Updating the ARS Fixed-Wing Spray Nozzle Models

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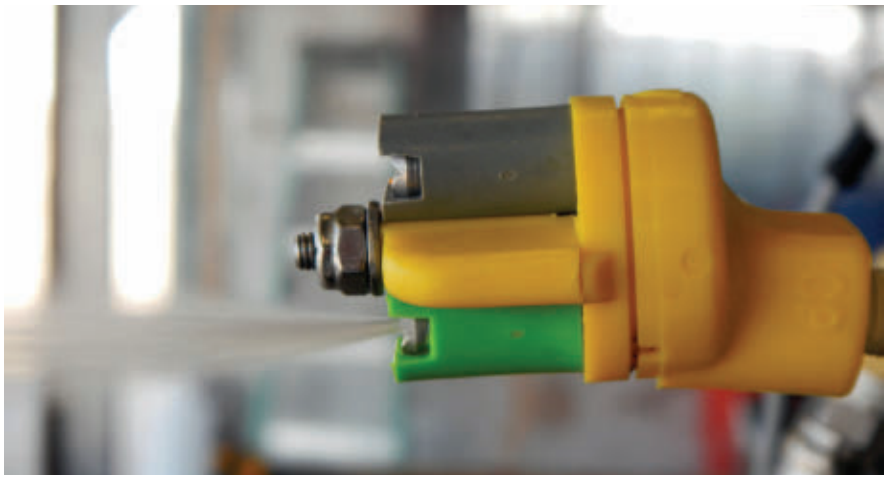
After several years of updating both the high speed wind tunnel and our spray measurement system, as well as establishing standard methods for measuring spray droplet size from the aerial spray nozzles being tested, we are finally completing the update to our current spray nozzle models. As we have mentioned in previous articles and presentations, there are a number of reasons for these updates.

First, the current models were developed using an older measurement system, which is no longer in use. This means that all of the data we have generated and published over the past several years may not harmonize with the current models. Second, the current models are limited to airspeeds of 160 mph and spray pressures of 60 psi. With the new tunnel, we are increasing the airspeed range to 180 mph. Based on recent efforts showing the potential for higher spray pressures to increase droplet size, we are also increasing the spray pressure range to 90 psi. Lastly, the current models were generated back when nozzles such as the CP11TT either were not available or had a limited number of spray tips. While the current models do include 40- and 80-degree flat fans, they are actually for TeeJet nozzles on drop tubes and in standard screw top nozzle bodies. So, there is still confusion today when using the models as to how to correctly model the CP11TT. The 11TT has a built-in 8-degree deflection that must be added to the spray angle being considered. With the updated models, the actual CP11TT nozzle body was used in the testing meaning the 8-degree natural deflection and nozzle body effects were accounted for. Also, the 20-degree flat fans were not available from any nozzle manufacturer when the current models were developed.

As things stand now, data has been collected and draft models are completed for the following nozzles:

- CP11TT 20°, 40° and 80° Flat Fans
- CP03
- TeeJet 40° and 80° Flat Fans
- Disc Core #45
- Ceramic Disc Core #45
- Davidon TriSet
- CP09
- CP11TT Straight Stream
- Disc #45 Straight Stream



Courtesy of Clint Hoffmann

The Aerial Application Technology Research Unit tests a CP 11-TT nozzle with 40-degree flat fans in a high speed airstream.

In developing each model, 57 unique combinations of orifice, pressure, nozzle angle and airspeed had to be evaluated. 27 of these data points were used to generate the final model while the remainder served as test points to evaluate how well the model fit measured data. All of the nozzle models that have been completed showed a high level of fit to the measured data points, giving us confidence in final models.

The draft versions of these models have been sent out to a number of beta testers to ensure that they are as bug and error free as possible. We anticipate having the models completed, tested and ready for public release by the end of the year. With the updates, the Excel versions are being updated so that all models are contained on one single Excel file, rather than multiple files. We are also nearing completion of an update to the smartphone app so that the new model data can be uploaded.

One of the interesting things we observed when generating the new models was that several nozzle setups were evaluated as part of the experimental design that likely never will be used in a real application—for example, a 20-degree flat fan nozzle with a #04 orifice operating at 90 psi with a 90-degree deflection in 180 mph airspeed. This is not a setting we would either recommend, nor one you would ever consider running. However, in order to complete the model, it was a data point that had to be collected. Consequently, it is also a point that you will be able to run in the new models and see why you would never make this application.

One of the other major challenges was generating the higher pressures needed with the larger diameter orifices. Getting 90 psi through a #30 orifice is not the easiest thing to do. We realize that to use higher pressures in the field will likely require modifying current aircraft spray systems, but by generating and providing the data now, we will hopefully provide you the tools to make these decisions as well as future-proof these new models for several years to come. With the fixed-wing model updates nearing completion, we will turn out attention to the rotary-wing models, which we plan to have ready around the same time next year.

To learn more about the updated models, as well as what to expect from them in comparison to the current ones you are using, plan to attend the ASABE Technical Session at NAAA's 2014 convention, where the updated models will be discussed. ■