1.0 Object

1.1 To test the performance of Rossmax NB80 nebulizer

2.0 Equipment List

2.1 Rossmax NB80 Nebulizer*2
2.2 Rossmax Nebulizer kit*2
2.3 Malvern Spraytec particle size analyer
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 NB80 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 NB80 for testing.
4.1.5 After 3.0 minutes have been reached, stop the NB80 and then stop Spraytec.
4.1.6 Checks Spraytec records

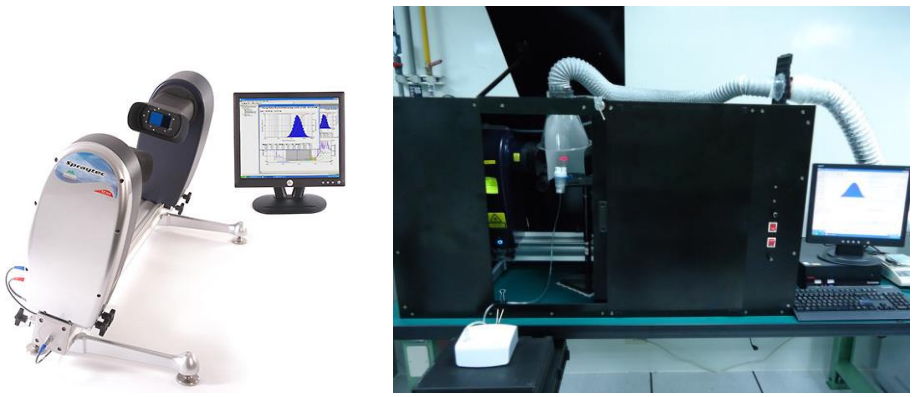

Fig 1. Malvern Spraytec and Testing site

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 NB80 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 NB80.(Sampling times can be varied for different nebulizers to allow for maximum deposit on each stage without coverloading stages.

4.2.7 After sampling for the required time, NB80 is switched off, followed a few seconds later by the sampling pump and then the suction pump.

4.2.8 Dismount the cascaade 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.

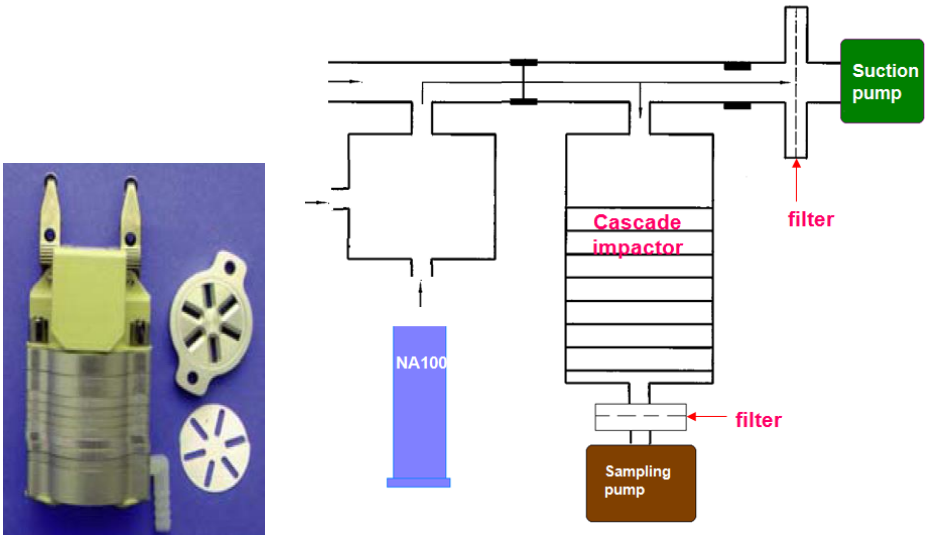

Fig 2. Cascade Impactor and Testing setup

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 NB80 and then start NB80 for testing.

4.3.4 After 1.0 minutes have been reached, stop the NB80

4.3.5 Calculates how many weight of the solution/drugs have been nebulizered

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 NB80 and put at the testing site,
4.4.4 Start NB80
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 NB80 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)

NB80	Valve Status	Testing times	Dv10	Dv50	Dv90	SMD	SR	
Sample 1	Fully Open	1	1.627	3.282	6.455	2.849	**3.967**	Fig 6
		2	1.786	3.641	7.146	3.139	**4.001**	
		3	1.847	3.828	7.604	3.277	**4.117**	
		Mean	**1.753**	**3.584**	**7.068**	**3.088**	**4.028**	
		Std Dev	**0.114**	**0.277**	**0.578**	**0.218**	**0.078**	
	Closed	1	1.664	4.165	9.684	3.256	**5.820**	Fig 7
		2	1.709	4.338	10.180	3.358	**5.957**	
		3	1.735	4.414	10.400	3.411	**5.994**	
		Mean	**1.703**	**4.306**	**10.088**	**3.342**	**5.924**	
		Std Dev	**0.036**	**0.128**	**0.367**	**0.079**	**0.092**	
Sample 2	Fully Open	1	1.867	3.837	7.566	3.298	**4.052**	
		2	1.831	3.752	7.400	3.231	**4.042**	Fig 8
		3	1.841	3.753	7.345	3.237	**3.990**	
		Mean	**1.846**	**3.781**	**7.437**	**3.255**	**4.028**	
		Std Dev	**0.019**	**0.049**	**0.115**	**0.037**	**0.034**	
	Closed	1	1.808	4.591	10.740	3.554	**5.940**	Fig 9
		2	1.831	4.694	11.160	3.617	**6.095**	
		3	1.863	4.801	11.440	3.680	**6.141**	
		Mean	**1.834**	**4.695**	**11.113**	**3.617**	**6.059**	
		Std Dev	**0.028**	**0.105**	**0.352**	**0.063**	**0.105**	

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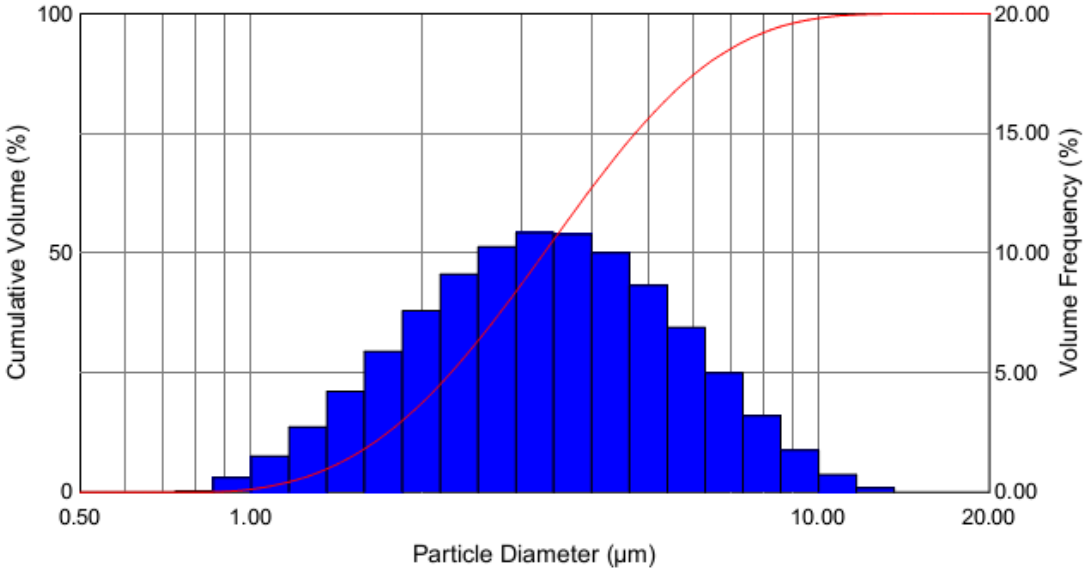
Average Particle Size Distribution 2012 Nov 18 - 16:17:11
(average size distribution, weighted)
20121116C.smea\Exp 001 - 2012 Nov 18\Averages\NB80_1_Open 1 1.psd
Sample : NB80_1_Open
Start+13 (s) :: +2:19 (s)

Standard Values:

Trans = 84.3 (%)	Dv(10) = 1.627 (µm)	Span = 1.471
Cv = 0.8334 (PPM)	Dv(50) = 3.282 (µm)	D[3][2] = 2.849 (µm)
SSA = 2.106 (m²/cc)	Dv(90) = 6.455 (µm)	D[4][3] = 3.726 (µm)



Size (µm)	% V <	% V	Size (µm)	% V <	% V	Size (µm)	% V <	% V
0.117	0.00	0.00	2.51	31.70	9.11	54.12	100.00	0.00
0.136	0.00	0.00	2.93	41.96	10.26	63.10	100.00	0.00
0.158	0.00	0.00	3.41	52.81	10.86	73.56	100.00	0.00
0.185	0.00	0.00	3.98	63.60	10.78	85.77	100.00	0.00
0.215	0.00	0.00	4.64	73.61	10.01	100.00	100.00	0.00
0.251	0.00	0.00	5.41	82.26	8.65	116.59	100.00	0.00
0.293	0.00	0.00	6.31	89.15	6.89	135.94	100.00	0.00
0.341	0.00	0.00	7.36	94.14	4.99	158.49	100.00	0.00
0.398	0.00	0.00	8.58	97.34	3.20	184.79	100.00	0.00
0.464	0.00	0.00	10.00	99.09	1.75	215.44	100.00	0.00
0.541	0.00	0.00	11.66	99.83	0.74	251.19	100.00	0.00
0.631	0.00	0.00	13.59	100.00	0.17	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	0.05	0.05	18.48	100.00	0.00	398.11	100.00	0.00
1.00	0.65	0.60	21.54	100.00	0.00	464.16	100.00	0.00
1.17	2.16	1.51	25.12	100.00	0.00	541.17	100.00	0.00
1.36	4.89	2.73	29.29	100.00	0.00	630.96	100.00	0.00
1.58	9.11	4.22	34.15	100.00	0.00	735.64	100.00	0.00
1.85	15.00	5.89	39.81	100.00	0.00	857.70	100.00	0.00
2.15	22.59	7.59	46.42	100.00	0.00	1000.00	100.00	0.00

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

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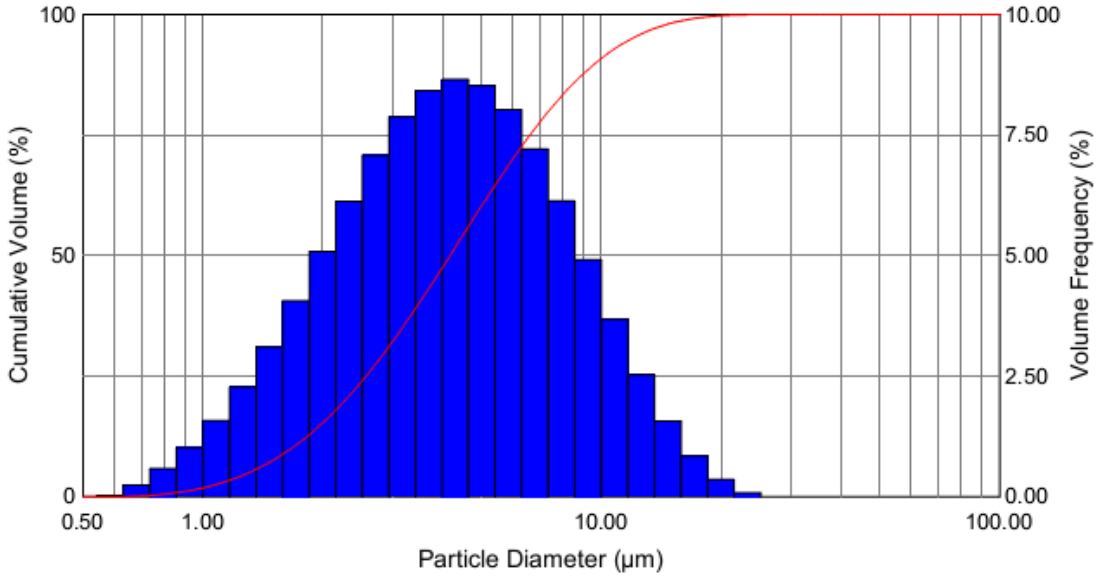
Malvern

Average Particle Size Distribution 2012 Nov 18 - 16:39:19
(average size distribution, weighted)
20121116C.smea\Exp 001 - 2012 Nov 18\Averages\NB80_1_Closed 1 1.psd
Sample : NB80_1_Closed
Start+16 (s) :: +2:33 (s)

Standard Values:

Trans = 76.8 (%)	Dv(10) = 1.664 (µm)	Span = 1.925
Cv = 1.469 (PPM)	Dv(50) = 4.165 (µm)	D[3][2] = 3.256 (µm)
SSA = 1.843 (m²/cc)	Dv(90) = 9.684 (µm)	D[4][3] = 5.057 (µm)



Size (µm)	% V <	% V	Size (µm)	% V <	% V	Size (µm)	% V <	% V
0.117	0.00	0.00	2.51	24.09	6.12	54.12	100.00	0.00
0.136	0.00	0.00	2.93	31.17	7.08	63.10	100.00	0.00
0.158	0.00	0.00	3.41	39.04	7.87	73.56	100.00	0.00
0.185	0.00	0.00	3.98	47.46	8.42	85.77	100.00	0.00
0.215	0.00	0.00	4.64	56.11	8.65	100.00	100.00	0.00
0.251	0.00	0.00	5.41	64.64	8.53	116.59	100.00	0.00
0.293	0.00	0.00	6.31	72.68	8.03	135.94	100.00	0.00
0.341	0.00	0.00	7.36	79.89	7.21	158.49	100.00	0.00
0.398	0.00	0.00	8.58	86.02	6.13	184.79	100.00	0.00
0.464	0.00	0.00	10.00	90.93	4.91	215.44	100.00	0.00
0.541	0.00	0.00	11.66	94.61	3.68	251.19	100.00	0.00
0.631	0.02	0.02	13.59	97.14	2.53	292.87	100.00	0.00
0.736	0.27	0.25	15.85	98.71	1.57	341.46	100.00	0.00
0.858	0.85	0.58	18.48	99.56	0.85	398.11	100.00	0.00
1.00	1.87	1.02	21.54	99.92	0.36	464.16	100.00	0.00
1.17	3.44	1.58	25.12	100.00	0.08	541.17	100.00	0.00
1.36	5.71	2.27	29.29	100.00	0.00	630.96	100.00	0.00
1.58	8.81	3.10	34.15	100.00	0.00	735.64	100.00	0.00
1.85	12.87	4.06	39.81	100.00	0.00	857.70	100.00	0.00
2.15	17.96	5.09	46.42	100.00	0.00	1000.00	100.00	0.00

Fig4. Sample 1 testing result (Valve Closed)

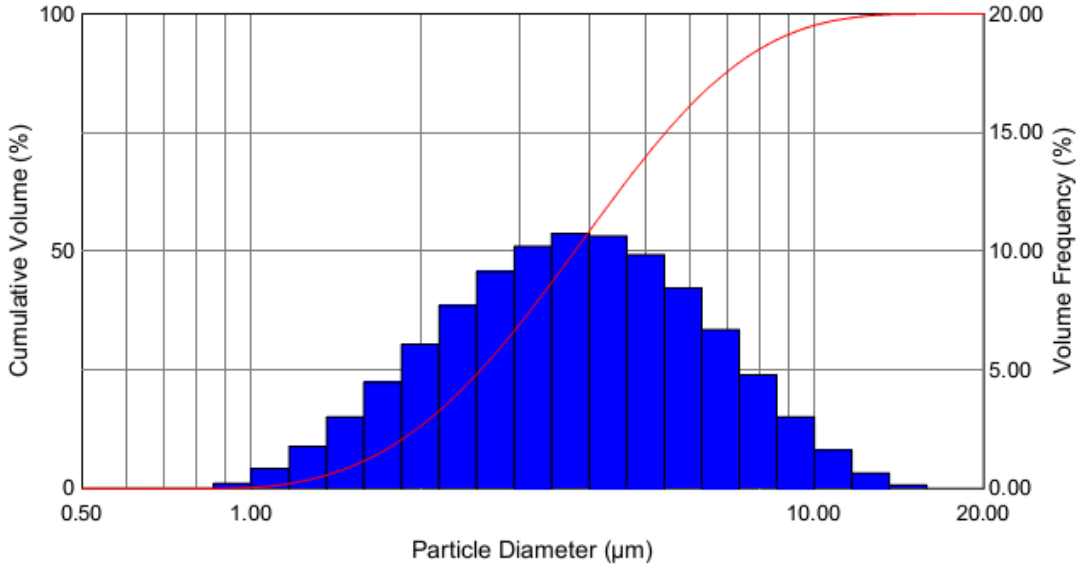
rossmax

Malvern

Average Particle Size Distribution 2012 Nov 18 - 16:31:55
(average size distribution, weighted)
20121116C.smea\Exp 001 - 2012 Nov 18\Averages\NB80_2_Open 1 2.psd
Sample : NB80_2_Open
Start+2:55 (s) :: +6:17 (s)

Standard Values:

Trans = 86.7 (%)	Dv(10) = 1.831 (µm)	Span = 1.484
Cv = 0.8138 (PPM)	Dv(50) = 3.752 (µm)	D[3][2] = 3.231 (µm)
SSA = 1.857 (m²/cc)	Dv(90) = 7.4 (µm)	D[4][3] = 4.258 (µm)



Size (µm)	% V <	% V	Size (µm)	% V <	% V	Size (µm)	% V <	% V
0.117	0.00	0.00	2.51	24.09	7.70	54.12	100.00	0.00
0.136	0.00	0.00	2.93	33.22	9.13	63.10	100.00	0.00
0.158	0.00	0.00	3.41	43.42	10.20	73.56	100.00	0.00
0.185	0.00	0.00	3.98	54.17	10.75	85.77	100.00	0.00
0.215	0.00	0.00	4.64	64.80	10.63	100.00	100.00	0.00
0.251	0.00	0.00	5.41	74.65	9.85	116.59	100.00	0.00
0.293	0.00	0.00	6.31	83.11	8.46	135.94	100.00	0.00
0.341	0.00	0.00	7.36	89.79	6.69	158.49	100.00	0.00
0.398	0.00	0.00	8.58	94.58	4.78	184.79	100.00	0.00
0.464	0.00	0.00	10.00	97.60	3.02	215.44	100.00	0.00
0.541	0.00	0.00	11.66	99.21	1.61	251.19	100.00	0.00
0.631	0.00	0.00	13.59	99.86	0.65	292.87	100.00	0.00
0.736	0.00	0.00	15.85	100.00	0.14	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	0.20	0.20	21.54	100.00	0.00	464.16	100.00	0.00
1.17	1.04	0.84	25.12	100.00	0.00	541.17	100.00	0.00
1.36	2.82	1.78	29.29	100.00	0.00	630.96	100.00	0.00
1.58	5.83	3.01	34.15	100.00	0.00	735.64	100.00	0.00
1.85	10.30	4.47	39.81	100.00	0.00	857.70	100.00	0.00
2.15	16.39	6.09	46.42	100.00	0.00	1000.00	100.00	0.00

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

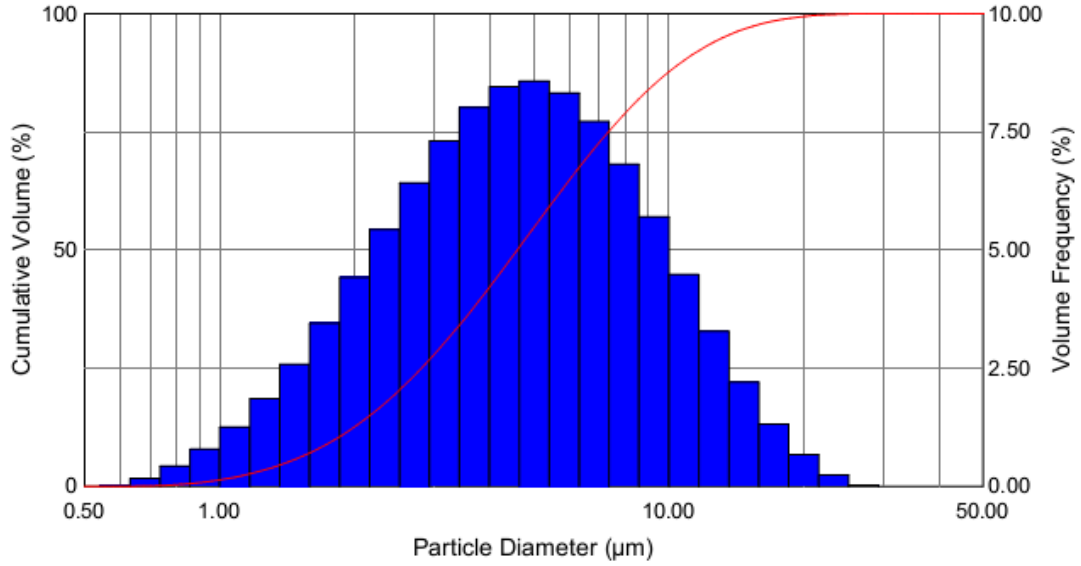
rossmax

Malvern

Average Particle Size Distribution 2012 Nov 18 - 16:49:57
(average size distribution, weighted)
20121116C.smea\Exp 001 - 2012 Nov 18\Averages\NB80_2_Closed 1 1.psd
Sample : NB80_2_Closed
Start+27 (s) :: +3:21 (s)

Standard Values:

Trans = 75.9 (%)	Dv(10) = 1.808 (µm)	Span = 1.946
Cv = 1.699 (PPM)	Dv(50) = 4.591 (µm)	D[3][2] = 3.554 (µm)
SSA = 1.688 (m²/cc)	Dv(90) = 10.74 (µm)	D[4][3] = 5.584 (µm)



Size (µm)	% V <	% V	Size (µm)	% V <	% V	Size (µm)	% V <	% V
0.117	0.00	0.00	2.51	20.40	5.44	54.12	100.00	0.00
0.136	0.00	0.00	2.93	26.83	6.42	63.10	100.00	0.00
0.158	0.00	0.00	3.41	34.14	7.31	73.56	100.00	0.00
0.185	0.00	0.00	3.98	42.16	8.02	85.77	100.00	0.00
0.215	0.00	0.00	4.64	50.62	8.46	100.00	100.00	0.00
0.251	0.00	0.00	5.41	59.19	8.57	116.59	100.00	0.00
0.293	0.00	0.00	6.31	67.52	8.33	135.94	100.00	0.00
0.341	0.00	0.00	7.36	75.24	7.72	158.49	100.00	0.00
0.398	0.00	0.00	8.58	82.06	6.82	184.79	100.00	0.00
0.464	0.00	0.00	10.00	87.76	5.70	215.44	100.00	0.00
0.541	0.00	0.00	11.66	92.24	4.48	251.19	100.00	0.00
0.631	0.01	0.01	13.59	95.53	3.28	292.87	100.00	0.00
0.736	0.17	0.16	15.85	97.73	2.20	341.46	100.00	0.00
0.858	0.61	0.43	18.48	99.05	1.32	398.11	100.00	0.00
1.00	1.39	0.79	21.54	99.72	0.67	464.16	100.00	0.00
1.17	2.65	1.26	25.12	99.97	0.25	541.17	100.00	0.00
1.36	4.50	1.85	29.29	100.00	0.03	630.96	100.00	0.00
1.58	7.09	2.59	34.15	100.00	0.00	735.64	100.00	0.00
1.85	10.54	3.45	39.81	100.00	0.00	857.70	100.00	0.00
2.15	14.96	4.42	46.42	100.00	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=2.262 μ m

FPD(Fine Particle Dose)=81.79%(particle size less than 5.0 μ m)

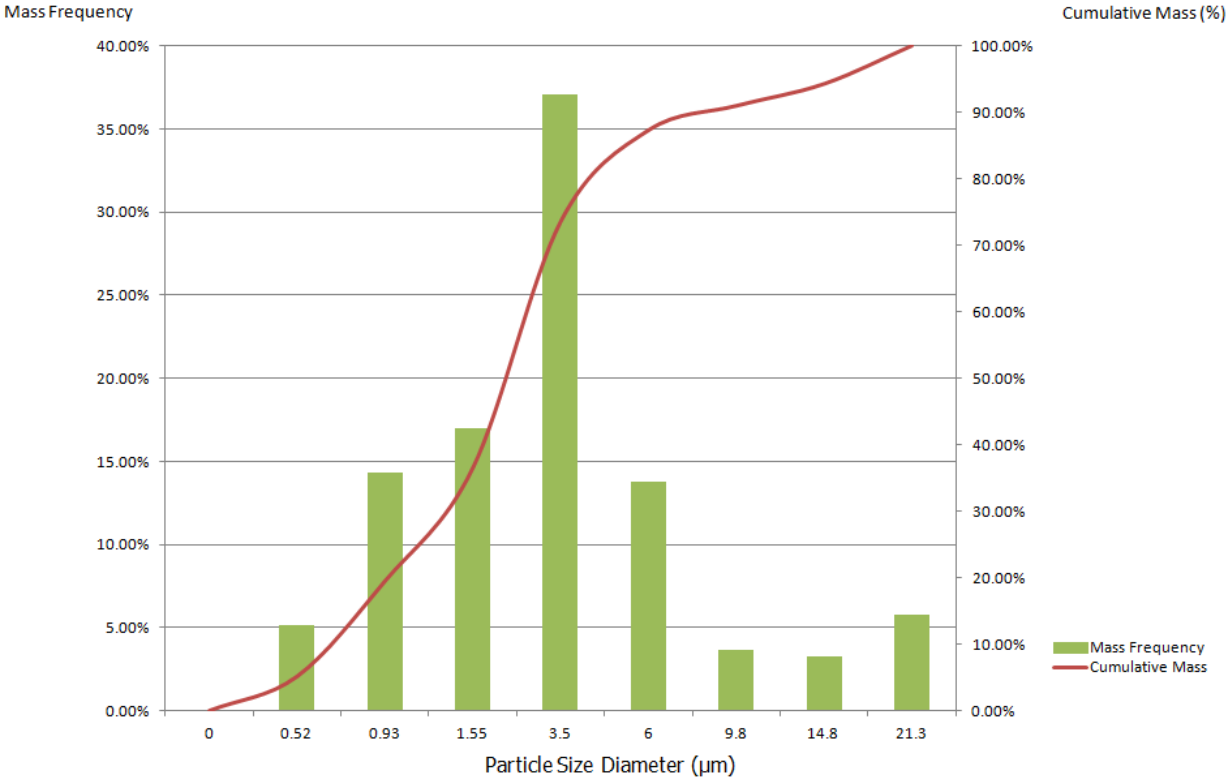


Fig 6. Aerodynamic particle size distribution

5.3 Nebulization Rate Testing(Including Drug Testings)

NB80	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	0.39	0.175	0.41	0.149	0.456	0.163	0.418	0.142	0.405	0.186
Dv(50) µm	4.307	4.700	4.645	4.902	4.738	4.933	4.671	4.951	4.697	4.394

5.4 Residual Volume Testing

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