Design of Axial Hollow Cone Pressure Swirl Nozzles to Atomize Non-Newtonian Fluids

A calculation model is presented to predict the resulting droplet size in dependence on operating conditions, geometry and the characteristics of the non-Newtonian fluid itself. The model is valid for laminar wave break-up of a swirling liquid sheet. By using the CFD package FLUENT, one is able to simulate the locally detailed and discrete flow field inside the nozzle as well as the arising phase interface. With the obtained film thickness, viscosity and velocities at the nozzle outlet, the developed calculation models can be applied to describe the sheet formation as well as its alteration of thickness, velocities, etc. in dependence on axial direction. As the liquid is influenced by disturbances of the gas-phase, the sheet decays first in torus-shaped ligaments and finally in droplets.

The non-Newtonian behaviour of the liquid is taken into consideration by using the Carreau-Yasuda-Model as it fits a wide range of experimental data. For different nozzle geometries, liquids with non-Newtonian behaviour and various flow rates, the comparison between the numerically obtained Sauter mean diameter and experimental data shows quite satisfying agreement, Fig. 1.

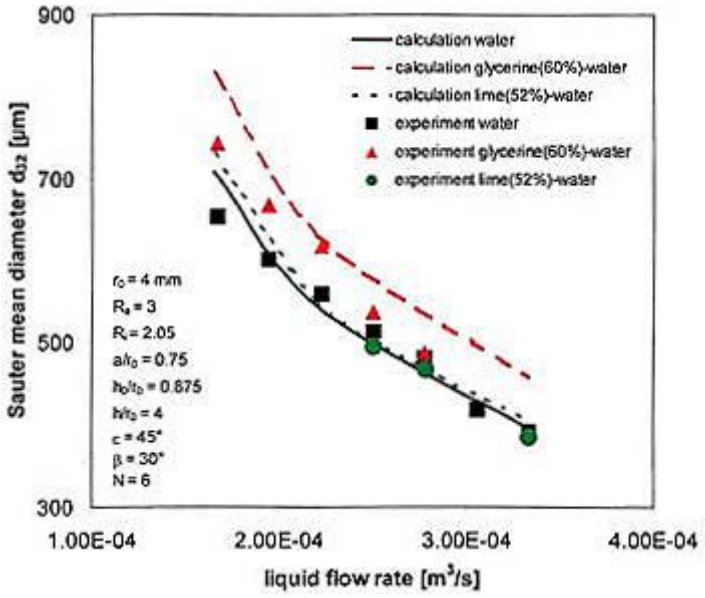

Fig. 1: Comparison between calculated and experimentally gained data in dependence on flow rate, nozzle geometry and liquid characteristics.