

**TITLE:**

- Dataset underlying the research of: a submerged cylindrical object in a liquid-solid fluidised bed - measuring local voidage and profile using a hydraulic weighing technique

**SHORT DESCRIPTION:**

- A new soft-sensor was developed to measure a hydraulics pressure gradient in a liquid-solid fluidised bed (LSF). LSF is frequently encountered in drinking water treatment processes, often to obtain a large liquid-solid interfacial surface area. A large surface area is crucial for optimal seeded crystallisation in full-scale softening reactors. Due to crystallisation, particles grow and migrate to a lower zone in the reactor which leads to a stratified bed. Larger particles adversely affect the surface area. To maintain optimal process conditions in the fluidised beds, information is needed about the distribution of particle size, local voidage and available surface area, over the reactor height. This data set contains 54 individual measurements of calciet pellets (0.8-0.9mm), (0.9-1.0mm) and a mixture (0.5-0.63mm+1.25-1.4mm) and 3 mm glass beads for various water flow rates.

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#### FORMAT:

- Experimental data

#### CONTACT INFORMATION:

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#### ORGANIZATIONS:

- Delft University of Technology, Faculty of Civil Engineering and Geosciences, Department of Water Management
- Delft University of Technology, Faculty of Mechanical, Maritime and Materials Engineering, Department of Process and Energy
- Waternet, Amsterdam (funder)
- HU University of Applied Sciences Utrecht, Institute for Life Science and Chemistry
- Queen Mary University of London, Division of Chemical Engineering, School of Engineering and Materials Science

#### SUBJECT:

- Hydraulic modelling of multiphase flow systems

#### KEYWORDS:

- multiphase phenomena
- liquid-solid fluidisation
- drinking water treatment
- hydrostatic soft sensor water softening

#### METHODOLOGICAL INFORMATION:

- Experimental data-set

#### ADDITIONAL TECHNICAL INFORMATION:

► O.J.I. Kramer, P.J. de Moel, J.T. Padding, E.T. Baars, Y.M.F. el Hasadi, E.S. Boek, J.P. van der Hoek, Accurate voidage prediction in fluidisation systems for full-scale drinking water pellet softening reactors using data driven models, *Journal of Water Process Engineering*. 37, 101481 (2020) 1–15.  
<https://doi.org/10.1016/j.jwpe.2020.101481>

► O.J.I. Kramer, J.T. Padding, W.H. van Vugt, P.J. de Moel, E.T. Baars, E.S. Boek, J.P. van der Hoek, Improvement of voidage prediction in liquid-solid fluidized beds by inclusion of the Froude number in effective drag relations, *International Journal of Multiphase Flow*. 127, 103261 (2020) 1–13.  
<https://doi.org/10.1016/j.ijmultiphaseflow.2020.103261>

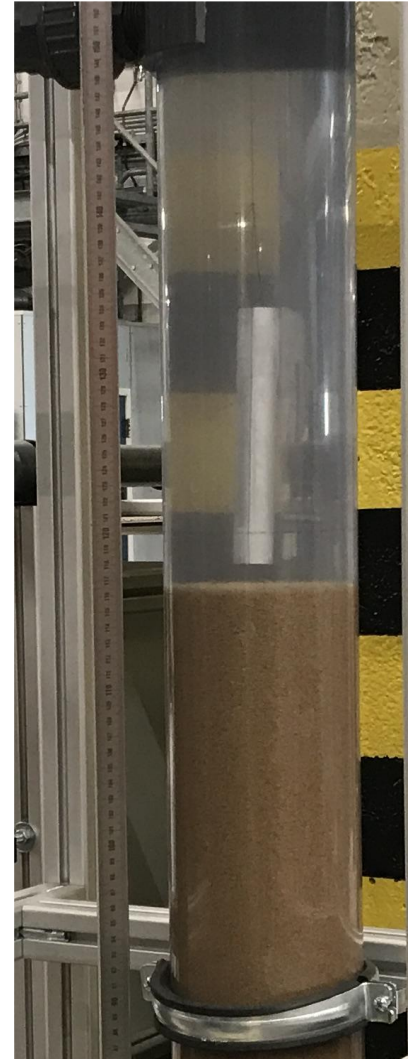
## 1 Experimental set-up



**Figure 1** Cylindrical aluminium objects



**Figure 2** Waterjet submerged experimental object set-up



**Figure 3** Sensor and cylindrical object

## 2 Video material

Three short videos are included in the data-set.

Submerged object (0.5-0.63+1.25-1.4mm calcite pellets).wmv

Submerged object (0.9-1.0mm calcite pellets). wmv

Submerged object (3.0mm glass beads). wmv

### PROJECT:

- This research is part of the project “Hydraulic modelling of liquid-solid fluidisation in drinking water treatment processes” carried out by Waternet, Delft University of Technology, and HU University of Applied Sciences Utrecht and Queen Mary University of London. Financial support came from Waternet Drinking Water Production Department.

### SHARING AND ACCESS INFORMATION:

- 4TU.ResearchData
- Delft, 12 March 2021

### 3 Experimental raw data

All the data gathered during the fluidisation experiments are shared. To discriminate the different stages, an index 0, 1, 2 or 3 is added to the data.

Legend:                status 0: fixed bed  
                          status 0: object hanging in air  
                          status 1: object hanging in water  
                          status 2: object hanging in fluidised bed fraction 1  
                          status 3: object hanging in fluidised bed fraction 2

3.1        Experiments with aluminium objects (page 5)

3.2        Experiments with a titanium object (page 30)

#### 3.1 Experiments with aluminium objects

Measurement number	14				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.08803	[kg]			
Mass apparent object	0.05622	[kg]			
Length object	0.100	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000316	[m2]			
Volume object	0.0000319	[m3]			
Outside area object	0.00693	[m2]			
Density object	2757	[kg/m3]			
Weight object	0.864	[N]			
Weight apparent object	0.552	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	63.8	[m/h]			
Fixed bed height	0.519	[m]			
Fluid bed height	0.784	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.80	[mm]			
Particle size (highest)	0.90	[mm]			
Particle size (average)	0.85	[mm]			
Particle mass	10.00	[kg]			
Particle density	2614	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.784	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.592	[m³/m³]			
Volume fraction i	0.00382	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.19	[mm]			
Distance between centres 2 particles	1.03	[mm]			
Estimated number of particles around object	6463	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]
2	0.0864	-1	761	11.0	0.783
3	0.0540	520	759	11.0	0.784
4	0.0347	1073	764	11.0	0.784
5	0.0352	1173	758	11.0	0.784
6	0.0332	1297	766	11.0	0.784
7	0.0319	1371	755	11.0	0.784
8	0.0320	1473	758	11.0	0.784
9	0.0318	1572	764	11.0	0.784
10	0.0326	1672	760	11.0	0.784
11	0.0295	1745	756	11.0	0.784

Measurement number	22				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.14129	[kg]			
Mass apparent object	0.08990	[kg]			
Length object	0.160	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000319	[m2]			
Volume object	0.0000514	[m3]			
Outside area object	0.01077	[m2]			
Density object	2746	[kg/m3]			
Weight object	1.386	[N]			
Weight apparent object	0.882	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	8.8	[oC]			
Water density	999.8	[kg/m3]			
Kinematic viscosity	0.00134	[kg/m/s]			
Superficial velocity (average)	71.4	[m/h]			

Fixed bed height	0.519	[m]				
Fluid bed height	0.833	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite pellets	[-]				
Particle size (lowest)	0.80	[mm]				
Particle size (highest)	0.90	[mm]				
Particle size (average)	0.85	[mm]				
Particle mass	10.00	[kg]				
Particle density	2614	[kg/m³]				
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.833	[m]				
Fixed bed voidage	0.402	[m³/m³]				
Incipient bed voidage	0.412	[m³/m³]				
Average fluidised bed voidage	0.616	[m³/m³]				
Volume fraction i	0.00382	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.21	[mm]				
Distance between centres 2 particles	1.06	[mm]				
Estimated number of particles around object	9952	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[°C]	[m]	[m]
1	0.1421	-3	850	8.8	0.833	
2	0.0892	454	850	8.8	0.833	
3	0.0587	1080	843	8.8	0.832	
4	0.0581	1166	850	8.8	0.832	
5	0.0578	1196	852	8.8	0.833	
6	0.0560	1311	852	8.8	0.833	
7	0.0560	1428	852	8.8	0.833	
8	0.0557	1544	852	8.8	0.833	
9	0.0562	1661	852	8.8	0.833	
10	0.0494	1749	852	8.8	0.833	
11	0.0480	1753	852	8.8	0.833	
-----						
Measurement number	15					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m²]				
Volume object	0.0000319	[m³]				
Outside area object	0.00693	[m²]				
Density object	2757	[kg/m³]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m²]				
[ Fluid properties ]						
Average temperature	11.0	[°C]				
Water density	999.6	[kg/m³]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	76.4	[m/h]				
Fixed bed height	0.519	[m]				
Fluid bed height	0.847	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite pellets	[-]				
Particle size (lowest)	0.80	[mm]				
Particle size (highest)	0.90	[mm]				
Particle size (average)	0.85	[mm]				
Particle mass	10.00	[kg]				
Particle density	2614	[kg/m³]				
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.847	[m]				
Fixed bed voidage	0.402	[m³/m³]				
Incipient bed voidage	0.412	[m³/m³]				
Average fluidised bed voidage	0.622	[m³/m³]				
Volume fraction i	0.00382	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.21	[mm]				
Distance between centres 2 particles	1.06	[mm]				
Estimated number of particles around object	6153	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[°C]	[m]	[m]
1	0.0880	0910	11.0	0.846		
2	0.0551	828	910	11.0	0.846	
3	0.0366	1009	910	11.0	0.847	
4	0.0360	1109	916	11.0	0.848	
5	0.0350	1192	910	11.0	0.847	
6	0.0341	1309	906	11.0	0.847	
7	0.0335	1407	913	11.0	0.847	
8	0.0332	1509	906	11.0	0.847	
9	0.0334	1608	912	11.0	0.847	
10	0.0343	1708	905	11.0	0.847	
11	0.0253	1752	908	11.0	0.847	
-----						
Measurement number	20					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m²]				
Volume object	0.0000514	[m³]				
Outside area object	0.01077	[m²]				
Density object	2746	[kg/m³]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m²]				
[ Fluid properties ]						
Average temperature	8.8	[°C]				
Water density	999.8	[kg/m³]				
Kinematic viscosity	0.00134	[kg/m/s]				
Superficial velocity (average)	87.7	[m/h]				
Fixed bed height	0.519	[m]				
Fluid bed height	0.933	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				

Type of particle	Calcite pellets	[-]				
Particle size (lowest)	0.80	[mm]				
Particle size (highest)	0.90	[mm]				
Particle size (average)	0.85	[mm]				
Particle mass	10.00	[kg]				
Particle density	2614	[kg/m³]				
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.933	[m]				
Fixed bed voidage	0.402	[m³/m³]				
Incipient bed voidage	0.412	[m³/m³]				
Average fluidised bed voidage	0.657	[m³/m³]				
Volume fraction i	0.00382	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.25	[mm]				
Distance between centres 2 particles	1.10	[mm]				
Estimated number of particles around object	9259	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1407	01045	8.8	0.933		
2	0.0898	550	1045	8.8	0.933	
3	0.0629	979	1045	8.8	0.933	
4	0.0613	1093	1045	8.8	0.933	
5	0.0621	1208	1045	8.8	0.933	
6	0.0592	1327	1045	8.8	0.933	
7	0.0584	1448	1045	8.8	0.933	
8	0.0591	1565	1045	8.8	0.933	
9	0.0590	1680	1045	8.8	0.933	
10	0.0531	1745	1045	8.8	0.933	
11	0.0545	1752	1042	8.8	0.931	
-----						
Measurement number	16					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m2]				
Volume object	0.0000319	[m3]				
Outside area object	0.00693	[m2]				
Density object	2757	[kg/m3]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	89.7	[m/h]				
Fixed bed height	0.519	[m]				
Fluid bed height	0.915	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite pellets	[-]				
Particle size (lowest)	0.80	[mm]				
Particle size (highest)	0.90	[mm]				
Particle size (average)	0.85	[mm]				
Particle mass	10.00	[kg]				
Particle density	2614	[kg/m³]				
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.915	[m]				
Fixed bed voidage	0.402	[m³/m³]				
Incipient bed voidage	0.412	[m³/m³]				
Average fluidised bed voidage	0.650	[m³/m³]				
Volume fraction i	0.00382	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.24	[mm]				
Distance between centres 2 particles	1.09	[mm]				
Estimated number of particles around object	5860	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.0880	01070	11.0	0.915		
2	0.0551	578	1070	11.0	0.915	
3	0.0358	944	1068	11.0	0.915	
4	0.0371	1042	1073	11.0	0.915	
5	0.0371	1142	1067	11.0	0.915	
6	0.0364	1241	1068	11.0	0.915	
7	0.0355	1342	1075	11.0	0.915	
8	0.0355	1440	1060	11.0	0.915	
9	0.0356	1541	1070	11.0	0.915	
10	0.0349	1641	1068	11.0	0.915	
11	0.0338	1741	1067	11.0	0.915	
12	0.0332	1741	1067	11.0	0.915	
-----						
Measurement number	17					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m2]				
Volume object	0.0000319	[m3]				
Outside area object	0.00693	[m2]				
Density object	2757	[kg/m3]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	97.7	[m/h]				
Fixed bed height	0.519	[m]				
Fluid bed height	0.975	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite pellets	[-]				
Particle size (lowest)	0.80	[mm]				
Particle size (highest)	0.90	[mm]				

Particle size (average)	0.85	[mm]			
Particle mass	10.00	[kg]			
Particle density	2614	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.975	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.672	[m³/m³]			
Volume fraction i	0.00382	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.27	[mm]			
Distance between centres 2 particles	1.11	[mm]			
Estimated number of particles around object	5619	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.0882	-1	1160	11.0	0.978
2	0.0556	612	1165	11.0	0.978
3	0.0402	876	1160	11.0	0.975
4	0.0399	976	1162	11.0	0.975
5	0.0387	1073	1162	11.0	0.975
6	0.0383	1175	1164	11.0	0.975
7	0.0389	1275	1167	11.0	0.975
8	0.0374	1375	1167	11.0	0.975
9	0.0371	1476	1167	11.0	0.975
10	0.0357	1575	1167	11.0	0.975
11	0.0366	1667	1167	11.0	0.975
12	0.0323	1749	1167	11.0	0.975
13	0.0326	1751	1152	11.0	0.975
-----					
Measurement number	18				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.08803	[kg]			
Mass apparent object	0.05622	[kg]			
Length object	0.100	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000316	[m2]			
Volume object	0.0000319	[m3]			
Outside area object	0.00693	[m2]			
Density object	2757	[kg/m3]			
Weight object	0.864	[N]			
Weight apparent object	0.552	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	114.9	[m/h]			
Fixed bed height	0.519	[m]			
Fluid bed height	1.082	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.80	[mm]			
Particle size (highest)	0.90	[mm]			
Particle size (average)	0.85	[mm]			
Particle mass	10.00	[kg]			
Particle density	2614	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	1.082	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.704	[m³/m³]			
Volume fraction i	0.00382	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.30	[mm]			
Distance between centres 2 particles	1.15	[mm]			
Estimated number of particles around object	5270	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.0884	01368	11.0	1.083	
2	0.0559	568	1375	11.0	1.085
3	0.0408	772	1365	11.0	1.082
4	0.0405	872	1368	11.0	1.082
5	0.0404	971	1368	11.0	1.082
6	0.0396	1073	1375	11.0	1.084
7	0.0393	1172	1363	11.0	1.082
8	0.0388	1271	1365	11.0	1.082
9	0.0379	1371	1368	11.0	1.082
10	0.0383	1473	1368	11.0	1.082
11	0.0385	1570	1368	11.0	1.082
12	0.0381	1670	1368	11.0	1.082
13	0.0369	1751	1374	11.0	1.082
14	0.0358	1752	1368	11.0	1.082
-----					
Measurement number	20				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.14129	[kg]			
Mass apparent object	0.08990	[kg]			
Length object	0.160	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000319	[m2]			
Volume object	0.0000514	[m3]			
Outside area object	0.01077	[m2]			
Density object	2746	[kg/m3]			
Weight object	1.386	[N]			
Weight apparent object	0.882	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	8.8	[oC]			
Water density	999.8	[kg/m3]			
Kinematic viscosity	0.00134	[kg/m/s]			
Superficial velocity (average)	139.4	[m/h]			
Fixed bed height	0.519	[m]			
Fluid bed height	1.331	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.80	[mm]			



Particle size (highest)	0.90	[mm]				
Particle size (average)	0.85	[mm]				
Particle mass	10.00	[kg]				
Particle density	2614	[kg/m³]				
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	1.331	[m]				
Fixed bed voidage	0.402	[m³/m³]				
Incipient bed voidage	0.412	[m³/m³]				
Average fluidised bed voidage	0.759	[m³/m³]				
Volume fraction i	0.00382	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.39	[mm]				
Distance between centres 2 particles	1.23	[mm]				
Estimated number of particles around object	7396	[#]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1416	71660	8.8	1.334		
2	0.0911	415	1662	8.8	1.330	
3	0.0709	585	1654	8.8	1.328	
4	0.0704	691	1658	8.8	1.330	
5	0.0695	806	1658	8.8	1.330	
6	0.0699	910	1661	8.8	1.330	
7	0.0689	1026	1661	8.8	1.330	
8	0.0691	1140	1668	8.8	1.335	
9	0.0681	1255	1664	8.8	1.334	
10	0.0675	1371	1661	8.8	1.330	
11	0.0671	1486	1658	8.8	1.330	
12	0.0665	1603	1658	8.8	1.330	
13	0.0653	1722	1658	8.8	1.330	
14	0.0625	1750	1665	8.8	1.334	
15	0.0621	1753	1660	8.8	1.330	
16	0.0626	1754	1665	8.8	1.334	
-----						
Measurement number	19					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m²]				
Volume object	0.0000319	[m³]				
Outside area object	0.00693	[m²]				
Density object	2757	[kg/m³]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m²]				
[ Fluid properties ]						
Average temperature	8.8	[oC]				
Water density	999.8	[kg/m³]				
Kinematic viscosity	0.00134	[kg/m/s]				
Superficial velocity (average)	139.9	[m/h]				
Fixed bed height	0.516	[m]				
Fluid bed height	1.336	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite pellets	[-]				
Particle size (lowest)	0.90	[mm]				
Particle size (highest)	1.00	[mm]				
Particle size (average)	0.95	[mm]				
Particle mass	10.00	[kg]				
Particle density	2625	[kg/m³]				
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	1.336	[m]				
Fixed bed voidage	0.402	[m³/m³]				
Incipient bed voidage	0.412	[m³/m³]				
Average fluidised bed voidage	0.761	[m³/m³]				
Volume fraction i	0.00381	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.43	[mm]				
Distance between centres 2 particles	1.38	[mm]				
Estimated number of particles around object	3731	[#]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.0896	21670	8.8	1.342		
2	0.0560	364	1670	8.8	1.340	
3	0.0453	517	1670	8.8	1.339	
4	0.0439	616	1670	8.8	1.338	
5	0.0442	718	1663	8.8	1.338	
6	0.0439	816	1668	8.8	1.338	
7	0.0433	917	1663	8.8	1.331	
8	0.0433	1015	1661	8.8	1.332	
9	0.0428	1117	1660	8.8	1.330	
10	0.0432	1215	1661	8.8	1.331	
11	0.0423	1317	1665	8.8	1.333	
12	0.0415	1418	1665	8.8	1.333	
13	0.0418	1517	1668	8.8	1.335	
14	0.0423	1615	1665	8.8	1.338	
15	0.0424	1716	1665	8.8	1.338	
16	0.0421	1716	1665	8.8	1.338	
17	0.0380	1741	1665	8.8	1.338	
-----						
Measurement number	1					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m²]				
Volume object	0.0000319	[m³]				
Outside area object	0.00693	[m²]				
Density object	2757	[kg/m³]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m²]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m³]				
Kinematic viscosity	0.00126	[kg/m/s]				

Superficial velocity (average)	88.1	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.876	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.876	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.636	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.25	[mm]			
Distance between centres 2 particles	1.20	[mm]			
Estimated number of particles around object	4860	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[°C]	[m]
1	0.0882	01049	11.0	0.876	
2	0.0563	450	1049	11.0	0.876
3	0.0381	981	1049	11.0	0.876
4	0.0389	1056	1049	11.0	0.876
5	0.0397	1156	1049	11.0	0.876
6	0.0372	1256	1049	11.0	0.876
7	0.0354	1356	1049	11.0	0.876
8	0.0351	1456	1049	11.0	0.876
9	0.0352	1556	1049	11.0	0.876
10	0.0369	1656	1049	11.0	0.876
11	0.0286	1749	1049	11.0	0.876
12	0.0276	1751	1049	11.0	0.876
Measurement number	1				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.20216	[kg]			
Mass apparent object	0.13150	[kg]			
Length object	0.100	[m]			
Diameter object	0.030	[m]			
Cross sectional area object	0.000703	[m²]			
Volume object	0.0000709	[m³]			
Outside area object	0.01084	[m²]			
Density object	2851	[kg/m³]			
Weight object	1.984	[N]			
Weight apparent object	1.290	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m²]			
[ Fluid properties ]					
Average temperature	11.0	[°C]			
Water density	999.6	[kg/m³]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	88.1	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.876	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.876	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.637	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.25	[mm]			
Distance between centres 2 particles	1.20	[mm]			
Estimated number of particles around object	7040	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[°C]	[m]
1	0.2040	01050	11.0	0.876	
2	0.1320	557	1050	11.0	0.876
3	0.0928	987	1050	11.0	0.876
4	0.0962	1086	1050	11.0	0.876
5	0.0939	1186	1050	11.0	0.876
6	0.0911	1286	1050	11.0	0.876
7	0.0879	1388	1050	11.0	0.876
8	0.0850	1487	1050	11.0	0.876

fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.870	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.636	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.25	[mm]			
Distance between centres 2 particles	1.20	[mm]			
Estimated number of particles around object	9303	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.3446	60	1047	11.0	0.870
2	0.2185	557	1047	11.0	0.870
3	0.1547	986	1047	11.0	0.870
4	0.1524	1087	1047	11.0	0.870
5	0.1481	1186	1047	11.0	0.870
6	0.1455	1287	1047	11.0	0.870
7	0.1398	1388	1047	11.0	0.870
8	0.1368	1487	1047	11.0	0.870
9	0.1440	1587	1047	11.0	0.870
10	0.1436	1687	1047	11.0	0.870
11	0.1143	1754	1047	11.0	0.870
-----					
Measurement number	4				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.14129	[kg]			
Mass apparent object	0.08990	[kg]			
Length object	0.160	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000319	[m2]			
Volume object	0.0000514	[m3]			
Outside area object	0.01077	[m2]			
Density object	2746	[kg/m3]			
Weight object	1.386	[N]			
Weight apparent object	0.882	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	88.6	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.876	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.876	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.636	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.25	[mm]			
Distance between centres 2 particles	1.20	[mm]			
Estimated number of particles around object	7769	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.1413	01055	11.0	0.876	
2	0.0899	661	1055	11.0	0.876
3	0.0613	1048	1055	11.0	0.876
4	0.0610	1147	1055	11.0	0.876
5	0.0590	1247	1055	11.0	0.876
6	0.0566	1347	1055	11.0	0.876
7	0.0561	1448	1055	11.0	0.876
8	0.0571	1544	1055	11.0	0.876
9	0.0584	1648	1055	11.0	0.876
10	0.0530	1753	1055	11.0	0.876
11	0.0485	1754	1055	11.0	0.876
-----					
Measurement number	5				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.32072	[kg]			
Mass apparent object	0.20834	[kg]			
Length object	0.160	[m]			
Diameter object	0.030	[m]			
Cross sectional area object	0.000703	[m2]			
Volume object	0.0001128	[m3]			
Outside area object	0.01644	[m2]			
Density object	2843	[kg/m3]			
Weight object	3.147	[N]			
Weight apparent object	2.044	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	88.4	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.876	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			

Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.876	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.638	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.26	[mm]			
Distance between centres 2 particles	1.20	[mm]			
Estimated number of particles around object	11150	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.3207	01053	11.0	0.876	
2	0.2108	644	1053	11.0	0.876
3	0.1480	1046	1053	11.0	0.876
4	0.1470	1148	1053	11.0	0.876
5	0.1442	1247	1053	11.0	0.876
6	0.1386	1346	1053	11.0	0.876
7	0.1380	1448	1053	11.0	0.876
8	0.1367	1547	1053	11.0	0.876
9	0.1395	1647	1053	11.0	0.876
10	0.1247	1745	1053	11.0	0.876
11	0.1196	1745	1053	11.0	0.876
-----					
Measurement number	6				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.54526	[kg]			
Mass apparent object	0.34432	[kg]			
Length object	0.160	[m]			
Diameter object	0.040	[m]			
Cross sectional area object	0.001257	[m2]			
Volume object	0.0002014	[m3]			
Outside area object	0.02262	[m2]			
Density object	2706	[kg/m3]			
Weight object	5.350	[N]			
Weight apparent object	3.379	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	87.7	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.869	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.869	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.638	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.26	[mm]			
Distance between centres 2 particles	1.20	[mm]			
Estimated number of particles around object	14682	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.5453	01045	11.0	0.869	
2	0.3528	850	1045	11.0	0.869
3	0.2454	1046	1045	11.0	0.869
4	0.2383	1148	1045	11.0	0.869
5	0.2327	1246	1045	11.0	0.869
6	0.2319	1247	1045	11.0	0.869
7	0.2254	1347	1045	11.0	0.869
8	0.2209	1447	1045	11.0	0.869
9	0.2191	1547	1045	11.0	0.869
10	0.2197	1648	1045	11.0	0.869
11	0.1930	1746	1045	11.0	0.869
-----					
Measurement number	5				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.10486	[kg]			
Mass apparent object	0.06676	[kg]			
Length object	0.120	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000317	[m2]			
Volume object	0.0000383	[m3]			
Outside area object	0.00820	[m2]			
Density object	2734	[kg/m3]			
Weight object	1.029	[N]			
Weight apparent object	0.655	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.3	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00125	[kg/m/s]			
Superficial velocity (average)	63.6	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.740	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			

Fluid bed height per fraction i	0.740	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.569	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.19	[mm]			
Distance between centres 2 particles	1.14	[mm]			
Estimated number of particles around object	6479	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]
1	0.1017	-1	759	11.3	0.740
2	0.0647	673	759	11.3	0.740
3	0.0388	1135	756	11.3	0.740
4	0.0388	1135	754	11.3	0.740
5	0.0381	1234	756	11.3	0.740
6	0.0372	1336	756	11.3	0.740
7	0.0361	1434	759	11.3	0.740
8	0.0354	1536	759	11.3	0.740
9	0.0354	1633	759	11.3	0.740
10	0.0295	1734	759	11.3	0.740
11	0.0301	1750	759	11.3	0.740

Measurement number	11				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.32072	[kg]			
Mass apparent object	0.20834	[kg]			
Length object	0.160	[m]			
Diameter object	0.030	[m]			
Cross sectional area object	0.000703	[m2]			
Volume object	0.0001128	[m3]			
Outside area object	0.01644	[m2]			
Density object	2843	[kg/m3]			
Weight object	3.147	[N]			
Weight apparent object	2.044	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m²s]			
Superficial velocity (average)	71.3	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.791	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.791	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.601	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.22	[mm]			
Distance between centres 2 particles	1.17	[mm]			
Estimated number of particles around object	11874	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]
1	0.3215	0850	11.0	0.791	
2	0.2062	675	850	11.0	0.791
3	0.2122	938	850	11.0	0.791
4	0.1404	1112	850	11.0	0.791
5	0.1365	1209	850	11.0	0.791
6	0.1354	1312	850	11.0	0.791
7	0.1340	1410	850	11.0	0.791
8	0.1315	1510	850	11.0	0.791
9	0.1290	1574	850	11.0	0.791
10	0.1284	1609	850	11.0	0.791
11	0.1275	1709	850	11.0	0.791
12	0.1204	1752	850	11.0	0.791
13	0.1215	1752	850	11.0	0.791

Measurement number	12				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.14129	[kg]			
Mass apparent object	0.08990	[kg]			
Length object	0.160	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000319	[m2]			
Volume object	0.0000514	[m3]			
Outside area object	0.01077	[m2]			
Density object	2746	[kg/m3]			
Weight object	1.386	[N]			
Weight apparent object	0.882	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m²s]			
Superficial velocity (average)	71.3	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.791	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.791	[m]			
Fixed bed voidage	0.402	[m³/m³]			

Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.598	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.21	[mm]			
Distance between centres 2 particles	1.16	[mm]			
Estimated number of particles around object	8283	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]
1	0.1409	-2	850	11.0	0.791
2	0.0894	640	850	11.0	0.791
3	0.0911	942	850	11.0	0.791
4	0.0571	1120	850	11.0	0.791
5	0.0570	1223	850	11.0	0.791
6	0.0552	1318	850	11.0	0.791
7	0.0550	1418	850	11.0	0.791
8	0.0526	1520	850	11.0	0.791
9	0.0509	1618	850	11.0	0.791
10	0.0496	1721	850	11.0	0.791
11	0.0479	1752	850	11.0	0.791
-----					
Measurement number	4				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.10486	[kg]			
Mass apparent object	0.06676	[kg]			
Length object	0.120	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000317	[m2]			
Volume object	0.0000383	[m3]			
Outside area object	0.00820	[m2]			
Density object	2734	[kg/m3]			
Weight object	1.029	[N]			
Weight apparent object	0.655	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.3	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00125	[kg/m²s]			
Superficial velocity (average)	74.1	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.803	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.803	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.603	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.22	[mm]			
Distance between centres 2 particles	1.17	[mm]			
Estimated number of particles around object	6153	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]
1	0.1006	0872	11.3	0.803	
2	0.0655	419	878	11.3	0.803
3	0.0406	1098	885	11.3	0.803
4	0.0411	1204	884	11.3	0.803
5	0.0396	1321	880	11.3	0.803
6	0.0377	1419	885	11.3	0.803
7	0.0374	1570	890	11.3	0.803
8	0.0380	1669	894	11.3	0.803
9	0.0349	1751	875	11.0	0.803
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Measurement number	9				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.32072	[kg]			
Mass apparent object	0.20834	[kg]			
Length object	0.160	[m]			
Diameter object	0.030	[m]			
Cross sectional area object	0.000703	[m2]			
Volume object	0.0001128	[m3]			
Outside area object	0.01644	[m2]			
Density object	2843	[kg/m3]			
Weight object	3.147	[N]			
Weight apparent object	2.044	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m²s]			
Superficial velocity (average)	81.0	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.840	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.840	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.626	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.24	[mm]			
Distance between centres 2 particles	1.19	[mm]			

Estimated number of particles around object	11392	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]
1	0.3215	0965	11.0	0.840	
2	0.2055	601	965	11.0	0.840
3	0.2064	744	965	11.0	0.840
4	0.2086	745	965	11.0	0.840
5	0.2048	903	965	11.0	0.840
6	0.1412	1055	965	11.0	0.840
7	0.1433	1074	965	11.0	0.840
8	0.1404	1172	965	11.0	0.840
9	0.1373	1274	965	11.0	0.840
10	0.1338	1370	965	11.0	0.840
11	0.1288	1472	965	11.0	0.840
12	0.1308	1546	965	11.0	0.840
13	0.1317	1574	965	11.0	0.840
14	0.1344	1652	965	11.0	0.840

Measurement number	1				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.10486	[kg]			
Mass apparent object	0.06676	[kg]			
Length object	0.120	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000317	[m2]			
Volume object	0.0000383	[m3]			
Outside area object	0.00820	[m2]			
Density object	2734	[kg/m3]			
Weight object	1.029	[N]			
Weight apparent object	0.655	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.2	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	86.7	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.855	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.855	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.627	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.24	[mm]			
Distance between centres 2 particles	1.19	[mm]			
Estimated number of particles around object	5914	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]
1	0.0880	01029	11.2	0.855	
2	0.0660	597	1029	11.2	0.855
3	0.0653	822	1037	11.2	0.855
4	0.0436	1030	1039	11.2	0.855
5	0.0446	1099	1026	11.2	0.855
6	0.0425	1211	1037	11.2	0.855
7	0.0407	1338	1028	11.2	0.855
8	0.0404	1457	1042	11.2	0.855
9	0.0383	1590	1030	11.2	0.855
10	0.0330	1729	1037	11.2	0.855

Measurement number	7	
[ Specifications object ]		
Object material	Aluminium	[-]
Mass object	0.32072	[kg]
Mass apparent object	0.20834	[kg]
Length object	0.160	[m]
Diameter object	0.030	[m]
Cross sectional area object	0.000703	[m2]
Volume object	0.0001128	[m3]
Outside area object	0.01644	[m2]
Density object	2843	[kg/m3]
Weight object	3.147	[N]
Weight apparent object	2.044	[N]
[ Specifications column ]		
Outer circumference	0.400	[m]
Wall thickness	0.0010	[m]
Offset distance encoder	1.756	[m]
Drain height	1.550	[m]
Internal diameter column	0.123	[m]
Internal surface area column	0.012	[m2]
[ Fluid properties ]		
Average temperature	11.0	[oC]
Water density	999.6	[kg/m3]
Kinematic viscosity	0.00126	[kg/m/s]
Superficial velocity (average)	99.0	[m/h]
Fixed bed height	0.516	[m]
Fluid bed height	0.937	[m]
[ Particle properties ]		
fraction nr.	Fraction 1	Fraction 2
Type of particle	Calcite pellets	[-]
Particle size (lowest)	0.90	[mm]
Particle size (highest)	1.00	[mm]
Particle size (average)	0.95	[mm]
Particle mass	10.00	[kg]
Particle density	2625	[kg/m³]
Differential pressure (estimated)	4.9	[kPa]
Fluid bed height per fraction i	0.937	[m]
Fixed bed voidage	0.402	[m³/m³]
Incipient bed voidage	0.412	[m³/m³]
Average fluidised bed voidage	0.661	[m³/m³]
Volume fraction i	0.00381	[m³]
Fraction i	100%	[%]
Distance between surface of two particles	0.28	[mm]
Distance between centres 2 particles	1.23	[mm]
Estimated number of particles around object	10682	[%]
[ Fluid bed measurements ]		

Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.3220	-10	1180	11.0	0.937
2	0.2091	539	1180	11.0	0.937
3	0.2091	540	1180	11.0	0.937
4	0.1535	987	1180	11.0	0.937
5	0.1505	1073	1180	11.0	0.937
6	0.1485	1185	1180	11.0	0.937
7	0.1438	1286	1180	11.0	0.937
8	0.1419	1385	1180	11.0	0.937
9	0.1417	1487	1180	11.0	0.937
10	0.1423	1529	1180	11.0	0.937
11	0.1435	1587	1180	11.0	0.937
12	0.1434	1672	1180	11.0	0.937
13	0.1436	1673	1180	11.0	0.937
14	0.1265	1753	1180	11.0	0.937

Measurement number	2				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.10486	[kg]			
Mass apparent object	0.06676	[kg]			
Length object	0.120	[m]			
Diameter object	0.020	[m]			
Cross sectional area object	0.000317	[m2]			
Volume object	0.0000383	[m3]			
Outside area object	0.00820	[m2]			
Density object	2734	[kg/m3]			
Weight object	1.029	[N]			
Weight apparent object	0.655	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.3	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m/s]			
Superficial velocity (average)	106.5	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.965	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.965	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.670	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.29	[mm]			
Distance between centres 2 particles	1.24	[mm]			
Estimated number of particles around object	5480	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.1039	01265	11.2	0.965	
2	0.0648	431	1272	11.3	0.965
3	0.0639	719	1262	11.3	0.965
4	0.0474	931	1266	11.3	0.965
5	0.0451	1052	1273	11.3	0.965
6	0.0456	1158	1272	11.3	0.965
7	0.0432	1266	1274	11.2	0.965
8	0.0415	1367	1272	11.2	0.965
9	0.0411	1465	1264	11.2	0.965
10	0.0448	1567	1265	11.2	0.965
11	0.0379	1722	1266	11.3	0.965

Measurement number	8				
[ Specifications object ]					
Object material	Aluminium	[-]			
Mass object	0.32072	[kg]			
Mass apparent object	0.20834	[kg]			
Length object	0.160	[m]			
Diameter object	0.030	[m]			
Cross sectional area object	0.000703	[m2]			
Volume object	0.0001128	[m3]			
Outside area object	0.01644	[m2]			
Density object	2843	[kg/m3]			
Weight object	3.147	[N]			
Weight apparent object	2.044	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	11.0	[oC]			
Water density	999.6	[kg/m3]			
Kinematic viscosity	0.00126	[kg/m.s]			
Superficial velocity (average)	107.0	[m/h]			
Fixed bed height	0.516	[m]			
Fluid bed height	0.974	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	10.00	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.974	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.675	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.30	[mm]			
Distance between centres 2 particles	1.25	[mm]			
Estimated number of particles around object	10414	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction



[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.3207	01275	11.0	0.974		
2	0.2089	684	1275	11.0	0.974	
3	0.2063	745	1275	11.0	0.974	
4	0.1549	931	1275	11.0	0.974	
5	0.1535	1029	1275	11.0	0.974	
6	0.1523	1132	1275	11.0	0.974	
7	0.1473	1232	1275	11.0	0.974	
8	0.1467	1331	1275	11.0	0.974	
9	0.1415	1430	1275	11.0	0.974	
10	0.1434	1531	1275	11.0	0.974	
11	0.1429	1627	1275	11.0	0.974	
12	0.1325	1729	1275	11.0	0.974	
13	0.1363	1729	1275	11.0	0.974	
14	0.1304	1750	1275	11.0	0.974	
15	0.1149	1751	1275	11.0	0.974	
16	0.1316	1751	1275	11.0	0.974	

Measurement number	3					
[ Specifications object ]						
Object material	Aluminium		[-]			
Mass object	0.10486		[kg]			
Mass apparent object	0.06676		[kg]			
Length object	0.120		[m]			
Diameter object	0.020		[m]			
Cross sectional area object	0.000317		[m2]			
Volume object	0.0000383		[m3]			
Outside area object	0.00820		[m2]			
Density object	2734		[kg/m3]			
Weight object	1.029		[N]			
Weight apparent object	0.655		[N]			
[ Specifications column ]						
Outer circumference	0.400		[m]			
Wall thickness	0.0010		[m]			
Offset distance encoder	1.756		[m]			
Drain height	1.550		[m]			
Internal diameter column	0.123		[m]			
Internal surface area column	0.012		[m2]			
[ Fluid properties ]						
Average temperature	11.3		[oC]			
Water density	999.6		[kg/m3]			
Kinematic viscosity	0.00125		[kg/m/s]			
Superficial velocity (average)	115.7		[m/h]			
Fixed bed height	0.516		[m]			
Fluid bed height	1.014		[m]			
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite pellets		[-]			
Particle size (lowest)	0.90		[mm]			
Particle size (highest)	1.00		[mm]			
Particle size (average)	0.95		[mm]			
Particle mass	10.00		[kg]			
Particle density	2625		[kg/m³]			
Differential pressure (estimated)	4.9		[kPa]			
Fluid bed height per fraction i	1.014		[m]			
Fixed bed voidage	0.402		[m³/m³]			
Incipient bed voidage	0.412		[m³/m³]			
Average fluidised bed voidage	0.685		[m³/m³]			
Volume fraction i	0.00381		[m³]			
Fraction i	100%		[%]			
Distance between surface of two particles	0.31		[mm]			
Distance between centres 2 particles	1.26		[mm]			
Estimated number of particles around object	5311		[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1041	01384	11.2	1.014		
2	0.0644	426	1378	11.3	1.014	
3	0.0471	899	1378	11.3	1.014	
4	0.0468	1021	1375	11.3	1.014	
5	0.0446	1149	1378	11.3	1.014	
6	0.0439	1250	1375	11.3	1.014	
7	0.0422	1363	1375	11.3	1.014	
8	0.0416	1472	1378	11.3	1.014	
9	0.0415	1563	1382	11.3	1.014	
10	0.0398	1699	1378	11.3	1.014	

Measurement number	10					
[ Specifications object ]						
Object material	Aluminium		[-]			
Mass object	0.32072		[kg]			
Mass apparent object	0.20834		[kg]			
Length object	0.160		[m]			
Diameter object	0.030		[m]			
Cross sectional area object	0.000703		[m2]			
Volume object	0.0001128		[m3]			
Outside area object	0.01644		[m2]			
Density object	2843		[kg/m3]			
Weight object	3.147		[N]			
Weight apparent object	2.044		[N]			
[ Specifications column ]						
Outer circumference	0.400		[m]			
Wall thickness	0.0010		[m]			
Offset distance encoder	1.756		[m]			
Drain height	1.550		[m]			
Internal diameter column	0.123		[m]			
Internal surface area column	0.012		[m2]			
[ Fluid properties ]						
Average temperature	11.0		[oC]			
Water density	999.6		[kg/m3]			
Kinematic viscosity	0.00126		[kg/m/s]			
Superficial velocity (average)	151.1		[m/h]			
Fixed bed height	0.516		[m]			
Fluid bed height	1.267		[m]			
[ Particle properties ]						
fraction nr.	Fraction 1		Fraction 2			
Type of particle	Calcite pellets		[-]			
Particle size (lowest)	0.90		[mm]			
Particle size (highest)	1.00		[mm]			
Particle size (average)	0.95		[mm]			
Particle mass	10.00		[kg]			
Particle density	2625		[kg/m³]			
Differential pressure (estimated)	4.9		[kPa]			
Fluid bed height per fraction i	1.267		[m]			
Fixed bed voidage	0.402		[m³/m³]			
Incipient bed voidage	0.412		[m³/m³]			
Average fluidised bed voidage	0.749		[m³/m³]			
Volume fraction i	0.00381		[m³]			
Fraction i	100%		[%]			
Distance between surface of two particles	0.41		[mm]			
Distance between centres 2 particles	1.36		[mm]			
Estimated number of particles around object	8815		[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	

[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.3207	01800	11.0	1.267		
2	0.2036	445	1800	11.0	1.267	
3	0.1703	641	1800	11.0	1.267	
4	0.1654	739	1800	11.0	1.267	
5	0.1638	840	1800	11.0	1.267	
6	0.1631	937	1800	11.0	1.267	
7	0.1591	1055	1800	11.0	1.267	
8	0.1579	1153	1800	11.0	1.267	
9	0.1547	1251	1800	11.0	1.267	
10	0.1549	1372	1800	11.0	1.267	
11	0.1537	1504	1800	11.0	1.267	
12	0.1542	1677	1800	11.0	1.267	
13	0.1367	1750	1800	11.0	1.267	
14	0.1362	1750	1800	11.0	1.267	

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Measurement number	13					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m2]				
Volume object	0.0000514	[m3]				
Outside area object	0.01077	[m2]				
Density object	2746	[kg/m3]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m.s]				
Superficial velocity (average)	151.1	[m/h]				
Fixed bed height	0.516	[m]				
Fluid bed height	1.255	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite pellets	[-]				
Particle size (lowest)	0.90	[mm]				
Particle size (highest)	1.00	[mm]				
Particle size (average)	0.95	[mm]				
Particle mass	10.00	[kg]				
Particle density	2625	[kg/m³]				
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	1.255	[m]				
Fixed bed voidage	0.402	[m³/m³]				
Incipient bed voidage	0.412	[m³/m³]				
Average fluidised bed voidage	0.746	[m³/m³]				
Volume fraction i	0.00381	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.41	[mm]				
Distance between centres 2 particles	1.36	[mm]				
Estimated number of particles around object	6187	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1413	01800	11.0	1.255		
2	0.0868	490	1800	11.0	1.255	
3	0.0692	653	1800	11.0	1.255	
4	0.0674	752	1800	11.0	1.255	
5	0.0676	851	1800	11.0	1.255	
6	0.0674	950	1800	11.0	1.255	
7	0.0665	1053	1800	11.0	1.255	
8	0.0660	1152	1800	11.0	1.255	
9	0.0652	1251	1800	11.0	1.255	
10	0.0654	1353	1800	11.0	1.255	
11	0.0635	1498	1800	11.0	1.255	
12	0.0632	1602	1800	11.0	1.255	
13	0.0595	1751	1800	11.0	1.255	

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Measurement number	30					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m2]				
Volume object	0.0000514	[m3]				
Outside area object	0.01077	[m2]				
Density object	2746	[kg/m3]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	13.5	[oC]				
Water density	999.3	[kg/m3]				
Kinematic viscosity	0.00118	[kg/m.s]				
Superficial velocity (average)	59.2	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	0.830	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.465	0.365	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.720	0.580	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.21	0.27	[mm]			
Distance between centres 2 particles	0.78	1.60	[mm]			
Estimated number of particles around object	17997	4544	[%]			
[ Fluid bed measurements ]						

Measurement number	33	
[ Specifications object ]		
Object material	Aluminium	[-]
Mass object	0.08803	[kg]
Mass apparent object	0.05622	[kg]
Length object	0.100	[m]
Diameter object	0.020	[m]
Cross sectional area object	0.000316	[m <sup>2</sup> ]
Volume object	0.0000319	[m <sup>3</sup> ]
Outside area object	0.00693	[m <sup>2</sup> ]
Density object	2757	[kg/m <sup>3</sup> ]
Weight object	0.864	[N]
Weight apparent object	0.552	[N]
[ Specifications column ]		
Outer circumference	0.400	[m]
Wall thickness	0.0010	[m]
Offset distance encoder	1.756	[m]
Drain height	1.550	[m]
Internal diameter column	0.123	[m]
Internal surface area column	0.012	[m <sup>2</sup> ]
[ Fluid properties ]		
Average temperature	11.8	[oC]
Water density	999.5	[kg/m <sup>3</sup> ]
Kinematic viscosity	0.00124	[kg/m <sup>2</sup> s]
Superficial velocity (average)	70.7	[m/h]
Fixed bed height	0.551	[m]
Fluid bed height	0.922	[m]
[ Particle properties ]		
fraction nr.	Fraction 1	Fraction 2
Type of particle	Calcite NH	Calcite pellets
Particle size (lowest)	0.50	1.25
Particle size (highest)	0.63	1.40
Particle size (average)	0.56	1.32
Particle mass	4.00	6.00
Particle density	2560	2632
Differential pressure (estimated)	4.9	[kPa]
Fluid bed height per fraction i	0.538	0.383
Fixed bed voidage	0.482	0.397
Incipient bed voidage	0.497	0.413
Average fluidised bed voidage	0.757	0.536
Volume fraction i	0.00156	0.00228
Fraction i	41%	59%
Distance between surface of two particles	0.25	0.22
Distance between centres 2 particles	0.81	1.55
Estimated number of particles around object	10246	3025

Measurement number	25				
[ Specifications object ]					
Object material	Aluminium				
Mass object	0.08803				
Mass apparent object	0.05622				
Length object	0.100				
Diameter object	0.020				
Cross sectional area object	0.000316				
Volume object	0.0000319				
Outside area object	0.00693				
Density object	2757				
Weight object	0.864				
Weight apparent object	0.552				
[ Specifications column ]					
Outer circumference	0.400				
Wall thickness	0.0010				
Offset distance encoder	1.756				
Drain height	1.550				
Internal diameter column	0.123				
Internal surface area column	0.012				
[ Fluid properties ]					
Average temperature	8.8				
Water density	999.8				
Kinematic viscosity	0.00134				
Superficial velocity (average)	72.4				
Fixed bed height	0.551				
Fluid bed height	0.936				
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite NH	Calcite pellets			
Particle size (lowest)	0.50	1.25			
Particle size (highest)	0.63	1.40			
Particle size (average)	0.56	1.32			
Particle mass	4.00	6.00			
Particle density	2560	2632			
Differential pressure (estimated)	4.9				
Fluid bed height per fraction i	0.549	0.387			
Fixed bed voidage	0.482	0.397			
Incipient bed voidage	0.497	0.413			
Average fluidised bed voidage	0.763	0.556			
Volume fraction i	0.00156	0.00228			
Fraction i	41%	59%			
Distance between surface of two particles	0.26	0.25			
Distance between centres 2 particles	0.82	1.57			
Estimated number of particles around object	10085	2943			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m]

2	0.0885	0858	8.8	0.937	0.388	
3	0.0464	810	860	8.8	0.937	0.388
4	0.0455	915	861	8.8	0.936	0.387
5	0.0442	1015	861	8.8	0.936	0.387
6	0.0436	1114	861	8.8	0.936	0.387
7	0.0434	1217	865	8.8	0.936	0.387
8	0.0422	1314	865	8.8	0.936	0.387
9	0.0366	1413	865	8.8	0.936	0.387
10	0.0285	1516	862	8.8	0.936	0.387
11	0.0290	1615	863	8.8	0.936	0.387
12	0.0253	1716	863	8.8	0.936	0.387
13	0.0248	1743	863	8.8	0.936	0.387

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Measurement number	29					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m2]				
Volume object	0.0000514	[m3]				
Outside area object	0.01077	[m2]				
Density object	2746	[kg/m3]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	13.5	[oC]				
Water density	999.3	[kg/m3]				
Kinematic viscosity	0.00118	[kg/m/s]				
Superficial velocity (average)	81.2	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	0.985	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.589	0.396	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.780	0.604	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.28	0.31	[mm]			
Distance between centres 2 particles	0.84	1.63	[mm]			
Estimated number of particles around object	15423	4379	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1413	468	968	13.5	0.985	0.396
2	0.0891	538	968	13.5	0.985	0.396
3	0.0718	924	968	13.5	0.985	0.396
4	0.0686	1083	968	13.5	0.985	0.396
5	0.0690	1206	965	13.5	0.984	0.396
6	0.0654	1367	968	13.5	0.985	0.396
7	0.0454	1526	968	13.5	0.985	0.396
8	0.0446	1525	968	13.5	0.985	0.396
9	0.0439	1685	968	13.5	0.985	0.396
10	0.0401	1731	968	13.5	0.985	0.396
11	0.0409	1752	968	13.5	0.985	0.396

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Measurement number	24					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m2]				
Volume object	0.0000319	[m3]				
Outside area object	0.00693	[m2]				
Density object	2757	[kg/m3]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	8.8	[oC]				
Water density	999.8	[kg/m3]				
Kinematic viscosity	0.00134	[kg/m/s]				
Superficial velocity (average)	89.3	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	1.092	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.674	0.418	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.806	0.615	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.32	0.32	[mm]			
Distance between centres 2 particles	0.88	1.64	[mm]			
Estimated number of particles around object	8869	2695	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.0885	-1	1060	8.8	1.092	0.418
2	0.0572	419	1069	8.8	1.092	0.418
3	0.0481	761	1066	8.8	1.092	0.418

4	0.0470	858	1062	8.8	1.092	0.418
5	0.0470	958	1062	8.8	1.092	0.418
6	0.0465	1060	1068	8.8	1.092	0.418
7	0.0459	1157	1068	8.8	1.092	0.418
8	0.0449	1258	1068	8.8	1.092	0.418
9	0.0419	1358	1063	8.8	1.092	0.418
10	0.0316	1458	1070	8.8	1.092	0.418
11	0.0325	1559	1057	8.8	1.092	0.418
12	0.0339	1660	1057	8.8	1.092	0.418
13	0.0255	1742	1057	8.8	1.092	0.418
14	0.0258	1742	1057	8.8	1.092	0.418

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Measurement number	32					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m2]				
Volume object	0.0000319	[m3]				
Outside area object	0.00693	[m2]				
Density object	2757	[kg/m3]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	10.5	[oC]				
Water density	999.7	[kg/m3]				
Kinematic viscosity	0.00128	[kg/m/s]				
Superficial velocity (average)	90.3	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	1.092	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.676	0.416	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.807	0.593	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.32	0.29	[mm]			
Distance between centres 2 particles	0.88	1.62	[mm]			
Estimated number of particles around object	8855	2788	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.0863	-1	1080	10.5	1.096	0.416
2	0.0572	527	1080	10.5	1.092	0.418
3	0.0560	530	1080	10.5	1.092	0.418
4	0.0466	767	1075	10.5	1.092	0.416
5	0.0450	867	1075	10.5	1.092	0.416
6	0.0455	965	1075	10.5	1.092	0.416
7	0.0449	1085	1075	10.5	1.092	0.416
8	0.0440	1181	1075	10.5	1.092	0.416
9	0.0426	1282	1075	10.5	1.092	0.416
10	0.0370	1383	1075	10.5	1.092	0.416
11	0.0292	1481	1075	10.5	1.092	0.416
12	0.0280	1581	1075	10.5	1.092	0.416
13	0.0280	1684	1075	10.5	1.092	0.416
14	0.0248	1740	1075	10.5	1.092	0.416

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Measurement number	26					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m2]				
Volume object	0.0000514	[m3]				
Outside area object	0.01077	[m2]				
Density object	2746	[kg/m3]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	8.8	[oC]				
Water density	999.8	[kg/m3]				
Kinematic viscosity	0.00134	[kg/m/s]				
Superficial velocity (average)	95.0	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	1.135	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.711	0.424	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.817	0.629	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.33	0.34	[mm]			
Distance between centres 2 particles	0.89	1.67	[mm]			
Estimated number of particles around object	13711	4201	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
2	0.1407	-3	1132	8.8	1.136	0.424

3	0.0888	457	1126	8.8	1.135	0.423
4	0.0761	779	1137	8.8	1.137	0.425
5	0.0744	894	1133	8.8	1.136	0.424
6	0.0736	1008	1128	8.8	1.135	0.423
7	0.0730	1123	1132	8.8	1.136	0.424
8	0.0721	1242	1132	8.8	1.136	0.424
9	0.0669	1365	1132	8.8	1.136	0.424
10	0.0513	1480	1132	8.8	1.134	0.424
11	0.0486	1587	1132	8.8	1.134	0.424
12	0.0452	1707	1132	8.8	1.134	0.424
13	0.0445	1750	1132	8.8	1.134	0.424

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Measurement number	28					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m2]				
Volume object	0.0000514	[m3]				
Outside area object	0.01077	[m2]				
Density object	2746	[kg/m3]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	12.5	[oC]				
Water density	999.4	[kg/m3]				
Kinematic viscosity	0.00121	[kg/m/s]				
Superficial velocity (average)	98.1	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	1.153	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.725	0.428	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.820	0.680	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.34	0.43	[mm]			
Distance between centres 2 particles	0.90	1.75	[mm]			
Estimated number of particles around object	13550	3835	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1416	-14	1170	12.5	1.153	0.428
2	0.0877	453	1160	12.5	1.153	0.428
3	0.0747	763	1170	12.5	1.153	0.428
4	0.0742	862	1170	12.5	1.153	0.428
5	0.0710	1091	1170	12.5	1.153	0.428
6	0.0709	1188	1170	12.5	1.153	0.428
7	0.0701	1280	1170	12.5	1.153	0.428
8	0.0683	1348	1170	12.5	1.153	0.428
9	0.0560	1430	1168	12.5	1.153	0.428
10	0.0501	1462	1168	12.5	1.153	0.428
11	0.0505	1664	1168	12.5	1.153	0.428
12	0.0423	1743	1168	12.5	1.153	0.428

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Measurement number	31					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m2]				
Volume object	0.0000319	[m3]				
Outside area object	0.00693	[m2]				
Density object	2757	[kg/m3]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	10.7	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00127	[kg/m/s]				
Superficial velocity (average)	104.7	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	1.263	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.819	0.444	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.841	0.594	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.38	0.29	[mm]			
Distance between centres 2 particles	0.94	1.62	[mm]			
Estimated number of particles around object	7817	2784	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.0865	01250	10.7	1.264	0.444	
2	0.0560	432	1240	10.7	1.263	0.444
3	0.0491	588	1245	10.7	1.263	0.444

4	0.0483	687	1245	10.7	1.263	0.444
5	0.0469	789	1245	10.7	1.263	0.444
6	0.0470	888	1245	10.7	1.263	0.444
7	0.0460	988	1245	10.7	1.263	0.444
8	0.0466	1087	1245	10.7	1.263	0.444
9	0.0456	1190	1255	10.7	1.264	0.444
10	0.0457	1286	1255	10.7	1.264	0.444
11	0.0348	1387	1240	10.7	1.262	0.444
12	0.0338	1487	1250	10.7	1.264	0.444
13	0.0336	1588	1250	10.7	1.264	0.444
14	0.0283	1690	1250	10.7	1.264	0.444
15	0.0249	1746	1250	10.7	1.264	0.444

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Measurement number	23					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m2]				
Volume object	0.0000319	[m3]				
Outside area object	0.00693	[m2]				
Density object	2757	[kg/m3]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	9.0	[oC]				
Water density	999.8	[kg/m3]				
Kinematic viscosity	0.00133	[kg/m/s]				
Superficial velocity (average)	106.6	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	1.286	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.837	0.449	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.844	0.609	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.38	0.31	[mm]			
Distance between centres 2 particles	0.94	1.64	[mm]			
Estimated number of particles around object	7727	2718	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.0875	12	1270	9.0	1.286	0.449
2	0.0547	405	1270	9.0	1.286	0.449
3	0.0512	570	1270	9.0	1.286	0.449
4	0.0501	670	1270	9.0	1.286	0.449
5	0.0487	770	1270	9.0	1.286	0.449
6	0.0476	870	1270	9.0	1.286	0.449
7	0.0469	968	1270	9.0	1.286	0.449
8	0.0468	1068	1270	9.0	1.286	0.449
9	0.0460	1168	1270	9.0	1.286	0.449
10	0.0454	1268	1270	9.0	1.286	0.449
11	0.0357	1370	1270	9.0	1.286	0.449
12	0.0330	1471	1270	9.0	1.286	0.449
13	0.0327	1569	1270	9.0	1.286	0.449
14	0.0344	1669	1270	9.0	1.286	0.449
15	0.0265	1747	1270	9.0	1.286	0.449
16	0.0264	1749	1270	9.0	1.286	0.449

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Measurement number	27					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m2]				
Volume object	0.0000514	[m3]				
Outside area object	0.01077	[m2]				
Density object	2746	[kg/m3]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	8.8	[oC]				
Water density	999.8	[kg/m3]				
Kinematic viscosity	0.00134	[kg/m/s]				
Superficial velocity (average)	111.8	[m/h]				
Fixed bed height	0.551	[m]				
Fluid bed height	1.323	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Calcite NH	Calcite pellets	[-]			
Particle size (lowest)	0.50	1.25	[mm]			
Particle size (highest)	0.63	1.40	[mm]			
Particle size (average)	0.56	1.32	[mm]			
Particle mass	4.00	6.00	[kg]			
Particle density	2560	2632	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]				
Fluid bed height per fraction i	0.873	0.450	[m]			
Fixed bed voidage	0.482	0.397	[m³/m³]			
Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.850	0.658	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.39	0.39	[mm]			
Distance between centres 2 particles	0.96	1.71	[mm]			
Estimated number of particles around object	12046	3996	[%]			
[ Fluid bed measurements ]						

Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1412	01325	8.8	1.325	0.451	
2	0.0887	415	1330	8.8	1.324	0.450
3	0.0785	587	1332	8.8	1.325	0.450
4	0.0768	703	1332	8.8	1.325	0.450
5	0.0756	820	1332	8.8	1.325	0.450
6	0.0760	944	1328	8.8	1.320	0.450
7	0.0735	1060	1328	8.8	1.320	0.450
8	0.0725	1178	1328	8.8	1.320	0.450
9	0.0709	1297	1328	8.8	1.320	0.450
10	0.0695	1331	1336	8.8	1.325	0.450
11	0.0569	1414	1328	8.8	1.320	0.450
12	0.0532	1529	1336	8.8	1.325	0.450
13	0.0514	1644	1336	8.8	1.325	0.450
14	0.0451	1740	1336	8.8	1.325	0.450
15	0.0458	1740	1336	8.8	1.325	0.450

Measurement number	1	
[ Specifications object ]		
Object material	Aluminium	[-]
Mass object	0.54526	[kg]
Mass apparent object	0.34432	[kg]
Length object	0.160	[m]
Diameter object	0.040	[m]
Cross sectional area object	0.001257	[m2]
Volume object	0.0002014	[m3]
Outside area object	0.02262	[m2]
Density object	2706	[kg/m3]
Weight object	5.350	[N]
Weight apparent object	3.379	[N]
[ Specifications column ]		
Outer circumference	0.400	[m]
Wall thickness	0.0010	[m]
Offset distance encoder	1.756	[m]
Drain height	1.550	[m]
Internal diameter column	0.123	[m]
Internal surface area column	0.012	[m2]
[ Fluid properties ]		
Average temperature	11.0	[oC]
Water density	999.6	[kg/m3]
Kinematic viscosity	0.00126	[kg/m.s]
Superficial velocity (average)	90.2	[m/h]
Fixed bed height	0.024	[m]
Fluid bed height	1.078	[m]
[ Particle properties ]		
fraction nr.	Fraction 1	Fraction 2
Type of particle	Calcite NH	Calcite pellets
Particle size (lowest)	0.50	1.25
Particle size (highest)	0.63	1.40
Particle size (average)	0.56	1.32
Particle mass	4.00	6.00
Particle density	2560	2632
Differential pressure (estimated)	7.9	[kPa]
Fluid bed height per fraction i	0.667	0.411
Fixed bed voidage	0.482	0.397
Incipient bed voidage	0.497	0.413
Average fluidised bed voidage	0.811	0.658
Volume fraction i	0.00156	0.00228
Fraction i	41%	59%
Distance between surface of two particles	0.32	0.39
Distance between centres 2 particles	0.89	1.71
Estimated number of particles around object	26757	7440

Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.5479	154	1075	11.0	1.078	0.411
2	0.3508	504	1075	11.0	1.078	0.411
3	0.3505	617	1075	11.0	1.078	0.411
4	0.3102	793	1075	11.0	1.078	0.411
5	0.2931	856	1075	11.0	1.078	0.411
6	0.2950	856	1075	11.0	1.078	0.411
7	0.2851	919	1075	11.0	1.078	0.411
8	0.2839	956	1075	11.0	1.078	0.411
9	0.2771	1056	1075	11.0	1.078	0.411
10	0.2776	1155	1075	11.0	1.078	0.411
11	0.2761	1256	1075	11.0	1.078	0.411
12	0.2700	1346	1075	11.0	1.078	0.411
13	0.2659	1355	1075	11.0	1.078	0.411
14	0.2081	1456	1075	11.0	1.078	0.411
15	0.2074	1467	1075	11.0	1.078	0.411
16	0.1899	1556	1075	11.0	1.078	0.411
17	0.1915	1655	1075	11.0	1.078	0.411
18	0.1738	1703	1075	11.0	1.078	0.411
19	0.1774	1753	1075	11.0	1.078	0.411

Measurement number	1		
[ Specifications object ]			
Object material	Aluminium	[-]	
Mass object	0.14129	[kg]	
Mass apparent object	0.08990	[kg]	
Length object	0.160	[m]	
Diameter object	0.020	[m]	
Cross sectional area object	0.000319	[m2]	
Volume object	0.0000514	[m3]	
Outside area object	0.01077	[m2]	
Density object	2746	[kg/m3]	
Weight object	1.386	[N]	
Weight apparent object	0.882	[N]	
[ Specifications column ]			
Outer circumference	0.400	[m]	
Wall thickness	0.0010	[m]	
Offset distance encoder	1.756	[m]	
Drain height	1.550	[m]	
Internal diameter column	0.123	[m]	
Internal surface area column	0.012	[m2]	
[ Fluid properties ]			
Average temperature	11.0	[oC]	
Water density	999.6	[kg/m3]	
Kinematic viscosity	0.00126	[kg/m/s]	
Superficial velocity (average)	90.2	[m/h]	
Fixed bed height	0.024	[m]	
Fluid bed height	1.078	[m]	
[ Particle properties ]			
fraction nr.	Fraction 1	Fraction 2	
Type of particle	Calcite NH	Calcite pellets	[-]
Particle size (lowest)	0.50	1.25	[mm]
Particle size (highest)	0.63	1.40	[mm]
Particle size (average)	0.56	1.32	[mm]
Particle mass	4.00	6.00	[kg]
Particle density	2560	2632	[kg/m³]
Differential pressure (estimated)	7.9	[kPa]	
Fluid bed height per fraction i	0.667	0.411	[m]
Fixed bed voidage	0.482	0.397	[m³/m³]



Incipient bed voidage	0.497	0.413	[m³/m³]			
Average fluidised bed voidage	0.823	0.625	[m³/m³]			
Volume fraction i	0.00156	0.00228	[m³]			
Fraction i	41%	59%	[%]			
Distance between surface of two particles	0.34	0.34	[mm]			
Distance between centres 2 particles	0.90	1.66	[mm]			
Estimated number of particles around object	13401	4229	[%]			
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.1434	01075	11.0	1.078	0.411	
2	0.0895	488	1075	11.0	1.078	0.411
3	0.0905	517	1075	11.0	1.078	0.411
4	0.0791	766	1075	11.0	1.078	0.411
5	0.0800	779	1075	11.0	1.078	0.411
6	0.0745	856	1075	11.0	1.078	0.411
7	0.0737	954	1075	11.0	1.078	0.411
8	0.0726	1053	1075	11.0	1.078	0.411
9	0.0722	1075	1075	11.0	1.078	0.411
10	0.0720	1156	1075	11.0	1.078	0.411
11	0.0704	1254	1075	11.0	1.078	0.411
12	0.0689	1355	1075	11.0	1.078	0.411
13	0.0621	1389	1075	11.0	1.078	0.411
14	0.0539	1459	1075	11.0	1.078	0.411
15	0.0512	1556	1075	11.0	1.078	0.411
16	0.0514	1636	1075	11.0	1.078	0.411
17	0.0513	1654	1075	11.0	1.078	0.411
18	0.0260	1746	1075	11.0	1.078	0.411
-----						
Measurement number	34					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.54526	[kg]				
Mass apparent object	0.34432	[kg]				
Length object	0.160	[m]				
Diameter object	0.040	[m]				
Cross sectional area object	0.001257	[m2]				
Volume object	0.0002014	[m3]				
Outside area object	0.02262	[m2]				
Density object	2706	[kg/m3]				
Weight object	5.350	[N]				
Weight apparent object	3.379	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.611	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.73	[mm]				
Distance between centres 2 particles	3.78	[mm]				
Estimated number of particles around object	1669	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.5453	02858	11.0	0.411		
2	0.3443	500	2858	11.0	0.411	
3	0.2205	1556	2858	11.0	0.411	
-----						
Measurement number	35					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.40852	[kg]				
Mass apparent object	0.25818	[kg]				
Length object	0.120	[m]				
Diameter object	0.040	[m]				
Cross sectional area object	0.001256	[m2]				
Volume object	0.0001511	[m3]				
Outside area object	0.01760	[m2]				
Density object	2701	[kg/m3]				
Weight object	4.009	[N]				
Weight apparent object	2.533	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.608	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.72	[mm]				

Distance between centres 2 particles	3.77	[mm]				
Estimated number of particles around object	1268	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.4085	02858	11.0	0.411		
2	0.2582	500	2858	11.0	0.411	
3	0.1704	1556	2858	11.0	0.411	
-----						
Measurement number	36					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.34276	[kg]				
Mass apparent object	0.21668	[kg]				
Length object	0.101	[m]				
Diameter object	0.040	[m]				
Cross sectional area object	0.001260	[m2]				
Volume object	0.0001270	[m3]				
Outside area object	0.01517	[m2]				
Density object	2698	[kg/m3]				
Weight object	3.363	[N]				
Weight apparent object	2.126	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.607	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.72	[mm]				
Distance between centres 2 particles	3.77	[mm]				
Estimated number of particles around object	1072	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.3428	02858	11.0	0.411		
2	0.2167	500	2858	11.0	0.411	
3	0.1403	1556	2858	11.0	0.411	
-----						
Measurement number	37					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.32072	[kg]				
Mass apparent object	0.20834	[kg]				
Length object	0.160	[m]				
Diameter object	0.030	[m]				
Cross sectional area object	0.000703	[m2]				
Volume object	0.0001128	[m3]				
Outside area object	0.01644	[m2]				
Density object	2843	[kg/m3]				
Weight object	3.147	[N]				
Weight apparent object	2.044	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.606	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.71	[mm]				
Distance between centres 2 particles	3.76	[mm]				
Estimated number of particles around object	1317	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.3207	02858	11.0	0.411		
2	0.2083	500	2858	11.0	0.411	
3	0.1362	1556	2858	11.0	0.411	
-----						
Measurement number	38					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.23070	[kg]				
Mass apparent object	0.14642	[kg]				
Length object	0.120	[m]				
Diameter object	0.030	[m]				
Cross sectional area object	0.000703	[m2]				
Volume object	0.0000847	[m3]				
Outside area object	0.01269	[m2]				

Density object	2721	[kg/m3]				
Weight object	2.264	[N]				
Weight apparent object	1.437	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.604	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.71	[mm]				
Distance between centres 2 particles	3.76	[mm]				
Estimated number of particles around object	999	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.2307	02858	11.0	0.411		
2	0.1464	500	2858	11.0	0.411	
3	0.0952	1556	2858	11.0	0.411	

Measurement number	39					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.20216	[kg]				
Mass apparent object	0.13150	[kg]				
Length object	0.100	[m]				
Diameter object	0.030	[m]				
Cross sectional area object	0.000703	[m2]				
Volume object	0.0000709	[m3]				
Outside area object	0.01084	[m2]				
Density object	2851	[kg/m3]				
Weight object	1.984	[N]				
Weight apparent object	1.290	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.603	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.70	[mm]				
Distance between centres 2 particles	3.75	[mm]				
Estimated number of particles around object	841	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[oC]	[m]	[m]
1	0.2022	02858	11.0	0.411		
2	0.1315	500	2858	11.0	0.411	
3	0.0892	1556	2858	11.0	0.411	

Measurement number	40					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.14129	[kg]				
Mass apparent object	0.08990	[kg]				
Length object	0.160	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000319	[m2]				
Volume object	0.0000514	[m3]				
Outside area object	0.01077	[m2]				
Density object	2746	[kg/m3]				
Weight object	1.386	[N]				
Weight apparent object	0.882	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[oC]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				

Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.602	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.70	[mm]				
Distance between centres 2 particles	3.75	[mm]				
Estimated number of particles around object	968	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[°C]	[m]	[m]
1	0.1413	02858	11.0	0.411		
2	0.0899	500	2858	11.0	0.411	
3	0.0564	1556	2858	11.0	0.411	

Measurement number	41					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.10486	[kg]				
Mass apparent object	0.06676	[kg]				
Length object	0.120	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000317	[m2]				
Volume object	0.0000383	[m3]				
Outside area object	0.00820	[m2]				
Density object	2734	[kg/m3]				
Weight object	1.029	[N]				
Weight apparent object	0.655	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[°C]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.601	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.70	[mm]				
Distance between centres 2 particles	3.75	[mm]				
Estimated number of particles around object	731	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[°C]	[m]	[m]
1	0.1049	02858	11.0	0.411		
2	0.0668	500	2858	11.0	0.411	
3	0.0431	1556	2858	11.0	0.411	

Measurement number	42					
[ Specifications object ]						
Object material	Aluminium	[-]				
Mass object	0.08803	[kg]				
Mass apparent object	0.05622	[kg]				
Length object	0.100	[m]				
Diameter object	0.020	[m]				
Cross sectional area object	0.000316	[m2]				
Volume object	0.0000319	[m3]				
Outside area object	0.00693	[m2]				
Density object	2757	[kg/m3]				
Weight object	0.864	[N]				
Weight apparent object	0.552	[N]				
[ Specifications column ]						
Outer circumference	0.400	[m]				
Wall thickness	0.0010	[m]				
Offset distance encoder	1.756	[m]				
Drain height	1.550	[m]				
Internal diameter column	0.123	[m]				
Internal surface area column	0.012	[m2]				
[ Fluid properties ]						
Average temperature	11.0	[°C]				
Water density	999.6	[kg/m3]				
Kinematic viscosity	0.00126	[kg/m/s]				
Superficial velocity (average)	239.9	[m/h]				
Fixed bed height	0.257	[m]				
Fluid bed height	0.411	[m]				
[ Particle properties ]						
fraction nr.	Fraction 1	Fraction 2				
Type of particle	Glass pearls	[-]				
Particle size (lowest)	3.00	[mm]				
Particle size (highest)	3.10	[mm]				
Particle size (average)	3.05	[mm]				
Particle mass	4.95	[kg]				
Particle density	2515	[kg/m³]				
Differential pressure (estimated)	2.4	[kPa]				
Fluid bed height per fraction i	0.411	[m]				
Fixed bed voidage	0.380	[m³/m³]				
Incipient bed voidage	0.400	[m³/m³]				
Average fluidised bed voidage	0.600	[m³/m³]				
Volume fraction i	0.00197	[m³]				
Fraction i	100%	[%]				
Distance between surface of two particles	0.70	[mm]				
Distance between centres 2 particles	3.75	[mm]				
Estimated number of particles around object	612	[%]				
[ Fluid bed measurements ]						
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction	
[#]	[kg]	[mm]	[L/h]	[°C]	[m]	[m]
1	0.0880	02858	11.0	0.411		
2	0.0562	500	2858	11.0	0.411	

3	0.0361	1556	2858	11.0	0.411
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## 3.2 Experiments with a titanium object

Measurement number	9				
[ Specifications object ]					
Object material	Titanium	[-]			
Mass object	0.56074	[kg]			
Mass apparent object	0.43539	[kg]			
Length object	0.130	[m]			
Diameter object	0.035	[m]			
Cross sectional area object	0.000962	[m2]			
Volume object	0.0001256	[m3]			
Outside area object	0.01622	[m2]			
Density object	4464	[kg/m3]			
Weight object	5.502	[N]			
Weight apparent object	4.272	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	8.0	[oC]			
Water density	999.8	[kg/m3]			
Kinematic viscosity	0.00137	[kg/m.s]			
Superficial velocity (average)	61.5	[m/h]			
Fixed bed height	0.576	[m]			
Fluid bed height	0.768	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	9.99	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.768	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.590	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.21	[mm]			
Distance between centres 2 particles	1.16	[mm]			
Estimated number of particles around object	11395	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.5625	0741	8.0	0.755	
2	0.4330	746	725	8.0	0.765
3	0.3567	1470	718	8.0	0.775
4	0.3543	1504	739	8.0	0.775
5	0.3550	1523	743	8.0	0.773
6	0.3529	1557	729	8.0	0.770
7	0.3543	1591	735	8.0	0.769
8	0.3520	1628	726	8.0	0.768
9	0.3490	1682	737	8.0	0.766
10	0.3485	1716	728	8.0	0.763
11	0.3450	1726	730	8.0	0.767

Measurement number	6				
[ Specifications object ]					
Object material	Titanium	[-]			
Mass object	0.56074	[kg]			
Mass apparent object	0.43539	[kg]			
Length object	0.130	[m]			
Diameter object	0.035	[m]			
Cross sectional area object	0.000962	[m2]			
Volume object	0.0001256	[m3]			
Outside area object	0.01622	[m2]			
Density object	4464	[kg/m3]			
Weight object	5.502	[N]			
Weight apparent object	4.272	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	8.0	[oC]			
Water density	999.8	[kg/m3]			
Kinematic viscosity	0.00137	[kg/m.s]			
Superficial velocity (average)	79.5	[m/h]			
Fixed bed height	0.576	[m]			
Fluid bed height	0.845	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	9.99	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.845	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.626	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.24	[mm]			
Distance between centres 2 particles	1.19	[mm]			
Estimated number of particles around object	10749	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.5619	0950	7.9	0.840	
2	0.4352	402	948	7.9	0.840
3	0.3646	1050	941	7.9	0.844
4	0.3630	1102	953	8.0	0.846
5	0.3600	1188	952	8.0	0.847
6	0.3585	1270	958	8.0	0.848
7	0.3500	1403	948	8.0	0.842
8	0.3485	1542	942	8.0	0.846
9	0.3510	1619	940	8.0	0.846
10	0.3490	1667	945	8.0	0.847
11	0.3290	1715	941	8.0	0.848

Measurement number	7				
[ Specifications object ]					
Object material	Titanium	[-]			
Mass object	0.56074	[kg]			
Mass apparent object	0.43539	[kg]			
Length object	0.130	[m]			
Diameter object	0.035	[m]			
Cross sectional area object	0.000962	[m2]			
Volume object	0.0001256	[m3]			
Outside area object	0.01622	[m2]			
Density object	4464	[kg/m3]			
Weight object	5.502	[N]			
Weight apparent object	4.272	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	8.1	[oC]			
Water density	999.8	[kg/m3]			
Kinematic viscosity	0.00137	[kg/m/s]			
Superficial velocity (average)	103.4	[m/h]			
Fixed bed height	0.576	[m]			
Fluid bed height	0.958	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	9.99	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	0.958	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.670	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.29	[mm]			
Distance between centres 2 particles	1.24	[mm]			
Estimated number of particles around object	9918	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.5616	01230	8.1	0.959	
2	0.4340	398	1232	8.1	0.954
3	0.3781	932	1225	8.1	0.964
4	0.3720	1035	1236	8.1	0.960
5	0.3685	1129	1233	8.1	0.960
6	0.3680	1233	1230	8.1	0.960
7	0.3620	1346	1231	8.1	0.956
8	0.3570	1443	1238	8.1	0.956
9	0.3570	1538	1226	8.1	0.957
10	0.3610	1616	1229	8.1	0.960
11	0.3570	1697	1235	8.1	0.961
12	0.3460	1756	1227	8.1	0.951

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Measurement number	8				
[ Specifications object ]					
Object material	Titanium	[-]			
Mass object	0.56074	[kg]			
Mass apparent object	0.43539	[kg]			
Length object	0.130	[m]			
Diameter object	0.035	[m]			
Cross sectional area object	0.000962	[m2]			
Volume object	0.0001256	[m3]			
Outside area object	0.01622	[m2]			
Density object	4464	[kg/m3]			
Weight object	5.502	[N]			
Weight apparent object	4.272	[N]			
[ Specifications column ]					
Outer circumference	0.400	[m]			
Wall thickness	0.0010	[m]			
Offset distance encoder	1.756	[m]			
Drain height	1.550	[m]			
Internal diameter column	0.123	[m]			
Internal surface area column	0.012	[m2]			
[ Fluid properties ]					
Average temperature	8.2	[oC]			
Water density	999.8	[kg/m3]			
Kinematic viscosity	0.00136	[kg/m/s]			
Superficial velocity (average)	121.5	[m/h]			
Fixed bed height	0.576	[m]			
Fluid bed height	1.053	[m]			
[ Particle properties ]					
fraction nr.	Fraction 1	Fraction 2			
Type of particle	Calcite pellets	[-]			
Particle size (lowest)	0.90	[mm]			
Particle size (highest)	1.00	[mm]			
Particle size (average)	0.95	[mm]			
Particle mass	9.99	[kg]			
Particle density	2625	[kg/m³]			
Differential pressure (estimated)	4.9	[kPa]			
Fluid bed height per fraction i	1.053	[m]			
Fixed bed voidage	0.402	[m³/m³]			
Incipient bed voidage	0.412	[m³/m³]			
Average fluidised bed voidage	0.699	[m³/m³]			
Volume fraction i	0.00381	[m³]			
Fraction i	100%	[%]			
Distance between surface of two particles	0.33	[mm]			
Distance between centres 2 particles	1.28	[mm]			
Estimated number of particles around object	9344	[%]			
[ Fluid bed measurements ]					
Measurement number	Mass	Distance	Water flow	Temperature	Bed height per fraction
[#]	[kg]	[mm]	[L/h]	[oC]	[m] [m]
1	0.5617	01444	8.2	1.046	
2	0.4345	389	1458	8.2	1.046
3	0.3870	832	1451	8.2	1.061
4	0.3813	930	1439	8.2	1.055
5	0.3750	1034	1446	8.2	1.051
6	0.3730	1147	1443	8.2	1.049
7	0.3655	1270	1444	8.2	1.049
8	0.3670	1396	1446	8.2	1.046
9	0.3630	1503	1449	8.2	1.055
10	0.3680	1622	1440	8.2	1.058
11	0.3630	1707	1452	8.2	1.065
12	0.3480	1741	1450	8.2	1.050

