

1.0 Object

- 1.1 To test the performance of Rossmax NB500 nebulizer

2.0 Equipment List

- 2.1 Rossmax NB500 Nebulizer*2
- 2.2 Rossmax Nebulizer kit*2
- 2.3 Malvern Spraytec particle size analyzer
- 2.4 Marple 298 Cascade Impactor
- 2.5 Chroma 61602 Programmable AC Source
- 2.6 Shimadzu AUW120D microbalance
- 2.7 A.P. Buck, Inc. Libra Plus LP-5 sampling pump
- 2.8 SSI P51-6BarS-A-MD-20mA pressure meter
- 2.9 Golden Mountain Enterprise Co. Ltd. F33L0096 flow meter
- 2.10 Humidity/Temperature Meter
- 2.11 Taiwan Biotech Co., Ltd 0.9% Saline solution
- 2.12 Atrovent Ipratropium Bromide
- 2.13 Atrovent Flixotide
- 2.14 AstraZeneca Terbutaline Sulphate
- 2.15 Ventoline (2.5mg) Salbutamol/Sulphate
- 2.16 Casio Timer

3.0 Testing Items

- 3.1 Aerosol Particle Size Distribution Testing(By Malvern Spraytec)
- 3.2 Aerosol Particle Size Distribution Testing(By Marple 298 Cascade Impactor)
- 3.3 Nebulization Rate Testing(Including drugs testing)
- 3.4 Residual Volume Testing

4.0 Testing Procedure

4.1 Aerosol Particle Size Distribution Testing(By Malvern Spraytec)

- 4.1.1 Each sample should be tested with 2.5ml 0.9% saline solution for 3 minutes.
- 4.1.2 Add 2.5ml 0.9% saline solution into the nebulizer kit,
- 4.1.3 Connect the nebulizer kit with NB500 and put at the testing site, the nebulizer kit's outlet must be kept at 3.0 cm from the laser beam.
- 4.1.4 Start recording Spraytec for more than 15 secs, then start NB500 for testing.
- 4.1.5 After 3.0 minutes have been reached, stop the NB500 and then stop Spraytec.
- 4.1.6 Checks Spraytec records

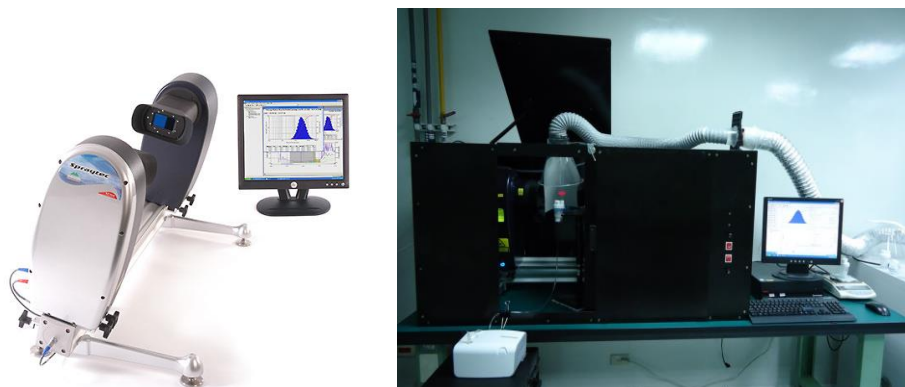


Fig 1. Malvern Spraytec and Testing site

4.2 Aerosol Particle Size Distribution Testing(By Marple 298 Cascade Impactor)

- 4.2.1 Each sample should be tested with 2.5 ml 0.9% saline solution.
- 4.2.2 Add 2.5 ml 0.9% saline solution into the nebulizer kit, measure the weight before and after the testing.
- 4.2.3 Connect suction and sampling pumps to the cascade impactor testing module as see in the Fig 2.
- 4.2.4 Connect the nebulizer kit with NB500 and connect the nebulizer kit outlet to cascade impactor inlet.(Fig 2.)
- 4.2.5 The suction and sampling pumps are turned on and allowed to stabilize at required flows.
- 4.2.6 Finally start the NB500.(Sampling times can be varied for different nebulizers to allow for maximum deposit on each stage without overloading stages.
- 4.2.7 After sampling for the required time, NB500 is switched off, followed a few seconds later by the sampling pump and then the suction pump.
- 4.2.8 Dismount the cascade impactor from the testing module
- 4.2.9 Dismantle the impactor and determine the amount of NaCl on the individual stages of the impactor, the input connection and the outlet filter.

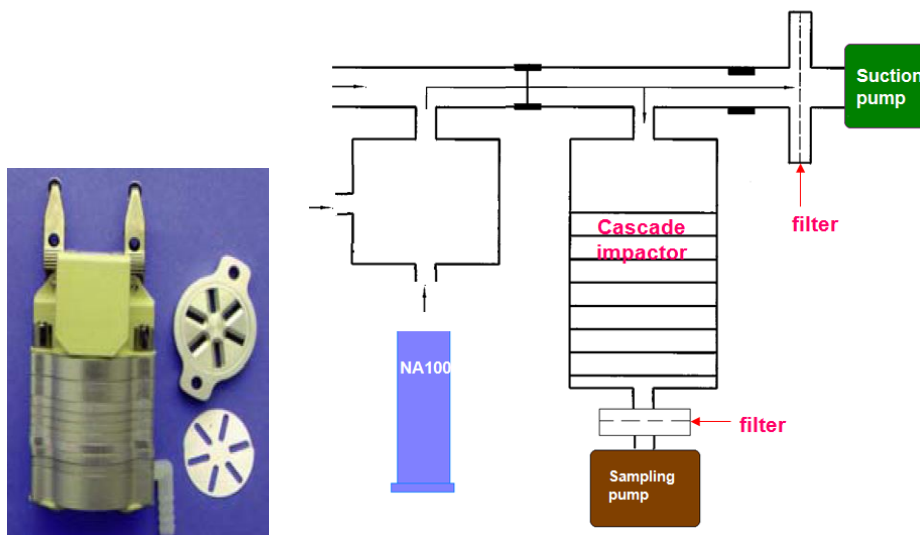


Fig 2. Cascade Impactor and Testing setup

4.3 Nebulization Rate Testing(Including Drug Testings)

- 4.3.1 Each sample should be tested with 2.0 ml 0.9% saline solution, Atrovent Ipratropium Bromide, Atrovent Flixotide, AstraZeneca Terbutaline Sulphate and Ventoline (2.5mg) Salbutamol/Sulphate for 1 minutes.
- 4.3.2 Add 2.0ml 0.9% saline solution/drugs into the nebulizer kit, measure the weight before and after the testing.
- 4.3.3 Connect the nebulizer kit with NB500 and then start NB500 for testing.
- 4.3.4 After 1.0 minutes have been reached, stop the NB500
- 4.3.5 Calculates how many weight of the solution/drugs have been nebulized

4.4 Residual Volume Testing

- 4.4.1 Each sample should be tested with 2.0ml 0.9% saline solution and nebulized till the bottle is empty.
- 4.4.2 Add 2.0ml 0.9% saline solution into the nebulizer kit, measure the weight before and after the testing.

- 4.4.3 Connect the nebulizer kit with NB500 and put at the testing site,
- 4.4.4 Start NB500
- 4.4.5 Shakes the nebulizer kit one or two times during nebulizing if there has large droplet stick on the wall inside the nebulizer kit.
- 4.4.6 After the nebulizer kit is empty, stop NB500 and measure the mass of the tested bottle
- 4.4.7 Calculates the Residual Volume

5.0 Testing Results

5.1 Aerosol Particle Size Distribution Testing(By Malvern Spraytec)

NB500	Valve Status	Testing times	Dv10	Dv50	Dv90	SMD	SR	
Sample 1	Fully Open	1	1.516	3.175	6.497	2.720	4.286	Fig 3
		2	1.545	3.232	6.607	2.770	4.276	
		3	1.573	3.258	6.554	2.800	4.167	
		Mean	1.545	3.222	6.553	2.763	4.243	
		Std Dev	0.029	0.042	0.055	0.040	0.066	
	Closed	1	1.280	2.943	6.529	2.421	5.101	Fig 4
		2	1.322	3.085	6.936	2.521	5.247	
		3	1.358	3.249	7.486	2.624	5.513	
		Mean	1.320	3.092	6.984	2.522	5.287	
		Std Dev	0.039	0.153	0.480	0.102	0.209	
Sample 2	Fully Open	1	1.595	3.164	6.346	2.783	3.979	
		2	1.568	3.120	6.302	2.743	4.019	Fig 5
		3	1.591	3.150	6.266	2.771	3.938	
		Mean	1.585	3.145	6.305	2.766	3.979	
		Std Dev	0.015	0.022	0.040	0.021	0.040	
	Closed	1	1.397	3.334	7.717	2.702	5.524	Fig 6
		2	1.426	3.492	8.294	2.796	5.816	
		3	1.465	3.627	8.646	2.885	5.902	
		Mean	1.429	3.484	8.219	2.794	5.747	
		Std Dev	0.034	0.147	0.469	0.092	0.198	

Average Particle Size Distribution

2012 Nov 18 - 15:31:13

(average size distribution, weighted)

20121116C.smealExp 001 - 2012 Nov 18\Averages\NB500_230_50_1_Open 1 1.psd

Sample : NB500_230_50_1_Open

Start+28 (s) :: +3:21 (s)

Standard Values:

Trans = 78.8 (%)

Cv = 1.079 (PPM)

SSA = 2.206 (m²/cc)

Dv(10) = 1.516 (μm)

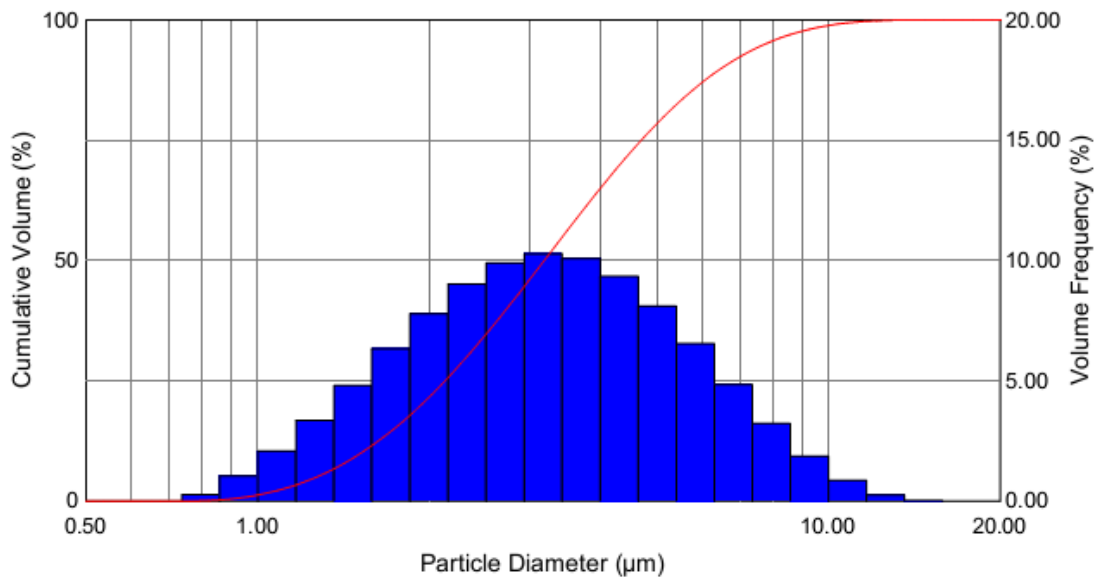
Dv(50) = 3.175 (μm)

Dv(90) = 6.497 (μm)

Span = 1.569

D[3][2] = 2.72 (μm)

D[4][3] = 3.661 (μm)



Size (μm)	% V <	% V	Size (μm)	% V <	% V	Size (μm)	% V <	% V
0.117	0.00	0.00	2.51	34.70	9.03	54.12	100.00	0.00
0.136	0.00	0.00	2.93	44.60	9.90	63.10	100.00	0.00
0.158	0.00	0.00	3.41	54.88	10.28	73.56	100.00	0.00
0.185	0.00	0.00	3.98	64.97	10.09	85.77	100.00	0.00
0.215	0.00	0.00	4.64	74.31	9.34	100.00	100.00	0.00
0.251	0.00	0.00	5.41	82.41	8.10	116.59	100.00	0.00
0.293	0.00	0.00	6.31	88.95	6.54	135.94	100.00	0.00
0.341	0.00	0.00	7.36	93.79	4.84	158.49	100.00	0.00
0.398	0.00	0.00	8.58	97.02	3.23	184.79	100.00	0.00
0.464	0.00	0.00	10.00	98.88	1.86	215.44	100.00	0.00
0.541	0.00	0.00	11.66	99.74	0.86	251.19	100.00	0.00
0.631	0.00	0.00	13.59	99.99	0.25	292.87	100.00	0.00
0.736	0.00	0.00	15.85	100.00	0.01	341.46	100.00	0.00
0.858	0.26	0.26	18.48	100.00	0.00	398.11	100.00	0.00
1.00	1.29	1.03	21.54	100.00	0.00	464.16	100.00	0.00
1.17	3.37	2.08	25.12	100.00	0.00	541.17	100.00	0.00
1.36	6.73	3.36	29.29	100.00	0.00	630.96	100.00	0.00
1.58	11.54	4.81	34.15	100.00	0.00	735.64	100.00	0.00
1.85	17.88	6.34	39.81	100.00	0.00	857.70	100.00	0.00
2.15	25.67	7.79	46.42	100.00	0.00	1000.00	100.00	0.00

Fig 3. Sample 1 testing result (Valve fully open)

Average Particle Size Distribution

2012 Nov 18 - 15:54:1

(average size distribution, weighted)

20121116C.smeal\Exp 001 - 2012 Nov 18\Averages\NB500_230_50_1_Closed 1 1.psd

Sample : NB500_230_50_1_Closed

Start+9 (s) :: +3:12 (s)

Standard Values:

Trans = 69.2 (%)

Dv(10) = 1.28 (µm)

Span = 1.784

Cv = 1.432 (PPM)

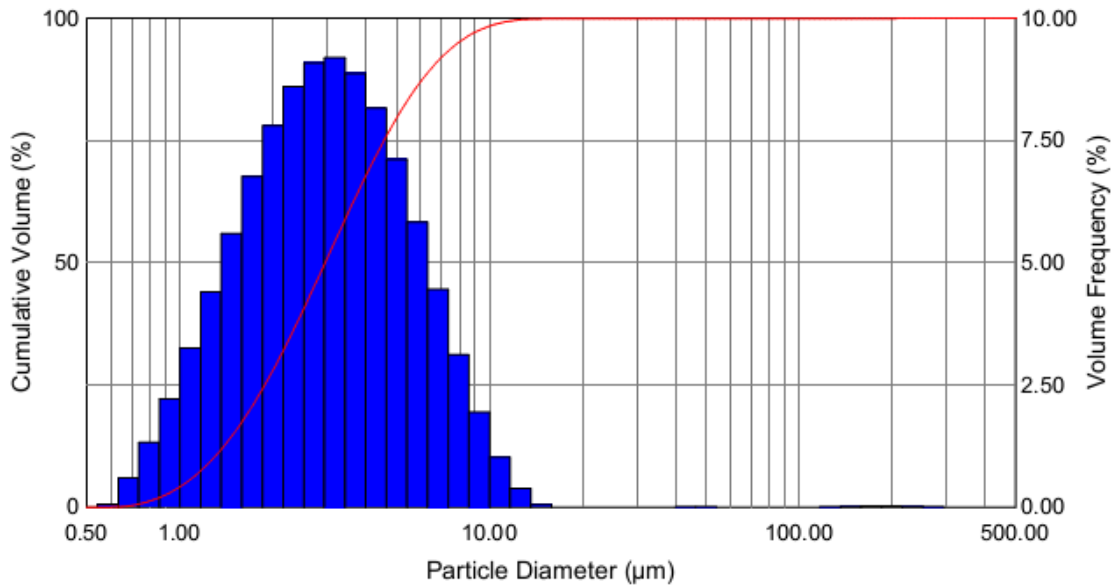
Dv(50) = 2.943 (µm)

D[3][2] = 2.421 (µm)

SSA = 2.478 (m²/cc)

Dv(90) = 6.529 (µm)

D[4][3] = 3.697 (µm)



Size (µm)	% V <	% V	Size (µm)	% V <	% V	Size (µm)	% V <	% V
0.117	0.00	0.00	2.51	40.63	8.60	54.12	99.89	0.00
0.136	0.00	0.00	2.93	49.72	9.09	63.10	99.89	0.00
0.158	0.00	0.00	3.41	58.91	9.19	73.56	99.89	0.00
0.185	0.00	0.00	3.98	67.78	8.88	85.77	99.89	0.00
0.215	0.00	0.00	4.64	75.94	8.16	100.00	99.89	0.00
0.251	0.00	0.00	5.41	83.06	7.11	116.59	99.90	0.00
0.293	0.00	0.00	6.31	88.89	5.83	135.94	99.90	0.01
0.341	0.00	0.00	7.36	93.35	4.46	158.49	99.92	0.02
0.398	0.00	0.00	8.58	96.47	3.12	184.79	99.95	0.03
0.464	0.00	0.00	10.00	98.41	1.95	215.44	99.98	0.03
0.541	0.00	0.00	11.66	99.44	1.03	251.19	99.99	0.02
0.631	0.06	0.06	13.59	99.83	0.39	292.87	100.00	0.01
0.736	0.66	0.60	15.85	99.88	0.05	341.46	100.00	0.00
0.858	1.98	1.32	18.48	99.88	0.00	398.11	100.00	0.00
1.00	4.20	2.22	21.54	99.88	0.00	464.16	100.00	0.00
1.17	7.45	3.26	25.12	99.88	0.00	541.17	100.00	0.00
1.36	11.86	4.40	29.29	99.88	0.00	630.96	100.00	0.00
1.58	17.46	5.60	34.15	99.88	0.00	735.64	100.00	0.00
1.85	24.22	6.77	39.81	99.88	0.00	857.70	100.00	0.00
2.15	32.03	7.80	46.42	99.89	0.00	1000.00	100.00	0.00

Fig4. Sample 1 testing result (Valve Closed)

Average Particle Size Distribution

2012 Nov 18 - 15:46:0

(average size distribution, weighted)

20121116C.smea\Exp 001 - 2012 Nov 18\Averages\NB500_230_50_2_Open 1 2.psd

Sample : NB500_230_50_2_Open

Start+3:18 (s) :: +7:02 (s)

Standard Values:

Trans = 69.9 (%)

Cv = 1.658 (PPM)

SSA = 2.187 (m²/cc)

Dv(10) = 1.568 (µm)

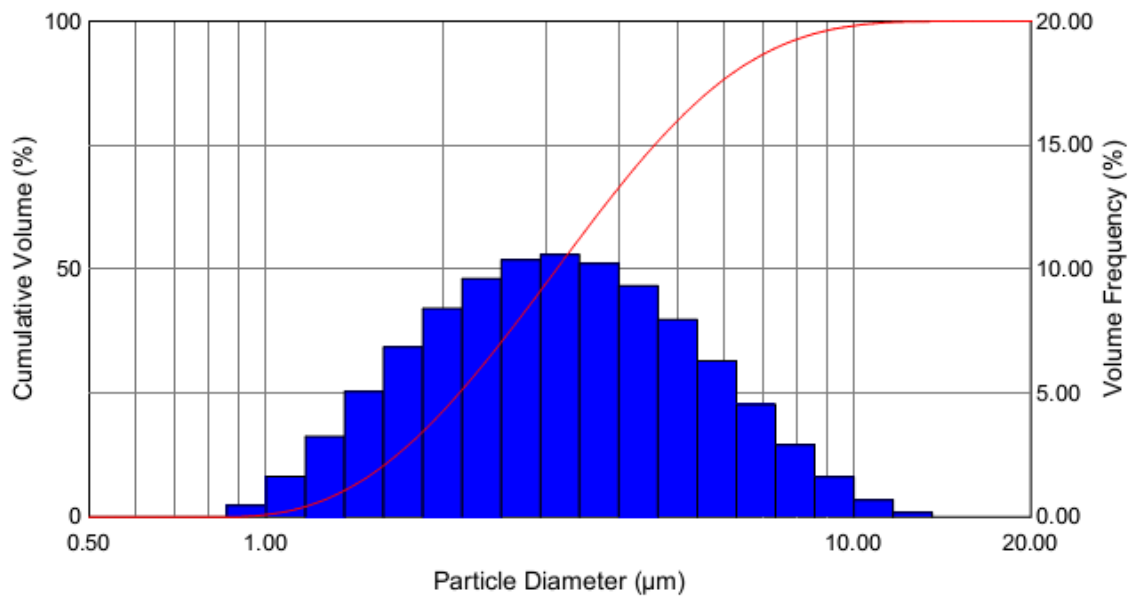
Dv(50) = 3.12 (µm)

Dv(90) = 6.302 (µm)

Span = 1.517

D[3][2] = 2.743 (µm)

D[4][3] = 3.596 (µm)



Size (µm)	% V <	% V	Size (µm)	% V <	% V	Size (µm)	% V <	% V
0.117	0.00	0.00	2.51	35.27	9.62	54.12	100.00	0.00
0.136	0.00	0.00	2.93	45.63	10.37	63.10	100.00	0.00
0.158	0.00	0.00	3.41	56.22	10.58	73.56	100.00	0.00
0.185	0.00	0.00	3.98	66.45	10.23	85.77	100.00	0.00
0.215	0.00	0.00	4.64	75.78	9.33	100.00	100.00	0.00
0.251	0.00	0.00	5.41	83.75	7.97	116.59	100.00	0.00
0.293	0.00	0.00	6.31	90.05	6.30	135.94	100.00	0.00
0.341	0.00	0.00	7.36	94.60	4.55	158.49	100.00	0.00
0.398	0.00	0.00	8.58	97.52	2.92	184.79	100.00	0.00
0.464	0.00	0.00	10.00	99.12	1.60	215.44	100.00	0.00
0.541	0.00	0.00	11.66	99.81	0.69	251.19	100.00	0.00
0.631	0.00	0.00	13.59	100.00	0.19	292.87	100.00	0.00
0.736	0.00	0.00	15.85	100.00	0.00	341.46	100.00	0.00
0.858	0.00	0.00	18.48	100.00	0.00	398.11	100.00	0.00
1.00	0.46	0.46	21.54	100.00	0.00	464.16	100.00	0.00
1.17	2.09	1.64	25.12	100.00	0.00	541.17	100.00	0.00
1.36	5.34	3.24	29.29	100.00	0.00	630.96	100.00	0.00
1.58	10.39	5.06	34.15	100.00	0.00	735.64	100.00	0.00
1.85	17.24	6.85	39.81	100.00	0.00	857.70	100.00	0.00
2.15	25.65	8.41	46.42	100.00	0.00	1000.00	100.00	0.00

Fig 5. Sample 2 testing result (Valve fully open)

Average Particle Size Distribution

2012 Nov 18 - 16:04:51

(average size distribution, weighted)

20121116C.smealExp 001 - 2012 Nov 18\Averages\NB500_230_50_2_Closed 1 1.psd

Sample : NB500_230_50_2_Closed

Start+13 (s) :: +3:04 (s)

Standard Values:

Trans = 64.2 (%)

Dv(10) = 1.397 (µm)

Span = 1.895

Cv = 1.959 (PPM)

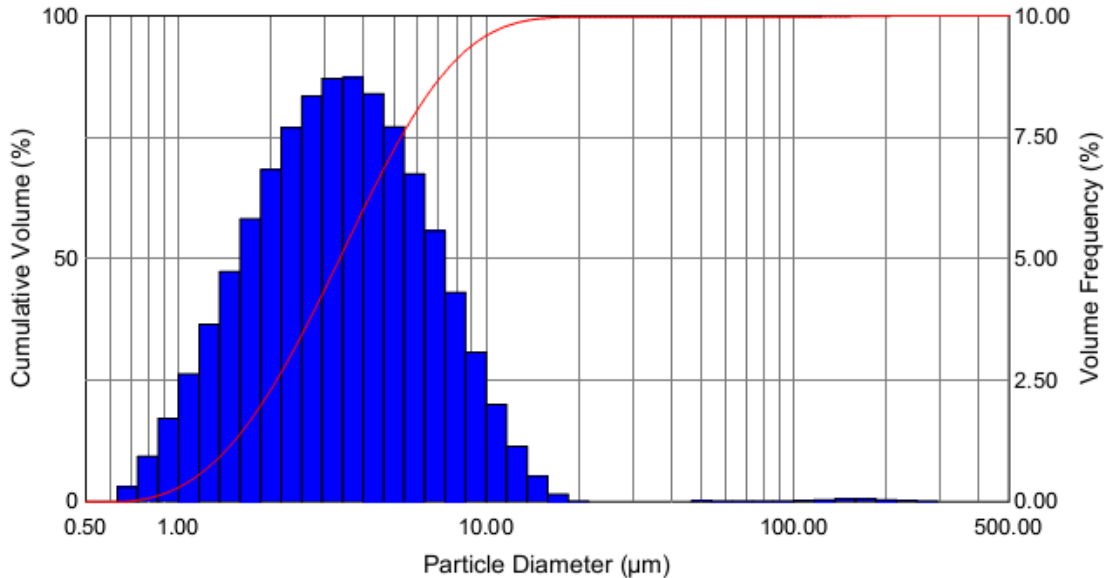
Dv(50) = 3.334 (µm)

D[3][2] = 2.702 (µm)

SSA = 2.221 (m²/cc)

Dv(90) = 7.717 (µm)

D[4][3] = 4.425 (µm)



Size (µm)	% V <	% V	Size (µm)	% V <	% V	Size (µm)	% V <	% V
0.117	0.00	0.00	2.51	34.30	7.70	54.12	99.74	0.01
0.136	0.00	0.00	2.93	42.65	8.35	63.10	99.75	0.01
0.158	0.00	0.00	3.41	51.36	8.71	73.56	99.76	0.00
0.185	0.00	0.00	3.98	60.10	8.73	85.77	99.76	0.00
0.215	0.00	0.00	4.64	68.50	8.40	100.00	99.77	0.01
0.251	0.00	0.00	5.41	76.21	7.72	116.59	99.78	0.02
0.293	0.00	0.00	6.31	82.96	6.75	135.94	99.82	0.04
0.341	0.00	0.00	7.36	88.53	5.57	158.49	99.88	0.06
0.398	0.00	0.00	8.58	92.84	4.31	184.79	99.94	0.06
0.464	0.00	0.00	10.00	95.92	3.08	215.44	99.98	0.04
0.541	0.00	0.00	11.66	97.92	2.00	251.19	100.00	0.02
0.631	0.00	0.00	13.59	99.06	1.14	292.87	100.00	0.00
0.736	0.30	0.30	15.85	99.58	0.52	341.46	100.00	0.00
0.858	1.23	0.93	18.48	99.73	0.15	398.11	100.00	0.00
1.00	2.94	1.71	21.54	99.73	0.01	464.16	100.00	0.00
1.17	5.57	2.63	25.12	99.73	0.00	541.17	100.00	0.00
1.36	9.22	3.65	29.29	99.73	0.00	630.96	100.00	0.00
1.58	13.95	4.73	34.15	99.73	0.00	735.64	100.00	0.00
1.85	19.77	5.82	39.81	99.73	0.00	857.70	100.00	0.00
2.15	26.60	6.83	46.42	99.73	0.00	1000.00	100.00	0.00

Fig6. Sample 2 testing result (Valve Closed)

5.2 Aerosol Particle Size Distribution Testing(By Marple 298 Cascade Impactor)

Tested with 0.9% saline solution

MMAD=2.07 μ m

FPD(Fine Particle Dose)=81.39%(particle size less than 5.0 μ m)

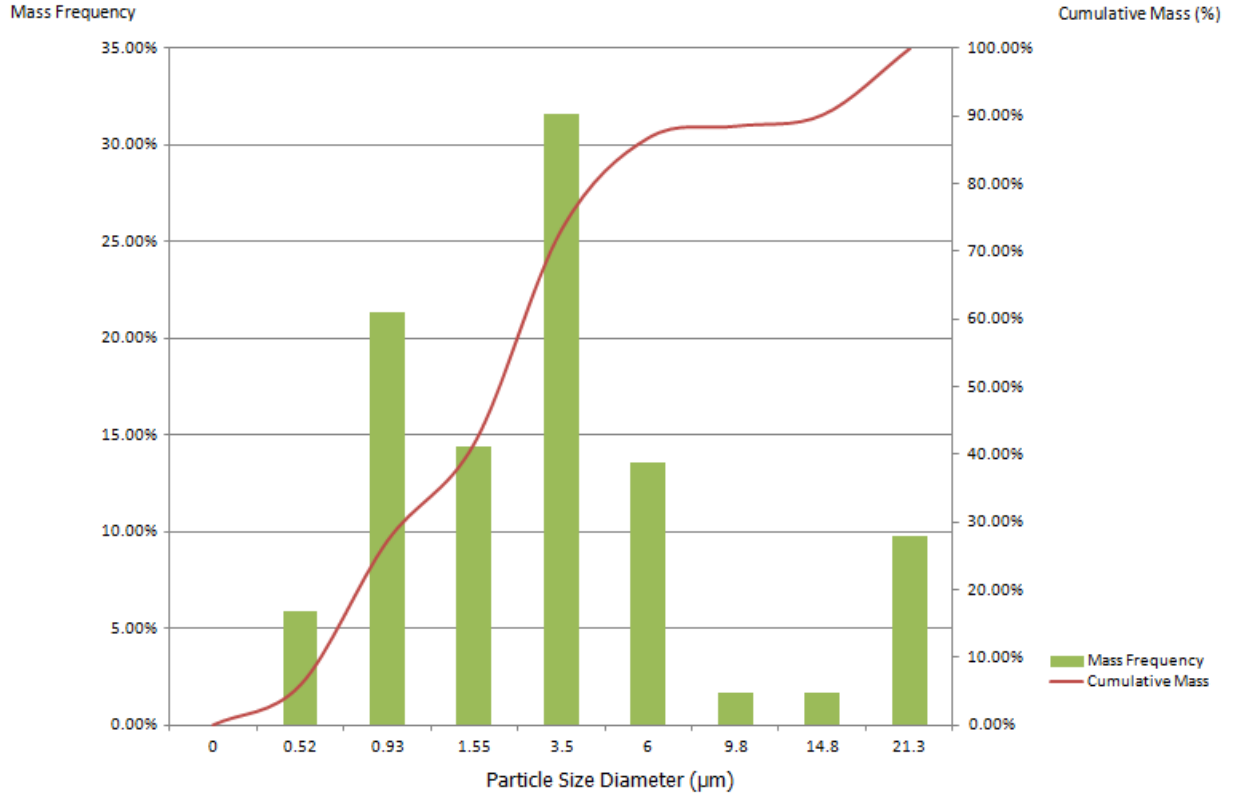


Fig 6. Aerodynamic particle size distribution

5.3 Nebulization Rate Testing(Including Drug Testings)

NB500	0.9% Saline		Atrovent Ipratropium Bromide		Atrovent Flixotide		AstraZeneca Terbutaline Sulphate		Ventoline(2.5mg) Salbutamol/ Sulphate	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed
ml/min	0.725	0.225	0.751	0.254	0.763	0.295	0.654	0.275	0.715	0.247
Dv(50) μ m	3.285	3.463	3.274	3.531	3.543	3.593	3.375	3.895	3.468	3.587

5.4 Residual Volume Testing

Valve(Fully Open/Closed)	Sample 1		Sample 2	
	Open	Closed	Open	Closed
Residual Volume (ml)	0.65	0.67	0.63	0.64