STUDY OF NON-NEWTONIAN SPRAY ATOMIZATION

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Non-Newtonian sprays are widely used in industrial applications, where the size and velocity distributions of droplets are crucial for the success of the application.

In this study, spray atomization has been investigated for both Newtonian and Non-Newtonian liquids by experimental and theoretical means. The experiments are carried out in the water spray facility of VKI, where “water” is used as the Newtonian fluid and 0.5% (w) aqueous “CarboxyMethyloCellulose (CMC)” solution as the Non-Newtonian. The experimental setup has been modified for Non-Newtonian spray tests. The fluid properties of CMC are obtained at the VKI.

Two separate techniques are used in the experimental approach; high speed imaging and Phase/Doppler Analyzer (PDA) system. High speed camera is used to obtain, qualitatively, the break-up patterns of both fluids (typical example is shown in figure 1) for three different nozzle types; full cone, flat spray and round nozzles. It has not been possible to match all the non-dimensional numbers for both fluids at the same time, but the experiments are performed at the same pressure instead. It is seen that the break up patterns for CMC solution is in the form of ligaments, rather than droplets as in the case for water, due to the higher effective viscosity of CMC. For each nozzle, the CMC spray exhibits different break-up behavior compared to water, such as repetitively occurring sudden changes in the flow pattern for the round nozzle.

PDA results for the droplet size and velocity are used to obtain either the horizontal profiles of mean values or the probability density functions (PDF) of these quantities. The droplets in the CMC spray are found to be larger for both nozzles, which is an indication for an earlier stage of atomization.

The MEF approach is used to obtain the droplet size distributions in a spray via a computer program developed in this study. The MEF model results show a similar distribution with the experiments (see figure 2) and refinement is in progress. It is worth improving the model in future studies since it requires only two mean inputs and gives as a result the whole PDF distributions. The model is also able to give the PDF of the droplet velocity, which is another motivation.

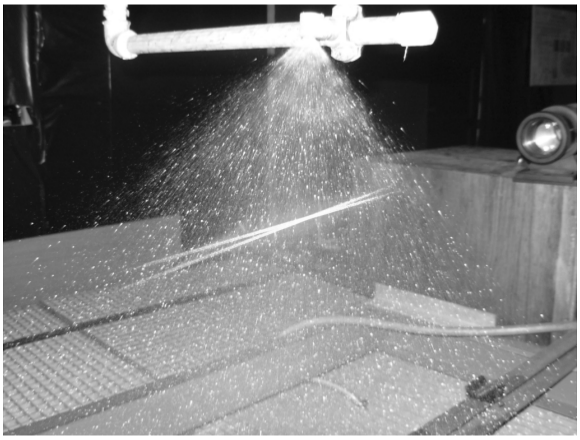

*Figure 1: PDA experiments with water for the full cone nozzle; P = 800 kPa, L = 100*d_0*

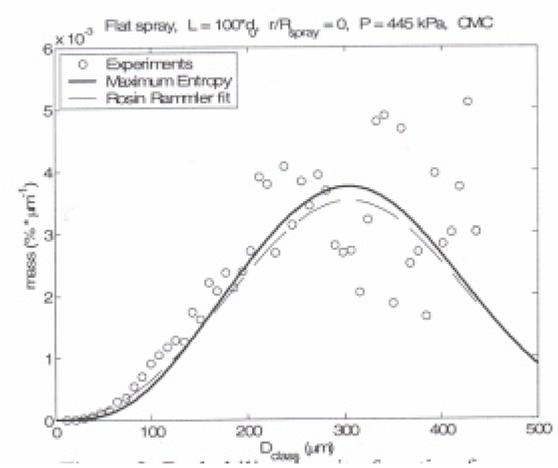

Figure 2: Probability density function for droplet size with CMC for flat spray nozzle