Medical Inhaler Spray Measured at Three Locations

Application Note PDPA-002

Sprays are used most often to disperse a liquid in space, such as a window cleaner spray or fuel spray. But sprays can also be used to disperse a medicine in the nose or mouth, in order to initiate its absorption into the human body. This is the aim of metered dose inhalers (MDIs).

A TSI Phase/Doppler Particle Analyzer (PDPA) can be used to obtain data that will be invaluable in comparing the MDIs. An MDI spray plume may be expected to undergo agglomeration and rapid evaporation downstream. Compared to hole type pressure atomizers, however, MDI sprays will be more spatially uniform in size and velocity, since there is no intact liquid core. Evaporation can be expected to be limited by the mixing rate. The opening and closing process of the MDI atomizer could introduce abnormally large and/or slow moving droplets.

A 1D PDPA was set up with a 300 mW laser, FBL1 fiberlight™ beam generator, and TM250 transmitter probe. Signals were captured by a RV1070 receiver and sent to a PDM1000-1P detector module. An FSA 3500-1P signal processor and FLOWSIZER™ software were used to analyze the data. A custom MDI test stand was used, which produced an output signal at the start of aerosol generation. The measurement position was kept on the centerline, but was set to 25 mm, 100 mm, or 150 mm down stream of the MDI outlet, as shown in Figure 1.

Figure 1 shows the measured results for a single MDI unit at three downstream locations. Two things can be pointed out in the figure: There are fewer of the smaller droplets between 25 mm and 100 mm, but an increase in larger droplets between the same points. Secondly, between 100 mm and 150 mm, the peak diameter decreases rapidly. Thus, it can be concluded that evaporation may cause an

Table 1. Statistical Results for MDI Plume Measurement

	Downstream Position		
	25 mm	**100 mm**	**150 mm**
Mean Velocity (m/s)	8.06	4.31	2.75
Turbulence Intensity (%)	38.76	37.7	35.1
D10 (µm)	45.7	47.7	20.1
D20 (µm)	47.9	51.3	25.3
D30 (µm)	50.2	55	30.5
D32 (µm)	54.9	63.3	44
Vol. Median Dia. (µm)	55.4	66.1	50.2
Vol. 10% (µm)	33.1	37.7	21.9
Vol. 90% (µm)	76.8	94.6	84.9
Concentration (#/cc)	1765	1851	1083

initial reduction in the number of smaller droplets, and agglomeration may be acting to increase the number of larger drops. Afterwards, the plume expands and mixes with ambient air, causing a sharp reduction in all droplet sizes. Table 1 shows a summary of the important statistics for the above three cases. Notice that the initial velocity is about 8m/s, which decays to under 3 m/s at the 150 mm location. Comparing the 25 mm location and 100 mm location, D10, D20, and D30 are fairly similar. D32 increases noticeably from the 25 mm location to the 100 mm location, possibly due to agglomeration and loss of smaller droplets. By 150 mm downstream, the concentration drops to about 1100 #/cc and D10 reaches 20um.

The above results illustrate some of the spatial analysis one can perform with data obtained using a TSI PDPA. For measurement of profiles through the plume, a computer-controlled traverse system can be used with the PDPA. Manual or fully automatic scans can be made.

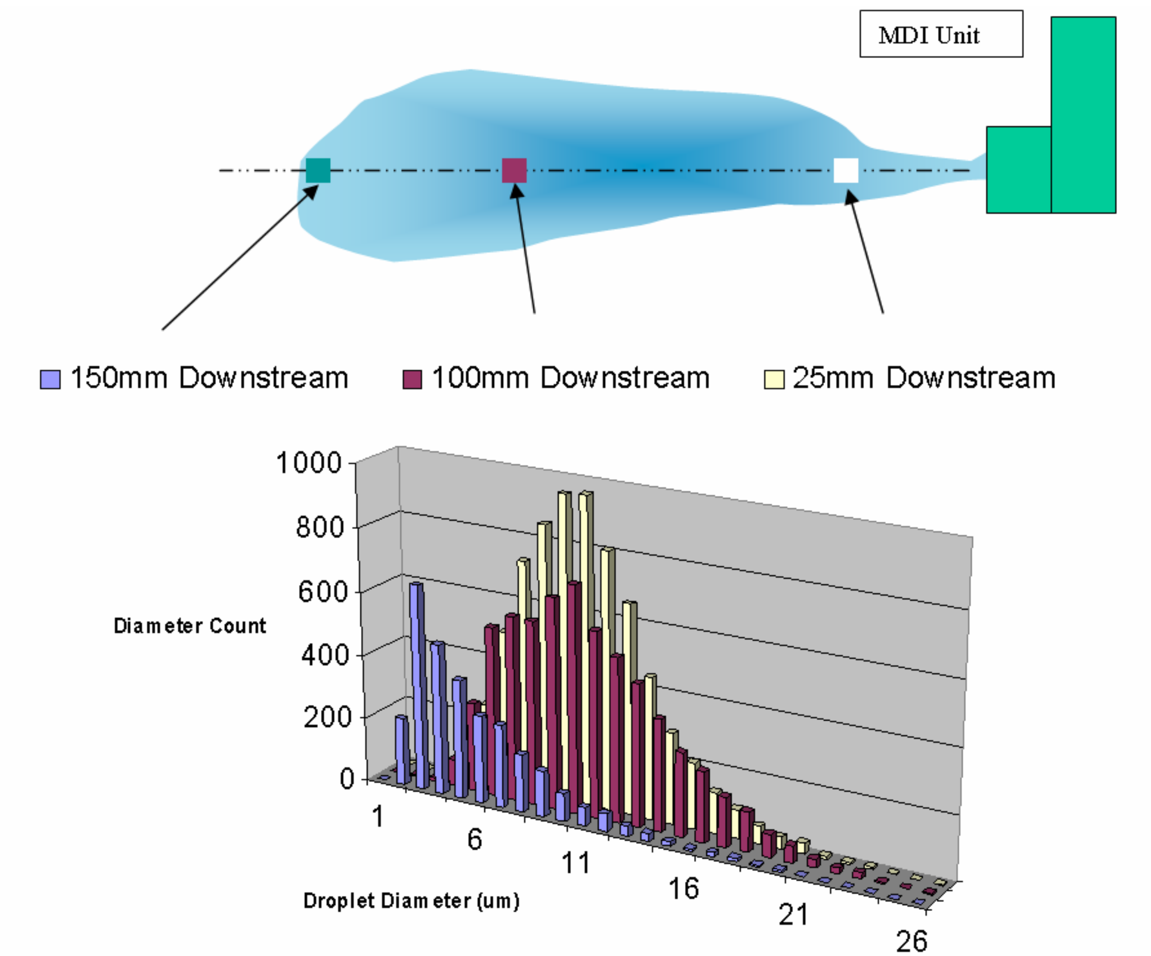

Figure 1: Measured diameter histograms at three locations in the MDI plume. Measurements were made on the plume centerline.

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