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APPARENT SIZE SHIFTS IN MEASUREMENTS OF DROPLETS WITH THE AERODYNAMIC PARTICLE SIZER AND THE AEROSIZER. *PAUL BARON, Gregory Deye, Anthony Martinez and Erica Jones, National Institute for Occupational Safety and Health, Cincinnati, OH*

Observations of the size of liquid droplets using the Aerodynamic Particle Sizer (APS, TSI, Inc.) and the Aerosizer (API, Inc. and TSI, Inc.) indicated that the measured size was significantly different from the aerodynamic diameter as measured by observing droplet settling velocity. The size shifts (Delta) were related to droplet aerodynamic diameter, viscosity and surface tension by the following empirical equation: Delta = a x diameter^b / (surface_tension^c x viscosity^e). The value of b was set to two. The values for a, c, and e were determined by a regression analysis of all the available data collected over several years with several models of each instrument. For the APS (Models 3300, 3320, 3321), the constants were: a = 1.22 x 10^-4; c = 0.5956; and e = 0.6916. For the Aerosizer (Models LD and DSP) the constants were: a = 4.061 x 10^-4; c = 0.9583; and e = 0.2516.

The size shifts were initially attributed to droplet distortion Bartley et al. [1]. This appears to be correct for the Aerosizer. However, for the APS, the situation was complicated by droplet deposition in the upper aerosol focusing nozzle. The nozzle Stokes diameter indicated that particles larger than about 5 micrometers can impact on the upper surface of the nozzle. Liquid built up in the nozzle, changing its shape and opening size, resulting in a velocity increase for particles passing through. When measuring particles, e.g. other droplets or solid particles, after liquid has deposited in the nozzle, the measured size shifted as much as 5 - 10%. After a few minutes this apparent size shift decreased by about half, but generally did not go away without cleaning of the nozzle. By cleaning the nozzle and observing the size shift immediately, the size shift due to droplet distortion was observed. The shift caused by nozzle loading then occurred usually within a few minutes at moderate concentrations of droplets larger than 5 micrometers. Thus, most of the measured size shifts for the APS as indicated by the equation above were caused by droplet loading in APS nozzle. Griffiths et al. [2] also documented significant size shifts for droplets observed with the APS. Their shifts were generally larger than in the present study and could be fitted using the above equations, though with different constants. While the above equations can be used to estimate the APS size shifts, these shifts may change with time and with liquid and, perhaps, solid particle loading.

1. Bartley, D.L., et al., Droplet Distortion in Accelerating Flow. J. Aerosol Sci., 2000. 31(12): p. 1447-1460.
2. Griffiths, W.D., P.J. Iles, and N.P. Vaughan, The Behaviour of Liquid Droplet Aerosols in an APS 3300. J. Aerosol Sci., 1986. 17(6): p. 921-930.

1PB2

A TOOL TO DESIGN AND EVALUATE AERODYNAMIC LENS SYSTEMS. *XIAOLIANG WANG, Peter H. McMurry, Department of Mechanical Engineering, University of Minnesota, 111 Church St. S.E., Minneapolis, MN 55455; Frank Einar Kruis, Process and Aerosol Measurement Technology, University Duisburg-Essen, D -47047 Duisburg, Germany*

Aerodynamic lens systems (Liu, et al., 1995a, b) have been widely used to produce particle beams with controlled dimensions and divergence. Many particle mass spectrometers use aerodynamic lenses as inlets to increase particle transport and detection efficiencies. Aerodynamic lens systems are also potentially promising tools to fabricate small parts in micro-electro-mechanical systems (MEMS). Although computational fluid dynamics and particle trajectory simulations can provide accurate results when designing or evaluating a lens system, such models require predefined geometry of the aerodynamic lens assembly, which needs to be iteratively optimized. This process is time consuming and computationally expensive. A simple lens design tool that can provide quick and reasonably accurate results is desirable for engineering purposes.
A lens system design guideline was proposed by Liu et al. (1996) assuming negligible pressure drops across lenses. However, the pressure drops are not negligible in many cases when the lens diameter is small or the mass flowrate is high. An inaccurate flow model might cause significant errors in the design.
In this study, we have developed a software tool to design and evaluate aerodynamic lens systems and have identified rules to optimize lens performance for a given set of parameters. A modified flow model considering the compressible and viscous effects of flow through orifices is implemented in this design tool. With this tool, the operating parameters (flowrate, pressure and carrier gas) and lens geometries (orifice size, number of lenses, tube diameter and spacer between lenses) can be optimized to obtain best lens performance (maximum particle focusing, minimum particle loss, minimum pumping capacity, etc.). Especially noteworthy is inclusion of a new criterion to minimize the effects of diffusional broadening for nanoparticles.

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