ICLASS 2009, 11th International Annual Conference on Liquid Atomization and Spray Systems, Vail, Colorado USA, July 2009

Atomization Modeling for an Agricultural Hollow Cone Nozzle

A. Belhadef and A. Vallet *
Cemagref
Agricultural and Environmental Engineering Research Centre
34 196 Montpellier Cedex 5, France

Abstract

The aim of the present study has been to propose an Eulerian model in order to investigate the atomization of a liquid sheet issued from a hollow cone nozzle. The model has been based on studies developed in the automotive and rocket engine fields, and has been adapted to agricultural sprays.

A fluid with variable density has been considered, ranging from the air density to the liquid density. Classical conservation equations have been solved for the fluid: a transport equation for the mean liquid mass fraction, and three other for the three velocity components. An original aspect of the model has concerned turbulence modeling. Turbulence has not been modeled using the classical (k-ε) model, as the flow involved was anisotropic. It has been modeled using transport equations for the six Reynolds Stress Tensor components.

Three-dimensional calculations have been carried out to study the flow of water in air from the inside of the nozzle to up to 1.5 cm outside the exit. The model has been applied to a hollow cone nozzle (ATR80 Lilas, Albuz) particularly used in orchards or wine growing. The computations have been performed using the CFD code Fluent using User Defined Functions.

Numerical calculations have shown a hollow cone liquid sheet expanded outside the nozzle, and a recirculation zone in the spray centre. Comparisons with experimental data have showed good agreement between the volume liquid fraction values, but bad agreement between the spray angles. Improvements concerning the liquid flux modeling are in progress. In the near future, the model could be used as initial conditions in drift models.

Key words: Agricultural spray, Atomization, Modeling, Eulerian model, Hollow cone nozzle

* Corresponding author, ariane.vallet@cemagref.fr