Sympatec GmbH
System-Partikel-Technik

QICPIC Particle Size Analysis
WINDOX 5

QICPIC (QP0104) & GRADIS, 0.50 63.0 mm - M8 (20 ... 6820 µm)
120529ab_JRT_S_M8 **2012-05-29, 12:18:28**,622

trigger condition: Gr_FR75_StaOpt0.05_StoOpt0.1..	
start:	c.opt >= 0.05%
valid:	always
stop:	30s c.opt <= 0.1% or 1200s real time

user parameters:
Sample Name: Zeolite (4x8)
Operator: Jonathan Tucker
Sample Mass: 0.00
Run Number: 0.00

evaluation: WINDOX 5.8.2.0	
calculation mode:	EQPC
class limits:	Variable

product: 120529ab_JRT_S_M8	
C_{opt}:	0.33 %

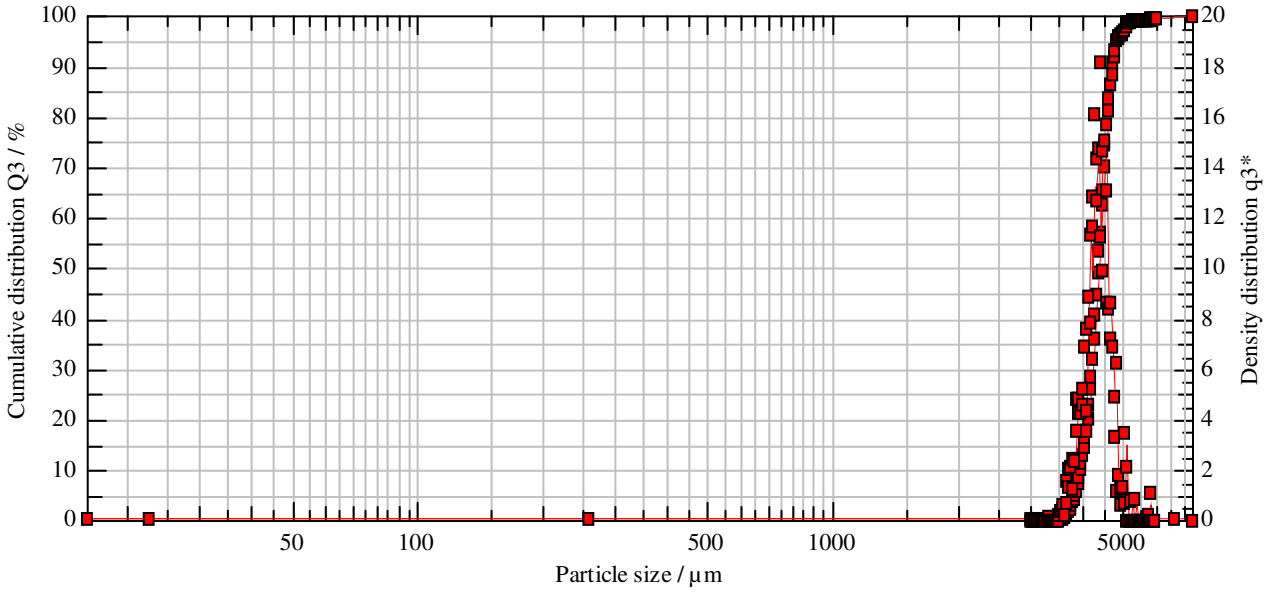
Size Distribution

Cumulative size distribution is a measure of the fraction of particles (based on volume) that could possibly pass through a sieve of a given opening. The
measure of particle size used is defined below under "calculation mode".

Diameter definitions are as follows:
EQPC: diameter of a circle that has the same area as the projected area of the particle
FERET: the distance between two parallel tangents in a well defined orientation (min, max, mean, max90, min90)
Chord Length: the distance of two points of the contour measured exactly across the center of gravity of the projected area (min, max, mean, vertical, horizontal, max90, min 90)
Martin Diameter: The chor dividing the projected area of the particle into two equal halves (min, max, mean)

Most common is EQPC and probably correlates most closely with laser measurements and is used most often. A well sieved sample may correlate better to FERET Minimum.

x_5 = 3838.96 µm	**x_{50} = 4354.34 µm**	**x_{90} = 4721.22 µm**	**SMD = 4325.87 µm**	**VMD = 4361.95 µm**
x_{16} = 3941.05 µm	x_{84} = 4635.61 µm	x_{95} = 4840.01 µm	**#PI = 383299**	



cumulative distribution

upper band limit x_0/µm	cumulative distribution Q_3/%	residue distribution $(1-Q_3)$/%	fraction in band dQ_3/%
22.57	0.00	100.00	0.00
3000.00	0.04	99.96	0.04
3021.08	0.04	99.96	0.00
3042.30	0.04	99.96	0.00
3063.68	0.04	99.96	0.00
3085.21	0.04	99.96	0.00
3106.88	0.04	99.96	0.00
3128.71	0.04	99.96	0.00
3150.69	0.04	99.96	0.00
3172.83	0.04	99.96	0.00
3195.12	0.04	99.96	0.00
3217.57	0.04	99.96	0.00
3240.18	0.04	99.96	0.00
3262.95	0.04	99.96	0.00
3285.87	0.05	99.95	0.01
3308.96	0.08	99.92	0.04
3332.21	0.08	99.92	0.00
3355.62	0.08	99.92	0.00
3379.20	0.08	99.92	0.00
3402.94	0.08	99.92	0.00
3426.85	0.08	99.92	0.00
3450.92	0.08	99.92	0.00
3475.17	0.08	99.92	0.00
3499.59	0.08	99.92	0.00
3524.18	0.14	99.86	0.06
3548.94	0.26	99.74	0.12
3573.87	0.38	99.62	0.12
3598.98	0.57	99.43	0.18
3624.27	0.63	99.37	0.06
3649.73	0.82	99.18	0.19
3675.38	1.28	98.72	0.46
3701.20	1.69	98.31	0.41
3727.20	2.32	97.68	0.63
3753.39	2.95	97.05	0.64
3779.76	3.68	96.32	0.73
3806.32	4.06	95.94	0.37
3833.06	4.76	95.24	0.71
3860.00	5.85	94.15	1.08
3887.12	7.29	92.71	1.45
3914.43	8.59	91.41	1.30
3941.93	10.05	89.95	1.45
3969.63	11.34	88.66	1.29
3997.52	12.91	87.09	1.57
4025.60	14.30	85.70	1.39
4053.89	16.39	83.61	2.09
4082.37	17.71	82.29	1.32
4111.05	20.01	79.99	2.31
4139.94	22.71	77.29	2.70
4169.03	26.15	73.85	3.44
4198.32	28.52	71.48	2.37
4227.81	32.05	67.95	3.53
4257.52	35.96	64.04	3.91
4287.43	40.85	59.15	4.89
4317.56	44.70	55.30	3.85
4347.89	49.06	50.94	4.36
4378.44	53.53	46.47	4.47
4409.20	56.94	43.06	3.42
4440.18	62.45	37.55	5.51
4471.38	65.46	34.54	3.01
4502.80	69.92	30.08	4.45
4534.43	74.49	25.51	4.57
4566.29	78.46	21.54	3.97
4598.38	81.07	18.93	2.61
4630.68	83.61	16.39	2.54
4663.22	86.21	13.79	2.61
4695.98	88.41	11.59	2.20
4728.98	90.49	9.51	2.08
4762.20	91.97	8.03	1.48
4795.66	92.99	7.01	1.01
4829.36	94.89	5.11	1.90
4863.29	95.24	4.76	0.35
4897.46	95.78	4.22	0.54
4931.87	96.16	3.84	0.37
4966.52	96.35	3.65	0.19

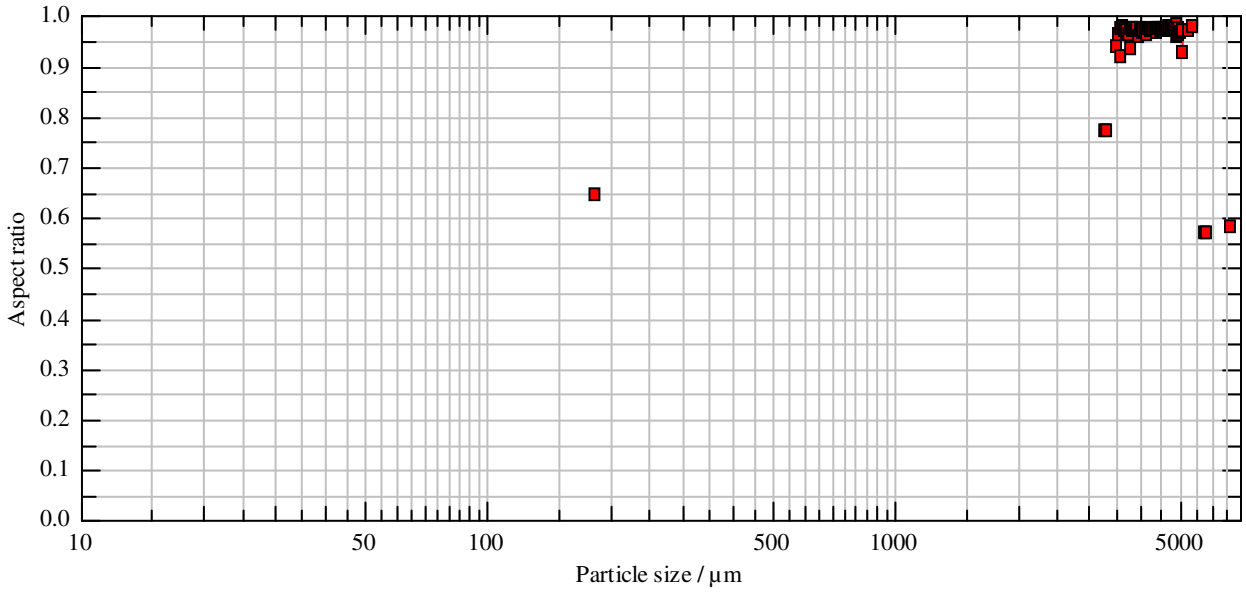
density distribution (log.)

mean size for band x_m/µm	density distribution $q_3$lg
15.96	0.00
260.20	0.00
3010.52	0.00
3031.67	0.00
3052.97	0.00
3074.42	0.00
3096.02	0.00
3117.78	0.00
3139.68	0.00
3161.74	0.00
3183.96	0.00
3206.33	0.00
3228.86	0.00
3251.54	0.00
3274.39	0.03
3297.39	0.13
3320.56	0.00
3343.89	0.00
3367.39	0.00
3391.05	0.00
3414.87	0.00
3438.86	0.00
3463.03	0.00
3487.36	0.00
3511.86	0.19
3536.53	0.39
3561.38	0.40
3586.40	0.61
3611.60	0.21
3636.98	0.64
3662.53	1.52
3688.26	1.33
3714.18	2.06
3740.28	2.10
3766.55	2.40
3793.02	1.23
3819.67	2.32
3846.51	3.56
3873.53	4.76
3900.75	4.27
3928.15	4.78
3955.75	4.26
3983.55	5.17
4011.53	4.56
4039.72	6.88
4068.10	4.33
4096.69	7.59
4125.47	8.87
4154.46	11.30
4183.65	7.80
4213.04	11.61
4242.64	12.84
4272.45	16.09
4302.47	12.65
4332.70	14.34
4363.14	14.70
4393.79	11.24
4424.67	18.11
4455.75	9.91
4487.06	14.65
4518.59	15.02
4550.33	13.06
4582.31	8.59
4614.50	8.34
4646.92	8.57
4679.57	7.22
4712.45	6.85
4745.56	4.88
4778.90	3.33
4812.48	6.26
4846.29	1.16
4880.34	1.78
4914.63	1.23
4949.16	0.63

5001.42	96.74	3.26	0.39	4983.94	1.29
5036.56	96.95	3.05	0.20	5018.95	0.67
5071.94	97.99	2.01	1.04	5054.22	3.43
5107.58	98.62	1.38	0.63	5089.73	2.08
5143.46	98.62	1.38	0.00	5125.49	0.00
5179.60	98.62	1.38	0.00	5161.50	0.00
5215.99	98.62	1.38	0.00	5197.77	0.00
5252.64	98.86	1.14	0.24	5234.29	0.77
5289.55	98.86	1.14	0.00	5271.06	0.00
5326.71	98.86	1.14	0.00	5308.10	0.00
5364.14	99.11	0.89	0.25	5345.39	0.83
5401.83	99.11	0.89	0.00	5382.95	0.00
5439.78	99.11	0.89	0.00	5420.77	0.00
5478.00	99.11	0.89	0.00	5458.86	0.00
5516.49	99.11	0.89	0.00	5497.21	0.00
5555.25	99.11	0.89	0.00	5535.83	0.00
5594.28	99.11	0.89	0.00	5574.73	0.00
5633.59	99.11	0.89	0.00	5613.90	0.00
5673.17	99.11	0.89	0.00	5653.34	0.00
5713.03	99.11	0.89	0.00	5693.06	0.00
5753.17	99.11	0.89	0.00	5733.06	0.00
5793.59	99.17	0.83	0.06	5773.34	0.19
5834.30	99.50	0.50	0.33	5813.91	1.09
5875.29	99.50	0.50	0.00	5854.76	0.00
5916.57	99.50	0.50	0.00	5895.89	0.00
5958.14	99.50	0.50	0.00	5937.32	0.00
6000.00	99.50	0.50	0.00	5979.03	0.00
7307.77	100.00	0.00	0.50	6621.68	0.06

Mean Aspect Ratio vs Mean Particle Size

Aspect ratio is defined as the ratio of the minimum to maximum FERET diameter. FERET diameter can be thought of as the kind of measure of diameter that one would achieve with a micrometer with the particle in a fixed geometric frame relative to the micrometer. The maximum diameter would correspond to the largest possible measurement of any particle orientation and viceversa for the minimum diameter. The values represent the mean measurement properties of the particles in the size class.

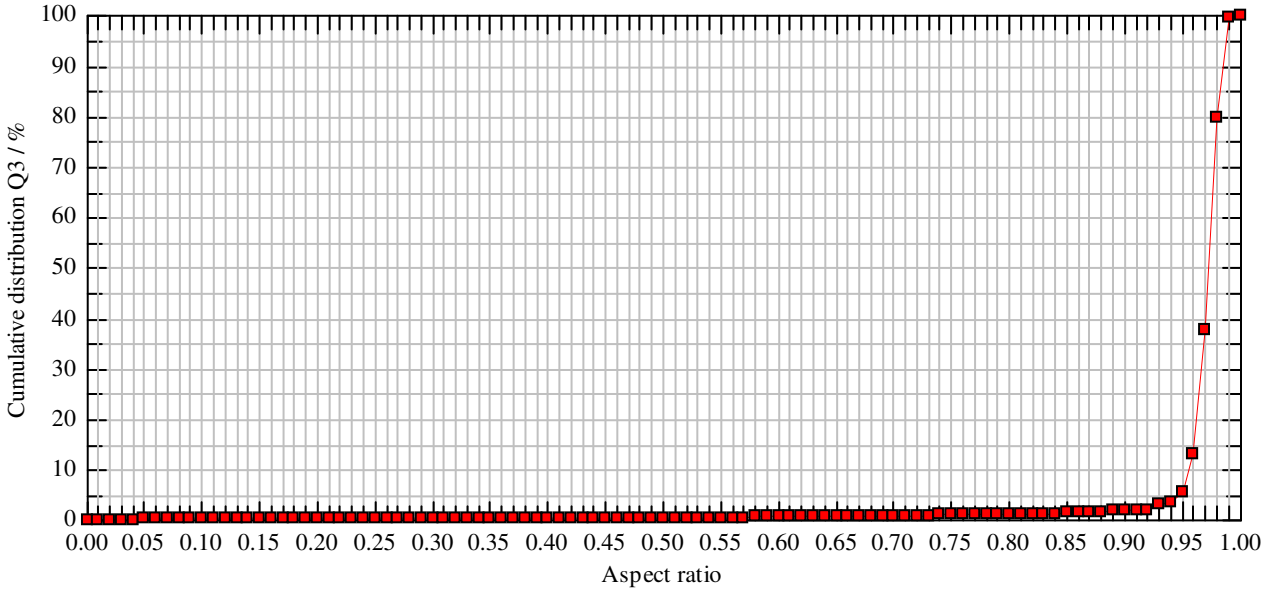


x_m/µm	aspect ratio	x_m/µm	aspect ratio	x_m/µm	aspect ratio	x_m/µm	aspect ratio
183.99	0.646	3586.40	0.975	4302.47	0.969	5161.50	
3010.52		3611.60	0.978	4332.70	0.969	5197.77	
3031.67		3636.98	0.969	4363.14	0.973	5234.29	0.971
3052.97		3662.53	0.975	4393.79	0.968	5271.06	
3074.42		3688.26	0.967	4424.67	0.974	5308.10	
3096.02		3714.18	0.970	4455.75	0.969	5345.39	0.979
3117.78		3740.28	0.964	4487.06	0.974	5382.95	
3139.68		3766.55	0.974	4518.59	0.974	5420.77	
3161.74		3793.02	0.933	4550.33	0.969	5458.86	
3183.96		3819.67	0.973	4582.31	0.976	5497.21	
3206.33		3846.51	0.969	4614.50	0.971	5535.83	
3228.86		3873.53	0.970	4646.92	0.974	5574.73	
3251.54		3900.75	0.972	4679.57	0.974	5613.90	
3274.39	0.774	3928.15	0.974	4712.45	0.977	5653.34	
3297.39	0.774	3955.75	0.957	4745.56	0.976	5693.06	
3320.56		3983.55	0.974	4778.90	0.980	5733.06	
3343.89		4011.53	0.970	4812.48	0.978	5773.34	0.570
3367.39		4039.72	0.967	4846.29	0.976	5813.91	0.570
3391.05		4068.10	0.969	4880.34	0.958	5854.76	
3414.87		4096.69	0.969	4914.63	0.982	5895.89	
3438.86		4125.47	0.969	4949.16	0.974	5937.32	
3463.03		4154.46	0.964	4983.94	0.964	5979.03	
3487.36		4183.65	0.974	5018.95	0.967	6621.68	0.579
3511.86	0.937	4213.04	0.968	5054.22	0.926		
3536.53	0.961	4242.64	0.969	5089.73	0.969		
3561.38	0.917	4272.45	0.971	5125.49			

CumulativeAspect Ratio Distribution

The cumulative aspect ratio distribution is the fraction of particles (based on volume) with aspect ratios less than the x-axis value.

a_{10} = 0.956	**a_{50} = 0.973**	**a_{90} = 0.985**
a_{16} = 0.961	a_{84} = 0.982	a_{99} = 0.990



cumulative distribution

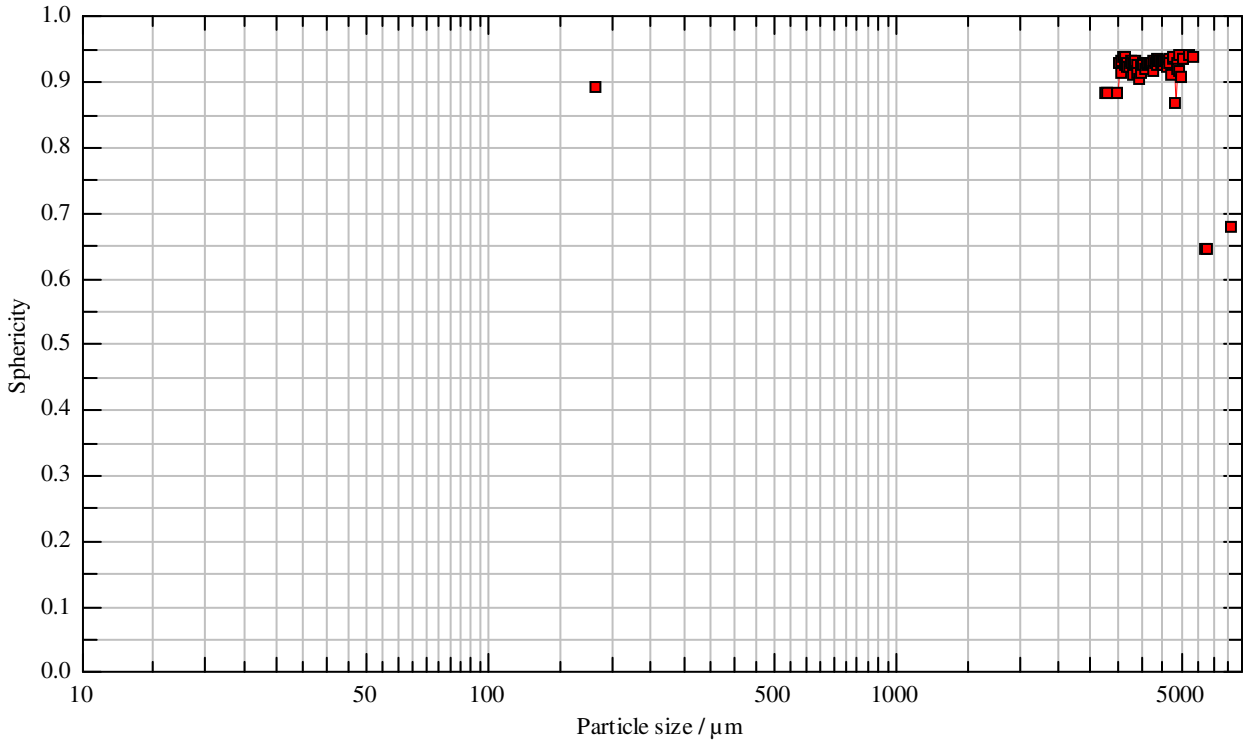
aspect ratio a_O	cumulative distribution Q_3 / %	residue distribution $(1-Q_3)$ / %
0.050	0.00	100.00
0.100	0.00	100.00
0.150	0.00	100.00
0.200	0.00	100.00
0.250	0.00	100.00
0.300	0.00	100.00
0.350	0.00	100.00
0.400	0.00	100.00
0.450	0.01	99.99
0.500	0.01	99.99
0.550	0.01	99.99
0.600	0.67	99.33
0.650	0.68	99.32
0.700	0.69	99.31
0.750	0.89	99.11
0.800	1.06	98.94
0.850	1.36	98.64
0.900	1.61	98.39
0.950	5.24	94.76
1.000	100.00	0.00

density distribution

mean aspect ratio for band a_m	density distribution q_3
0.045	0.000
0.095	0.000
0.145	0.000
0.195	0.000
0.245	0.000
0.295	0.000
0.345	0.000
0.395	0.000
0.445	0.004
0.495	0.001
0.545	0.001
0.595	0.001
0.645	0.001
0.695	0.001
0.745	0.003
0.795	0.106
0.845	0.215
0.895	0.001
0.945	1.694
0.995	0.527

Mean Sphericity vs Mean Particle Size

Sphericity is the ratio of the perimiter of the circle with the same projected area as the particle to the measured perimeter of the projected particle. Sphericity is a measure of surface roughness. The closer to 1, the smoother the surface. The data presented here is the mean property values for all particles in their respective size class.

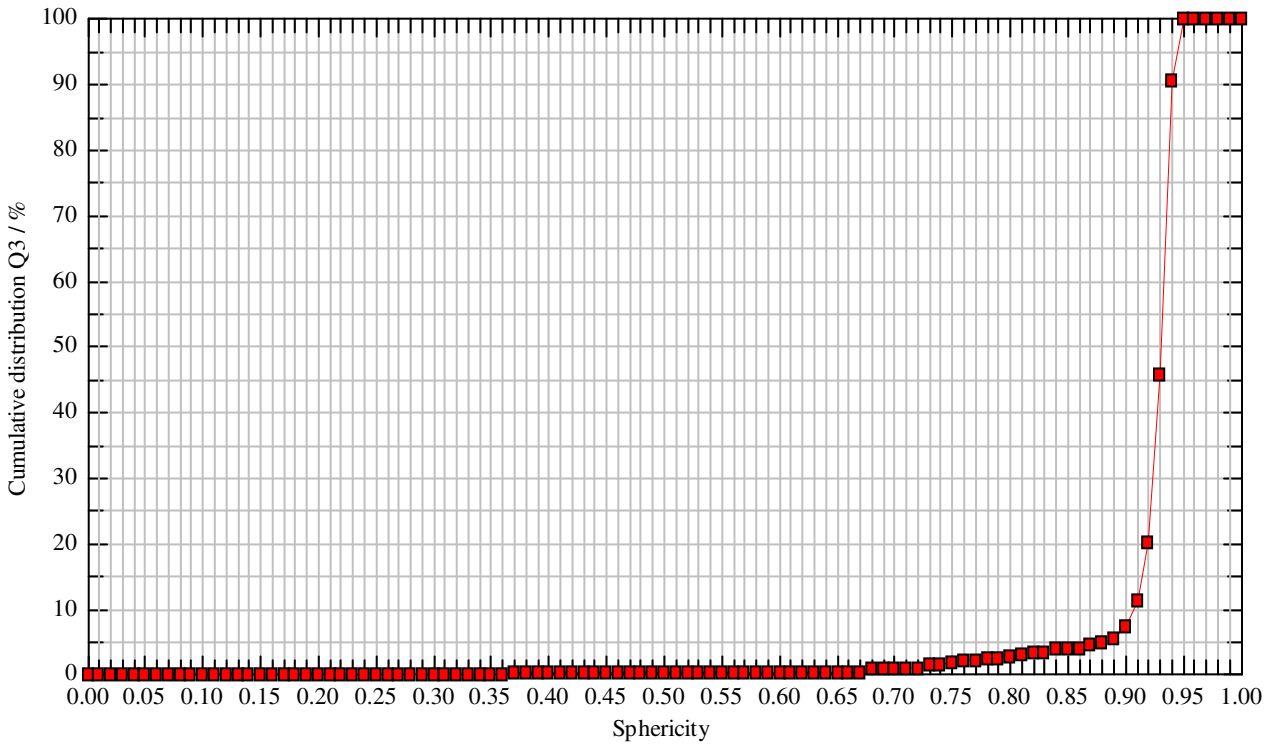


x_m/µm	sphericity	x_m/µm	sphericity	x_m/µm	sphericity	x_m/µm	sphericity
183.99	0.890	3586.40	0.929	4302.47	0.929	5161.50	
3010.52		3611.60	0.934	4332.70	0.925	5197.77	
3031.67		3636.98	0.923	4363.14	0.923	5234.29	0.937
3052.97		3662.53	0.934	4393.79	0.930	5271.06	
3074.42		3688.26	0.925	4424.67	0.928	5308.10	
3096.02		3714.18	0.919	4455.75	0.929	5345.39	0.935
3117.78		3740.28	0.919	4487.06	0.925	5382.95	
3139.68		3766.55	0.928	4518.59	0.924	5420.77	
3161.74		3793.02	0.925	4550.33	0.930	5458.86	
3183.96		3819.67	0.925	4582.31	0.929	5497.21	
3206.33		3846.51	0.908	4614.50	0.928	5535.83	
3228.86		3873.53	0.930	4646.92	0.918	5574.73	
3251.54		3900.75	0.922	4679.57	0.933	5613.90	
3274.39	0.880	3928.15	0.910	4712.45	0.926	5653.34	
3297.39	0.880	3955.75	0.900	4745.56	0.907	5693.06	
3320.56		3983.55	0.922	4778.90	0.933	5733.06	
3343.89		4011.53	0.911	4812.48	0.933	5773.34	0.641
3367.39		4039.72	0.927	4846.29	0.863	5813.91	0.641
3391.05		4068.10	0.922	4880.34	0.926	5854.76	
3414.87		4096.69	0.916	4914.63	0.916	5895.89	
3438.86		4125.47	0.923	4949.16	0.913	5937.32	
3463.03		4154.46	0.926	4983.94	0.937	5979.03	
3487.36		4183.65	0.924	5018.95	0.903	6621.68	0.674
3511.86	0.879	4213.04	0.926	5054.22	0.932		
3536.53	0.927	4242.64	0.924	5089.73	0.931		
3561.38	0.909	4272.45	0.913	5125.49			

Cumulative Sphericity Distribution

The cumulative sphericity distribution is the fraction of particles (based on volume) with sphericities less than the x-axis value.

s_{10} = 0.907	**s_{50} = 0.931**	**s_{90} = 0.940**
s_{16} = 0.916	s_{84} = 0.939	s_{99} = 0.949



cumulative distribution

sphericity s_O	cumulative distribution Q_3 / %	residue distribution $(1-Q_3)$ / %
0.050	0.00	100.00
0.100	0.00	100.00
0.150	0.00	100.00
0.200	0.00	100.00
0.250	0.00	100.00
0.300	0.00	100.00
0.350	0.00	100.00
0.400	0.00	100.00
0.450	0.00	100.00
0.500	0.00	100.00
0.550	0.00	100.00
0.600	0.00	100.00
0.650	0.29	99.71
0.700	0.65	99.35
0.750	1.79	98.21
0.800	2.58	97.42
0.850	3.86	96.14
0.900	7.25	92.75
0.950	100.00	0.00
1.000	100.00	0.00

density distribution

mean sphericity for band s_m	density distribution q_3
0.045	0.000
0.095	0.000
0.145	0.000
0.195	0.000
0.245	0.000
0.295	0.000
0.345	0.000
0.395	0.000
0.445	0.000
0.495	0.000
0.545	0.000
0.595	0.000
0.645	0.286
0.695	0.001
0.745	0.411
0.795	0.215
0.845	0.193
0.895	1.959
0.945	9.467
0.995	0.000

Summary and Comparrisons

EQPC SMD *(Preffered)* = 4325.87 µm **90% Distribution: x_5 = 3838.96 µm / x_{95} = 4840.01 µm**

Sphericity =	**0.931**	**(0.907 ~ 0.940)**
Aspect Ratio =	**0.973**	**(0.956 ~ 0.985)**
Convexity =	**0.985**	**(0.980 ~ 0.990)**
Straightness =	**0.991**	**(0.911 ~ 0.998)**
Elongation =	**0.379**	**(0.238 ~ 0.753)**

Feret Max SMD = 4417.29 µm **90% Distribution: x_5 = 3932.65 µm / x_{95} = 4904.57 µm**

Sphericity =	**0.931**	**(0.908 ~ 0.940)**
Aspect Ratio =	**0.973**	**(0.956 ~ 0.985)**
Convexity =	**0.985**	**(0.980 ~ 0.990)**
Straightness =	**0.991**	**(0.913 ~ 0.998)**
Elongation =	**0.380**	**(0.244 ~ 0.754)**

Feret Min SMD = 4281.07 µm **90% Distribution: x_5 = 3807.89 µm / x_{95} = 4790.32 µm**

Sphericity =	**0.931**	**(0.908 ~ 0.940)**
Aspect Ratio =	**0.973**	**(0.957 ~ 0.985)**
Convexity =	**0.985**	**(0.980 ~ 0.990)**
Straightness =	**0.991**	**(0.911 ~ 0.998)**
Elongation =	**0.379**	**(0.240 ~ 0.753)**

Feret Mean SMD = 4372.23 µm **90% Distribution: x_5 = 3875.40 µm / x_{95} = 4909.75 µm**

Sphericity =	**0.931**	**(0.906 ~ 0.940)**
Aspect Ratio =	**0.973**	**(0.956 ~ 0.985)**
Convexity =	**0.985**	**(0.980 ~ 0.990)**
Straightness =	**0.990**	**(0.908 ~ 0.998)**
Elongation =	**0.379**	**(0.232 ~ 0.753)**