Determine Spray Nozzle Attributes for New Formulation

Problem:
A drug delivery company was in the R&D stage of a new powder formulation for its spray dry process. Very small changes in operating conditions were causing dramatic changes in the spray characteristics. Therefore, proper operating conditions were essential.

Objective:
The company needed to qualify and quantify the spray processes critical to a new proprietary spray dry formulation. In order to optimize the process, a precision spray nozzle was needed to meet the stringent drop size requirements as well as other spray performance variables. It was essential that the ultimate solution be scalable from lab to production capacity while maintaining the successfully achieved spray characteristics.

Procedure:
Various air atomizing nozzles and fluid/air cap set-ups were tested to determine drop size, velocity, and density variations across the spray plume. Correlations between wet drop characteristics and dry particle characteristics were acquired. Lab scale and production scale flows were tested and compared to determine the feasibility of maintaining spray characteristics.

Solution:
A full cone air atomizing nozzle was determined to most efficiently provide the required spray characterization.

Based on initial test data, Spray Analysis and Research Services designed a prototype spray dry nozzle that met the drop size, flow rate and velocity requirements. Scale-up capacity nozzles were fabricated and tested and the project was able to proceed on schedule.
An increase in the mass ratio (gas flow to liquid flow) causes the drop size to decrease due to the larger amount of atomizing gas. The edges of the spray are most affected by this increase in gas flow while the drop size in the center of the spray plume decreases only slightly. Drop size in this figure is provided as a Sauter Mean Diameter ($D_{32}$) which is representative of the drop volume to drop surface area.

The average drop velocity is increased in the center of the spray as the mass ratio is increased. Mass ratio 2 provided the most uniform drop size while having a velocity that properly accomplished the spray dry process.