Sympatec GmbH
System-Partikel-Technik

QICPIC Particle Size Analysis
WINDOX 5

QICPIC (QP0104) & GRADIS, 0.50 63.0 mm - M8 (20 ... 6820 µm)
120529aa_JRT_S_M8 **2012-05-29, 12:04:05**,555

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 (8x12)
Operator: Jonathan Tucker
Sample Mass: 0.00
Run Number: 0.00

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

product: 120529aa_JRT_S_M8	
C_{opt}:	0.36 %

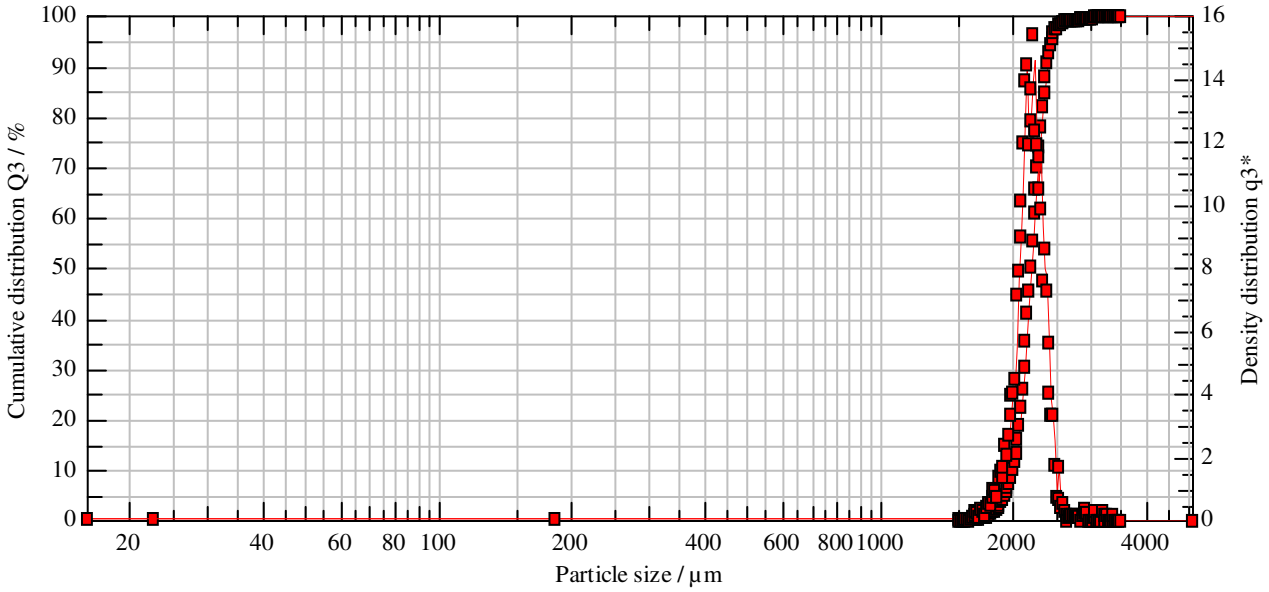
Size Distribution

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 = 1909.63 µm	**x_{50} = 2185.40 µm**	**x_{90} = 2377.39 µm**	**SMD = 2166.54 µm**	**VMD = 2186.34 µm**
x_{16} = 1987.61 µm	x_{84} = 2336.46 µm	x_{95} = 2437.37 µm	**#PI = 640363**	



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
1500.00	0.09	99.91	0.09
1512.89	0.09	99.91	0.00
1525.90	0.09	99.91	0.00
1539.01	0.09	99.91	0.00
1552.24	0.09	99.91	0.00
1565.58	0.09	99.91	0.01
1579.04	0.10	99.90	0.01
1592.61	0.10	99.90	0.00
1606.30	0.12	99.88	0.02
1620.11	0.16	99.84	0.04
1634.03	0.21	99.79	0.06
1648.08	0.31	99.69	0.10
1662.24	0.39	99.61	0.08
1676.53	0.43	99.57	0.04
1690.94	0.56	99.44	0.13
1705.48	0.67	99.33	0.11
1720.13	0.72	99.28	0.05
1734.92	0.79	99.21	0.07
1749.83	0.95	99.05	0.16
1764.87	1.16	98.84	0.21
1780.04	1.33	98.67	0.18
1795.34	1.62	98.38	0.28
1810.77	1.98	98.02	0.36
1826.34	2.32	97.68	0.34
1842.03	2.59	97.41	0.27
1857.87	3.10	96.90	0.51
1873.84	3.67	96.33	0.57
1889.94	4.18	95.82	0.52
1906.19	4.81	95.19	0.63
1922.57	5.70	94.30	0.89
1939.10	6.46	93.54	0.76
1955.76	7.46	92.54	1.00
1972.57	8.69	91.31	1.23
1989.53	10.17	89.83	1.48
2006.63	11.67	88.33	1.51
2023.88	13.33	86.67	1.65
2041.27	15.98	84.02	2.65
2058.82	18.90	81.10	2.93
2076.51	22.24	77.76	3.33
2094.36	26.01	73.99	3.77
2112.36	30.46	69.54	4.45
2130.52	35.64	64.36	5.18
2148.83	41.00	59.00	5.37
2167.30	45.42	54.58	4.42
2185.93	50.13	49.87	4.71
2204.72	55.21	44.79	5.08
2223.67	60.92	39.08	5.71
2242.78	65.52	34.48	4.60
2262.06	69.96	30.04	4.43
2281.50	73.86	26.14	3.90
2301.11	78.14	21.86	4.29
2320.89	81.81	18.19	3.67
2340.84	84.62	15.38	2.81
2360.96	87.82	12.18	3.20
2381.26	90.51	9.49	2.69
2401.72	92.61	7.39	2.10
2422.37	94.10	5.90	1.49
2443.19	95.35	4.65	1.25
2464.19	96.58	3.42	1.23
2485.37	97.24	2.76	0.65
2506.73	97.50	2.50	0.26
2528.28	98.13	1.87	0.63
2550.01	98.37	1.63	0.24
2571.93	98.52	1.48	0.16
2594.03	98.72	1.28	0.20
2616.33	98.84	1.16	0.12
2638.82	98.91	1.09	0.07
2661.50	98.91	1.09	0.00
2684.37	98.94	1.06	0.03
2707.45	99.00	1.00	0.06
2730.72	99.06	0.94	0.06
2754.19	99.12	0.88	0.06
2777.86	99.16	0.84	0.03

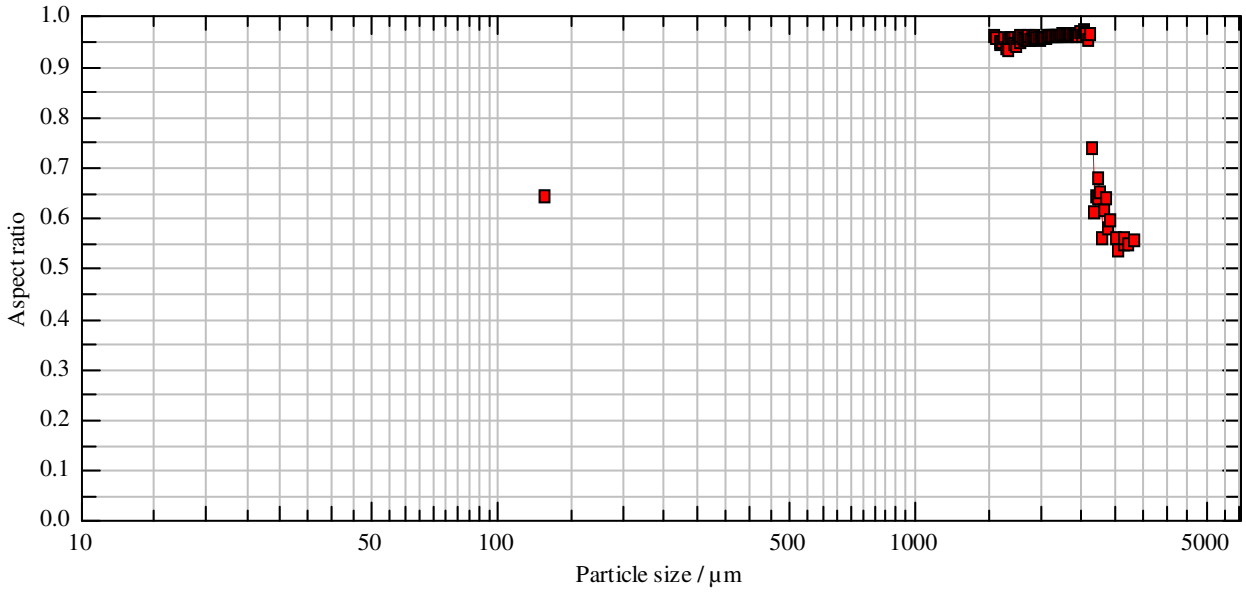
density distribution (log.)

mean size for band x_m/µm	density distribution $q_3$lg
15.96	0.00
183.99	0.00
1506.43	0.00
1519.38	0.00
1532.44	0.00
1545.61	0.00
1558.90	0.01
1572.30	0.01
1585.81	0.00
1599.44	0.04
1613.19	0.11
1627.05	0.15
1641.04	0.27
1655.14	0.21
1669.37	0.12
1683.72	0.35
1698.19	0.29
1712.79	0.15
1727.51	0.18
1742.36	0.43
1757.33	0.56
1772.44	0.48
1787.67	0.76
1803.04	0.97
1818.54	0.92
1834.17	0.72
1849.93	1.37
1865.83	1.53
1881.87	1.40
1898.05	1.69
1914.36	2.39
1930.82	2.03
1947.41	2.69
1964.15	3.32
1981.03	3.98
1998.06	4.06
2015.23	4.45
2032.56	7.13
2050.03	7.88
2067.65	8.96
2085.42	10.15
2103.34	11.98
2121.42	13.92
2139.66	14.44
2158.05	11.90
2176.60	12.68
2195.31	13.66
2214.17	15.37
2233.21	12.37
2252.40	11.92
2271.76	10.49
2291.29	11.53
2310.98	9.86
2330.85	7.56
2350.88	8.61
2371.09	7.25
2391.47	5.64
2412.02	4.02
2432.75	3.35
2453.66	3.32
2474.75	1.76
2496.03	0.70
2517.48	1.69
2539.12	0.65
2560.94	0.42
2582.95	0.53
2605.16	0.31
2627.55	0.19
2650.13	0.00
2672.91	0.08
2695.89	0.17
2719.06	0.17
2742.43	0.17
2766.00	0.09

2801.74	99.19	0.81	0.03	2789.77	0.09
2825.82	99.23	0.77	0.04	2813.75	0.10
2850.11	99.23	0.77	0.00	2837.94	0.00
2874.61	99.29	0.71	0.06	2862.33	0.17
2899.32	99.41	0.59	0.13	2886.93	0.34
2924.24	99.49	0.51	0.08	2911.75	0.22
2949.37	99.58	0.42	0.08	2936.78	0.22
2974.72	99.58	0.42	0.00	2962.02	0.00
3000.29	99.58	0.42	0.00	2987.48	0.00
3026.08	99.58	0.42	0.00	3013.16	0.00
3052.09	99.62	0.38	0.04	3039.06	0.12
3078.32	99.72	0.28	0.10	3065.18	0.26
3104.78	99.72	0.28	0.00	3091.52	0.00
3131.47	99.72	0.28	0.00	3118.10	0.00
3158.38	99.72	0.28	0.00	3144.90	0.00
3185.53	99.82	0.18	0.11	3171.93	0.28
3212.91	99.88	0.12	0.06	3199.19	0.15
3240.53	99.88	0.12	0.00	3226.69	0.00
3268.38	99.93	0.07	0.06	3254.42	0.15
3296.47	99.93	0.07	0.00	3282.40	0.00
3324.81	99.93	0.07	0.00	3310.61	0.00
3353.39	99.93	0.07	0.00	3339.07	0.00
3382.21	100.00	0.00	0.07	3367.77	0.18
3411.28	100.00	0.00	0.00	3396.71	0.00
3440.60	100.00	0.00	0.00	3425.91	0.00
3470.17	100.00	0.00	0.00	3455.35	0.00
3500.00	100.00	0.00	0.00	3485.05	0.00
7307.77	100.00	0.00	0.00	5057.39	0.00

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.

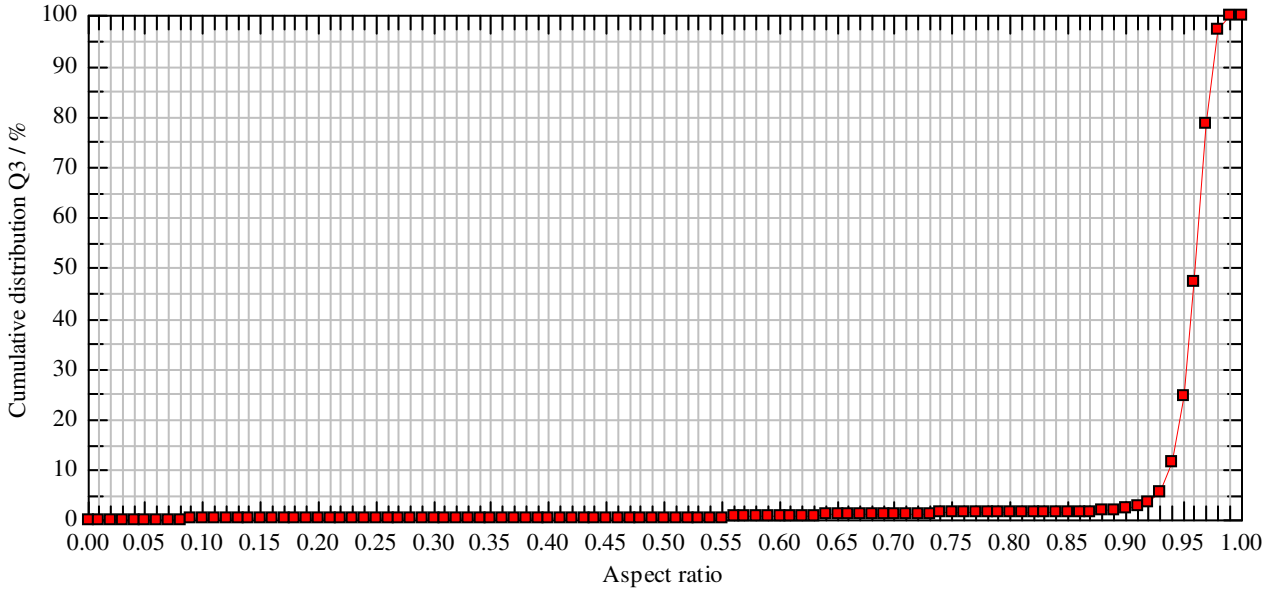


x_m/µm	aspect ratio	x_m/µm	aspect ratio	x_m/µm	aspect ratio	x_m/µm	aspect ratio
130.10	0.642	1865.83	0.950	2330.85	0.960	2911.75	0.579
1506.43		1881.87	0.959	2350.88	0.961	2936.78	0.594
1519.38		1898.05	0.949	2371.09	0.961	2962.02	
1532.44		1914.36	0.954	2391.47	0.957	2987.48	
1545.61		1930.82	0.953	2412.02	0.962	3013.16	
1558.90	0.958	1947.41	0.957	2432.75	0.962	3039.06	0.557
1572.30	0.954	1964.15	0.954	2453.66	0.957	3065.18	0.535
1585.81		1981.03	0.954	2474.75	0.959	3091.52	
1599.44	0.941	1998.06	0.952	2496.03	0.965	3118.10	
1613.19	0.948	2015.23	0.955	2517.48	0.960	3144.90	
1627.05	0.947	2032.56	0.956	2539.12	0.971	3171.93	0.545
1641.04	0.956	2050.03	0.956	2560.94	0.966	3199.19	0.558
1655.14	0.933	2067.65	0.956	2582.95	0.962	3226.69	
1669.37	0.951	2085.42	0.957	2605.16	0.951	3254.42	0.548
1683.72	0.929	2103.34	0.957	2627.55	0.962	3282.40	
1698.19	0.953	2121.42	0.957	2650.13		3310.61	
1712.79	0.952	2139.66	0.959	2672.91	0.735	3339.07	
1727.51	0.953	2158.05	0.959	2695.89	0.611	3367.77	0.554
1742.36	0.942	2176.60	0.958	2719.06	0.640	3396.71	
1757.33	0.939	2195.31	0.960	2742.43	0.676	3425.91	
1772.44	0.955	2214.17	0.960	2766.00	0.638	3455.35	
1787.67	0.945	2233.21	0.958	2789.77	0.650	3485.05	
1803.04	0.957	2252.40	0.958	2813.75	0.557	5057.39	
1818.54	0.954	2271.76	0.961	2837.94			
1834.17	0.950	2291.29	0.962	2862.33	0.612		
1849.93	0.949	2310.98	0.959	2886.93	0.638		

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} = 0.938	**a_{50} = 0.961**	**a_{90} = 0.976**
a_{16} = 0.944	a_{84} = 0.973	a_{99} = 0.986



cumulative distribution

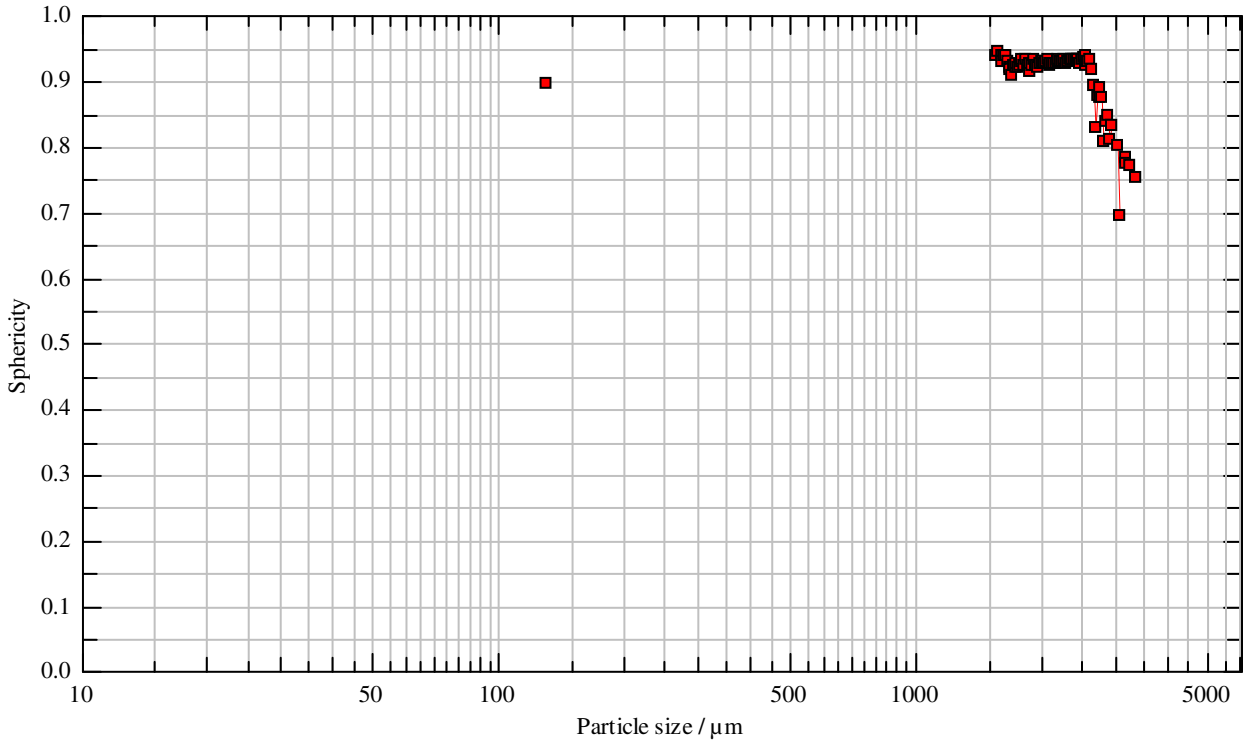
aspect ratio a_O	cumulative distribution Q_3 / %	residue distribution $(1-Q_3)$ / %
0.050	0.00	100.00
0.100	0.00	100.00
0.150	0.00	100.00
0.200	0.00	100.00
0.250	0.00	100.00
0.300	0.00	100.00
0.350	0.00	100.00
0.400	0.00	100.00
0.450	0.01	99.99
0.500	0.02	99.98
0.550	0.17	99.83
0.600	0.65	99.35
0.650	0.91	99.09
0.700	1.05	98.95
0.750	1.22	98.78
0.800	1.31	98.69
0.850	1.49	98.51
0.900	2.12	97.88
0.950	24.25	75.75
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	0.007
0.495	0.003
0.545	0.057
0.595	0.068
0.645	0.069
0.695	0.054
0.745	0.020
0.795	0.038
0.845	0.050
0.895	0.274
0.945	12.827
0.995	0.017

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.

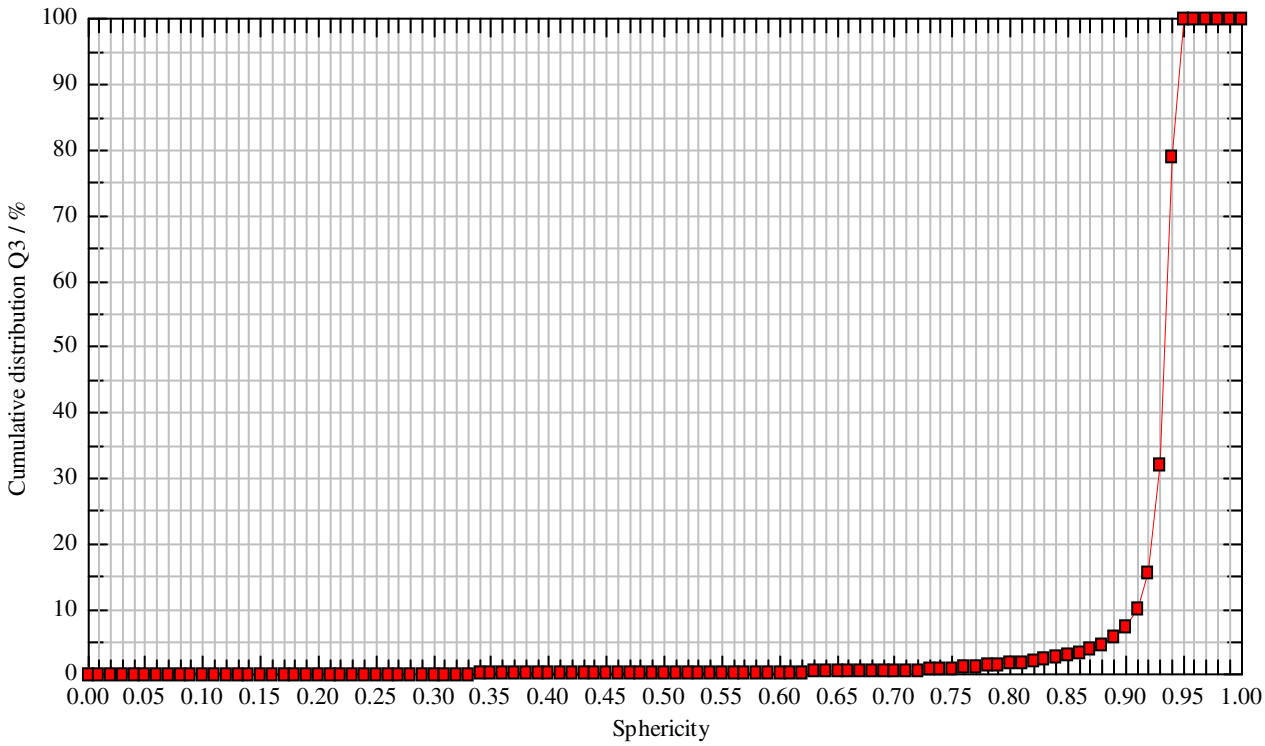


x_m/µm	sphericity	x_m/µm	sphericity	x_m/µm	sphericity	x_m/µm	sphericity
130.10	0.896	1865.83	0.914	2330.85	0.931	2911.75	0.811
1506.43		1881.87	0.925	2350.88	0.931	2936.78	0.831
1519.38		1898.05	0.921	2371.09	0.932	2962.02	
1532.44		1914.36	0.930	2391.47	0.931	2987.48	
1545.61		1930.82	0.923	2412.02	0.932	3013.16	
1558.90	0.938	1947.41	0.923	2432.75	0.932	3039.06	0.799
1572.30	0.942	1964.15	0.919	2453.66	0.932	3065.18	0.694
1585.81		1981.03	0.927	2474.75	0.925	3091.52	
1599.44	0.938	1998.06	0.927	2496.03	0.932	3118.10	
1613.19	0.929	2015.23	0.924	2517.48	0.934	3144.90	
1627.05	0.937	2032.56	0.926	2539.12	0.937	3171.93	0.781
1641.04	0.936	2050.03	0.927	2560.94	0.921	3199.19	0.774
1655.14	0.927	2067.65	0.930	2582.95	0.929	3226.69	
1669.37	0.920	2085.42	0.923	2605.16	0.932	3254.42	0.770
1683.72	0.916	2103.34	0.924	2627.55	0.918	3282.40	
1698.19	0.907	2121.42	0.924	2650.13		3310.61	
1712.79	0.922	2139.66	0.927	2672.91	0.891	3339.07	
1727.51	0.919	2158.05	0.927	2695.89	0.826	3367.77	0.751
1742.36	0.926	2176.60	0.929	2719.06	0.876	3396.71	
1757.33	0.920	2195.31	0.930	2742.43	0.887	3425.91	
1772.44	0.921	2214.17	0.929	2766.00	0.872	3455.35	
1787.67	0.927	2233.21	0.928	2789.77	0.872	3485.05	
1803.04	0.933	2252.40	0.930	2813.75	0.807	5057.39	
1818.54	0.921	2271.76	0.931	2837.94			
1834.17	0.932	2291.29	0.927	2862.33	0.838		
1849.93	0.924	2310.98	0.927	2886.93	0.846		

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} = 0.910	**s_{50} = 0.934**	**s_{90} = 0.945**
s_{16} = 0.920	s_{84} = 0.943	s_{99} = 0.950



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	0.03	99.97
0.600	0.22	99.78
0.650	0.32	99.68
0.700	0.45	99.55
0.750	0.89	99.11
0.800	1.54	98.46
0.850	2.78	97.22
0.900	7.25	92.75
0.950	99.93	0.07
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	0.016
0.645	0.013
0.695	0.029
0.745	0.102
0.795	0.226
0.845	0.331
0.895	1.753
0.945	21.255
0.995	0.000

Summary and Comparrisons

EQPC SMD *(Preffered)* = 2166.54 µm **90% Distribution: x_5 = 1909.63 µm / x_{95} = 2437.37 µm**

Sphericity =	**0.934**	**(0.910 ~ 0.945)**
Aspect Ratio =	**0.961**	**(0.938 ~ 0.976)**
Convexity =	**0.982**	**(0.972 ~ 0.988)**
Straightness =	**0.994**	**(0.977 ~ 0.999)**
Elongation =	**0.730**	**(0.372 ~ 0.782)**

Feret Max SMD = 2260.79 µm **90% Distribution: x_5 = 1979.34 µm / x_{95} = 2541.60 µm**

Sphericity =	**0.934**	**(0.905 ~ 0.945)**
Aspect Ratio =	**0.960**	**(0.935 ~ 0.976)**
Convexity =	**0.982**	**(0.971 ~ 0.988)**
Straightness =	**0.994**	**(0.975 ~ 0.999)**
Elongation =	**0.726**	**(0.368 ~ 0.781)**

Feret Min SMD = 2140.99 µm **90% Distribution: x_5 = 1886.20 µm / x_{95} = 2403.53 µm**

Sphericity =	**0.934**	**(0.911 ~ 0.945)**
Aspect Ratio =	**0.961**	**(0.939 ~ 0.976)**
Convexity =	**0.982**	**(0.972 ~ 0.988)**
Straightness =	**0.994**	**(0.977 ~ 0.999)**
Elongation =	**0.731**	**(0.372 ~ 0.782)**

Feret Mean SMD = 2202.07 µm **90% Distribution: x_5 = 1935.30 µm / x_{95} = 2469.42 µm**

Sphericity =	**0.934**	**(0.908 ~ 0.945)**
Aspect Ratio =	**0.961**	**(0.937 ~ 0.976)**
Convexity =	**0.982**	**(0.972 ~ 0.988)**
Straightness =	**0.994**	**(0.976 ~ 0.999)**
Elongation =	**0.729**	**(0.370 ~ 0.782)**