3PE4

AERODYNAMIC PARTICLE FOCUSING SYSTEM ASSISTED BY RADIATION PRESSURE. *SANGBOK KIM; Hyungho Park; Sangsoo Kim, KAIST, Deajon, Korea*

A technique for a fine particle beam focusing under the atmospheric pressure was introduced by using an aerodynamic lens assisted by radiation pressure. To introduce the radiation pressure in the aerodynamic focusing system, a 25 mm plano-convex lens having a 2.5 mm hole at its center was used as an orifice. The particle beam width was measured for various laser power, particle size, and flow velocity. In addition, the effect of the laser characteristics on the beam focusing was evaluated by comparing an Ar-Ion continuous wave laser and a pulsed Nd-YAG laser. For the pure aerodynamic focusing system, the particle beam width decreased as particle size and Reynolds number increased. For the particle diameter of 0.5 µm, the particle beam was broken due to the secondary flow at Reynolds number of 694. Using the Ar-Ion CW laser, the particle beam width became smaller than that of the pure aerodynamic focusing system about 16 %, 11.4 % and 9.6 % for PSL particle size of 2.5 µm, 1.0 µm, and 0.5 µm respectively at the Reynolds number of 320. Particle beam width was minimized around the laser power of 0.2 W. However, as the laser power was higher than 0.4 W, the particle beam width increased a little and it approached almost a constant value which was still smaller than that of the pure aerodynamic focusing system. The radiation pressure effect on the particle beam width is intensified as Reynolds number decreases or particle size increases relatively. On the other hand, using 30 Hz pulsed Nd-YAG laser, the effect of the radiation pressure on the particle beam width was not distinct unlike Ar-Ion CW laser.

3PE5

A MODEL FOR DROPLET DISTORTION EFFECTS IN AERODYNAMIC PARTICLE SIZING INSTRUMENTS. *David J. Schmidt, ERIC GESSNER, Goodarz Ahmadi, Department of Mechanical and Aeronautical Engineering, Clarkson University, Potsdam, NY 13699-5725; Paul A. Baron, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45226*

Aerodynamic Particle Sizers (APS) are widely used to measure size distributions of aerosols. Typically, aerosol particles are accelerated to high velocities in the detection zones of these instruments. These high velocities could lead to the occurrence of non-Stokesian flow, and in the case of liquid droplets, a shape distortion that could affect the estimation of the true aerodynamic diameter. Droplets have been observed to distort into oblate spheroids in the acceleration field of the APS, resulting in an underestimation of particle aerodynamic diameter. Droplet deformation and breakup is of primary concern to understanding of the spray formation processes. Improving the efficiency of sprays is of interest in many industrial processes including internal combustion engines, inhalation drug delivery devices, spray painting, and aerosol coatings.

When a liquid droplet travels through a gas at high speed, the dynamic interaction between the carrier gas and the droplet leads to variations in pressure along the droplet surface. In addition to surface shear, these pressure variations cause the droplet to deform. However, surface tension tends to restore the drop to a spherical shape. If the pressure difference and the shear forces overcome the surface tension force, the droplet deforms and may eventually break up. The shape of the droplet as it deforms is determined by the interplay of surface tension and the shear and pressure forces. The ratio of these forces, characterized by the Weber number, in combination with a ratio of liquid properties (Ohnesorge number, density and viscosity ratios), are the primary parameters that describe the droplet deformation and breakup processes.

In this study, the axisymmetric deformation of a liquid droplet as it accelerates through the flow of air in a converging nozzle that models an APS instrument is examined. It is assumed that the initially spherical droplet remains symmetric as it deforms into an oblate ellipsoid. The relative velocity between the droplet and the surrounding laminar flow is estimated with the use of the FLUENTTM code. Subsequent estimations of droplet aspect ratio and diameter changes are made. For the moderate Reynolds number flow, non-Stokesian effects are accounted for in the drag correlation. The computational model is tested for a number of fluids with varying Ohnesorge, liquid-gas density and liquid-gas viscosity ratios. It is found that the predicted droplet distortions are consistent with the available experimental data for the range of parameter space examined. Furthermore, the model provides an efficient and computationally inexpensive way to predict droplet shape distortion in an accelerating flow field.