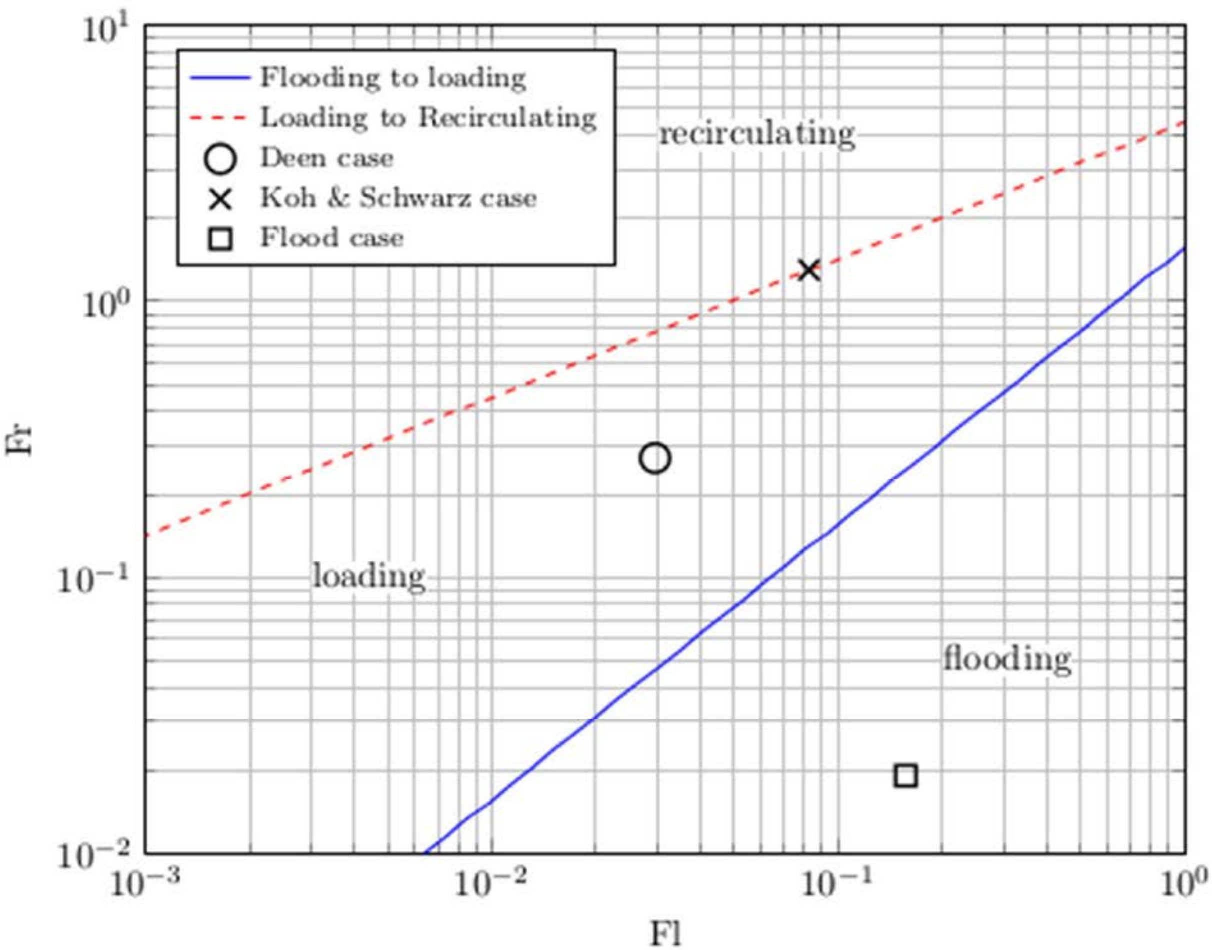
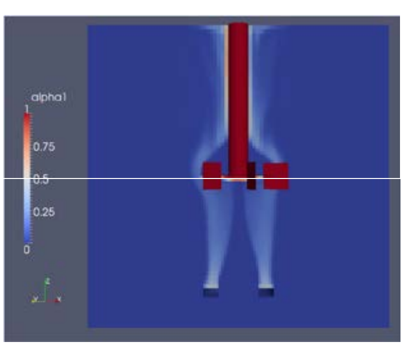
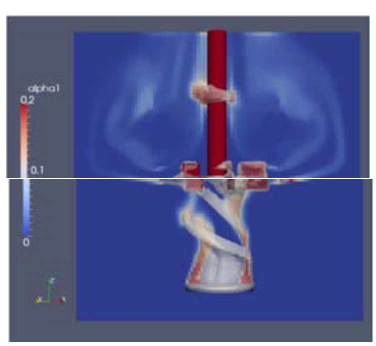


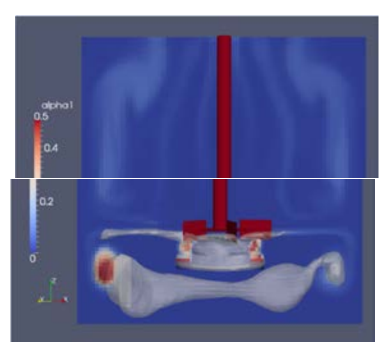
Figure 2: Regime map for an aerated stirred tank (Lee and Dudukovic, 2014). The symbols mark the predicted regime of the simulated cases (□: Fig. 3.a, ○: Fig. 3.b, x: Fig. 3.c).



(a) Flooding regime



(b) Loading regime



c) Recirculating regime

Figure 3: Gas-phase volume fraction in the plane midway between two baffles.
The grey shaded area indicates the gas phase volume fraction iso-volume (α=0.1).

References

B. W. Lee and M. P. Dudukovic. Determination of flow regime and gas holdup in gas-liquid stirred tanks. Chemical Engineering Science, 109:264-275, 2014

H. Wu and G. K. Patterson. Laser-Doppler measurements of turbulent-flow parameters in a stirred mixer. Chemical Engineering Science, 44:2207-2211, 1989