Particle Size

All particles have mass, the strongest forces acting on mass are gravity and inertial forces. Volume is not a consideration of particle size determination. A bubble has volume but essentially no mass. Gravity does not affect volume.

A cascade impactor uses inertial impaction principle to segregate particles by size and it does so by separating particles by mass. Particle size is a function of volume not of mass, when particles are generated from a homogenous solution, particles of larger size (large volume) will have a greater mass.

As particles traverse the cascade impactor, the larger particles will resist change in direction and tend to impact earlier. The cascade impactor is divided into stages separated by nozzles with ever-smaller orifices. The flow drawing the aerosol into the impactor is constant and calibrated for each unit. Since flow is constant and the particles must change direction and pass through ever-smaller orifices, particles will rainout (impact) by size with larger particles impacting earlier in the device. Since the size of a tube determines flow, the flowrate in the system is accelerated as the particles move through the smaller orifice sizes. So smaller particles remain in the flow and travel on to the next plate.

Method Rationale

A cascade impactor is the gold standard for particle measurement. It is specified in the USP and accepted by the FDA for particle sizing when measuring particles in medical aerosols. Cascade impactors separate particles physically by mass and provides a more direct method of measurement[3].

Laser particle analysis is somewhat flawed, because it indirectly measures the size and volume of particles from the scattering of light from a laser beam reflected off the particle. Larger particles scatter more light. Laser analysis cannot measure mass. Laser analysis assumes that all particles are round, when they are not. It extrapolates the size of large numbers of particles from the measurement of a few particles in a cluster. Overlapping of particles will create the illusion of larger particles, which must be excluded from the count. Further, the laser cannot distinguish small spherical particles from larger elliptical particles viewed on end.

Using consistent controllable parameters such as temperature, humidity, and flow, we are able to reproduce testing conditions, thus minimizing bias and erroneous results.

Conclusion

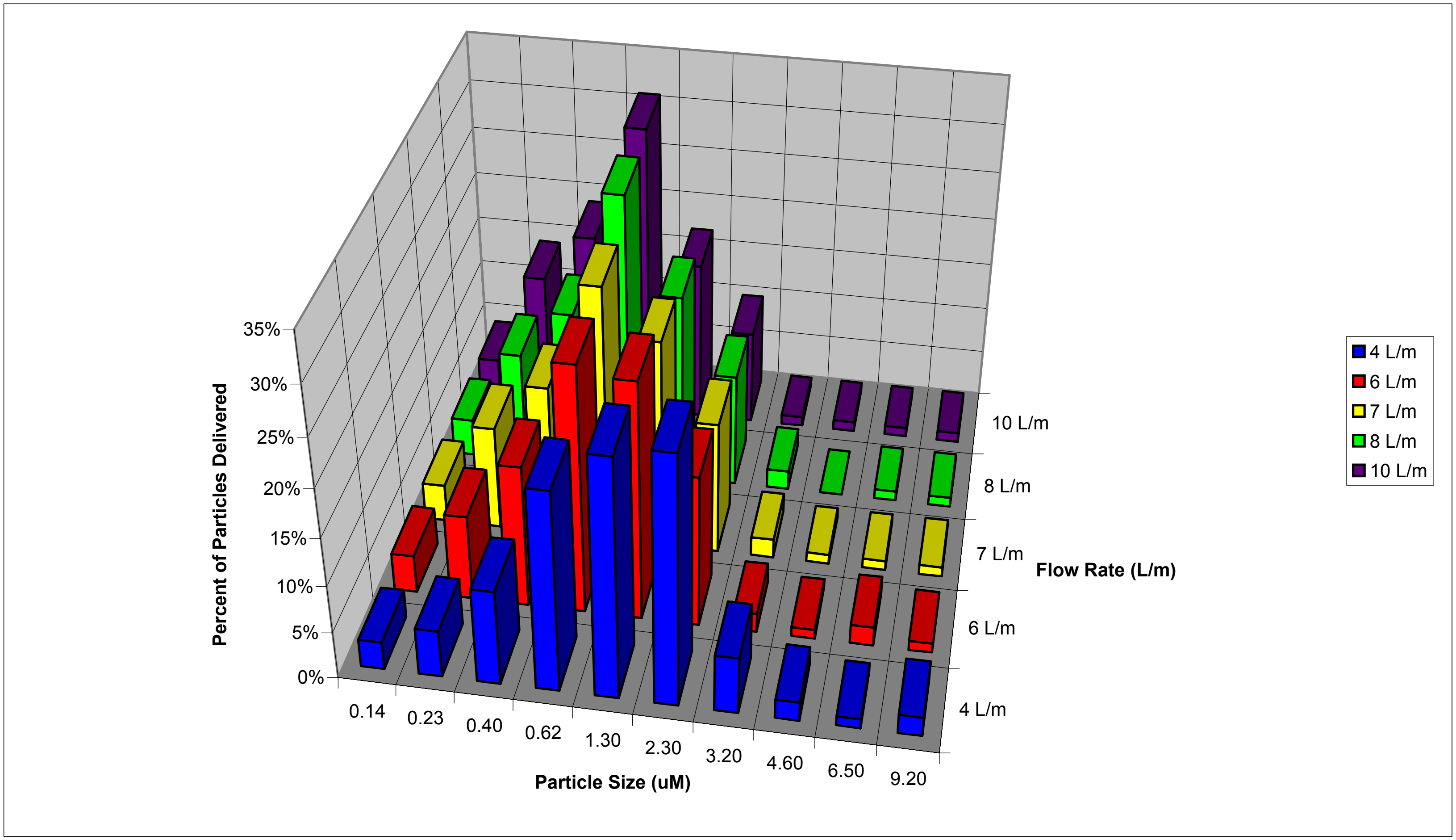
The bar graph reveals that the NebuTech® HDN® has a Mass Median Aerodynamic Diameter (MMAD) of 0.98 to 1.30 at a flowrate of .4 to 10 lpm.

When evaluating the performance of nebulizers it is important to note that the testing conditions are all the same. For instance, a drug tested in a water solution will have a different particle size range and MMAD than a drug that was tested in a saline solution. MMAD is the central point of the mass of an aerosol. Fifty percent of the mass of the aerosol will be above the central number and 50% will be below it. Assuming the ideal respirable particle size range is between 0.5 and 5 microns the ideal MMAD will be centered in this range by mass.

The NebuTech HDN at 8 lpm has a respirable range of 0.4 microns to 3.2 microns. At this flowrate, 81% of the particles are respirable and the MMAD (which takes into account all particles) is 1.0.

NebuTech HDN

Flow Rate (L/min.)	Particle Size (microns)										
	0.14	0.23	0.40	0.62	1.30	2.30	3.20	4.60	6.50	9.20	MMAD
4	3%	5%	10%	21%	25%	26%	6%	2%	1%	2%	1.30
6	4%	9%	15%	26%	25%	16%	2%	1%	2%	1%	1.10
7	4%	11%	16%	27%	22%	14%	2%	1%	1%	1%	1.10
8	4%	12%	17%	30%	20%	12%	2%	0%	1%	1%	1.00
10	4%	14%	19%	31%	17%	10%	1%	1%	1%	1%	0.98



Test Specifications: Tests were performed with 50 psi source pressure with 0.9% NaCl. Particle size distribution measured by QCM Cascade Impactor.