ROTARY ATOMIZER DROP SIZE DISTRIBUTION DATABASE

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ABSTRACT. *Wind tunnel measurements of drop size distributions from Micronair AU4000 and AU5000 rotary atomizers were collected to develop a database for model use. The measurements varied tank mix, flow rate, air speed, and blade angle conditions, which were correlated by multiple regressions (average R^2 = 0.995 for AU4000 and 0.988 for AU5000). This database replaces an outdated set of rotary atomizer data measured in the 1980s by the USDA Forest Service and fills in a gap in data measured in the 1990s by the Spray Drift Task Force. Since current USDA Forest Service spray projects rely on rotary atomizers, the creation of the database (and its multiple regression interpolation) satisfies a need seen for ten years.*

Keywords. *AGDISP, Database, Drop size distribution, Multiple regression, Rotary atomizer.*

The drop size distribution of aerially applied spray material atomized by nozzles influences the magnitude of evaporation, spray deposition, drift, and application effectiveness. Droplet size information, in particular the volume fraction in the smaller droplet sizes (which tend to be more prone to drift) and the larger droplet sizes (which fall largely within the application area), is critical to forestry and agricultural applications, where specific levels of spray material in specific droplet size ranges must be deposited to achieve efficacy.

In an effort to build a database of typical formulations and aerial application conditions, the USDA Forest Service (FS), and other agencies and companies, conducted wind tunnel tests to determine drop size distributions of pesticides and simulant spray material when applied through hydraulic and rotary atomizers. These studies, from the 1970s to the 1990s, were intended to provide data to determine the effects of application and tank mix variables on the atomization of aerially applied sprays. The factors considered in these studies included the spray pressure, liquid flow rate, air velocity and shear across the atomizer, physical chemistry (viscosity, specific gravity, and surface tension), and atmospheric conditions. The FS database was summarized in Skyler and Barry (1991) and assembled as a library within the FS aerial spray prediction models AGDISP and FSCBG. A preliminary examination of this database produced techniques for collapsing and correlating the data (Teske et al., 1991) and examining possible non-Newtonian effects (Teske and Bilanin, 1994).

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These data were measured with a Particle Measurement Systems (PMS) optical array probe, with a minimum droplet resolution of 34 μm. Recently, the Spray Drift Task Force (SDTF) developed a large database of spray droplet size information (Hewitt et al., 2002) based on the Malvern laser diffraction analyzer. This technique allowed measurements of droplet diameters down to 4 μm. The SDTF field and subsequent modeling studies (Teske et al., 2002a; Bird et al., 2002) established that knowledge of the droplet spectrum at its smaller droplet sizes is important for drift assessment, and that the Malvern (or similar) instrument range is essential to recover that detail.

Droplets in the range of 80 to 120 μm are often desirable for efficacy in forestry applications. To achieve these droplet sizes, some important fraction of sub-80 μm droplets will always be produced below the 34 μm PMS cutoff. The historical FS database contains 40 AU5000 rotary atomizer entries, out of 250, while the SDTF database contains only three AU5000 entries, out of 1294 (the SDTF was more concerned with hydraulic nozzles spraying agricultural pesticides). To extend the usefulness of the PMS data, an analytical approach was developed to convert PMS rotary atomizer data to Malvern-like data (Teske et al., 2002b). However, a revised database of drop size distributions is now necessary, since many of the spray materials tested in the original FS database are no longer sprayed in forestry situations. For example, the primary use of rotary atomizers by the FS is in spraying *Bacillus thuringiensis* (Bt) in gypsy moth control. Bt is best applied by rotary atomizers (to recover the smaller droplet sizes desired for application efficiency). Generating a model database for rotary atomizers would then provide a ready resource for planning future spray projects. This article summarizes additional wind tunnel experiments conducted to generate this database, and the strong statistical correlation generated from the data.

ROTARY ATOMIZER DATA COLLECTION

The new data consist of 310 drop size distribution measurements (including replicates), varying tank mix [water, water with 1% w/w Sta-Put polyacrylamide (Nalco Chemical Company, Naperville, Ill.), water with 0.25% w/w