Reference Spray Dryer, Model Supporting Organic Solvent

Repeatability of granulation test

Mesh	#1	#2	#3	#4
12 and up	5.6	0.8	1.2	1.3
12~16	0.5	0.9	1	1.2
16~24	0.6	0.8	1.2	1.4
24~32	0.7	0.8	0.9	1.1
32~42	1.6	1.7	1.9	1.8
42~60	5.9	4.3	4.8	3.5
60~80	9.6	8.5	8.5	6.6
80~115	13.2	15.6	13.4	12.8
115 and under	66.8	66.6	67	70.6
Average particle size*	135.6	135.7	138.3	136.9

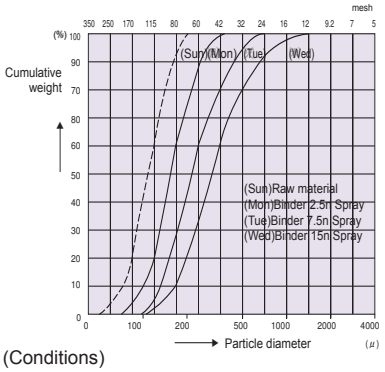
*Average particle diameter of the geometric mean

The granulation process has many operation factors, the reproducibility depends on the skill level of the operation. The flow state of the granules has a significant impact on the test results. By adjusting the amount of hot air consistent flow conditions are achievable.

(Conditions)

Raw material	Sintered alumina (average particle size 40) 400g
Binder	5% PVA solution (#500) 25g
Inlet temperature	100°C
Binder liquid feed rate	12.4g/min
Binder spray times	6 times
Binder spray pressure	78kPa(0.8kg/cm²)
Nozzle height	25cm from microporous plate

Change of particle diameter

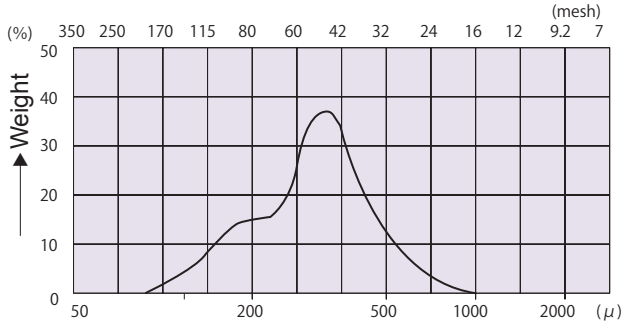


The factors that influence the particle diameter are the binder liquid feed rate and the spray pressure, the former being the most influential. A higher binder amount will result in larger diameter particles.

(Conditions)

Raw material	Lactose(100 mesh under) 200g
Binder	70% Sorbitol solution
Inlet temperature	90°C
Binder liquid feed rate	12g/min
Binder spray pressure	98kPa (1.0kg/cm²)
Nozzle height	25cm from microporous plate

Repeatability of granulation test



Particles generated by the pulvis mini bed are usually in the range of 0.1~1.5a, The particle size uniformity is lower than extrusion granulation and compression granulation methods.
The granularity consistency may be regulated by test conditions.

(Conditions)

Raw material	Lactose (100 mesh under) 200g
Binder	70% Sorbitol solution 7.3g
Inlet temperature	90°C
Binder liquid feed rate	12g/min
Binder spray times	7 times
Binder spray pressure	98kPa(1.0kg/cm²)
Nozzle height	22.5cm from microporous plate

Example of implementation (Spray dryer ADL311SA)

Sample name	Composition (%)	Inlet temp. (°C)	Outlet temp. (°C)	Dry air amount (m³/min)	Spray air pressure kPa (kg/cm²)	Sent amount of sample liquid (g/min)	Sample recovery rate (%)
Dextrin (solution)	10	150	80	0.4	98 (1.0)	6.1	66
Dextrin (emulsion)	40	150	80	0.4	98 (1.0)	5.1	63
Oxidized titanium (suspended liquid)	10	150	85	0.42	98 (1.0)	5.3	50
Soy sauce	50	130	75	0.36	98 (1.0)	5.1	60
Salt	10	145	85	0.38	98 (1.0)	5.3	52

Repeatability of spray drying test (spray dryer ADL311SA)

Test No.	Sample name	Sample density (%)	Drying conditions							Yield (g)	Recovery rate (%)
			Inlet temp. (°C)	Outlet temp. (°C)	Dry air amount (m³/min)	Spray air pressure kPa(kg/cm²)	Test sample amount (g/min)	Sent amount of sample liquid (g/min)	Test time (min)		
1	Coffee solution	5.00	150	75	0.45	147(1.5)	93.1	3.1	30	4.3	92.4
2	Coffee solution	5.00	150	75	0.45	147(1.5)	93	3.1	30	4	86
3	Coffee solution	5.00	150	75	0.45	147(1.5)	91.4	2.0	30	4	87.5
4	Coffee solution	5.00	150	75	0.45	147(1.5)	84.9	2.8	30	3.7	87.2
5	Coffee solution	5.00	150	75	0.45	147(1.5)	83.8	2.8	30	3.7	88.3

Example of implementation (Pulvis mini spray GB-210A)

Sample name	Sample density	Inlet temp. (°C)	Outlet temp. (°C)	Dry air amount (m³/min)	Spray air pressure kPa(kg/cm²)	Sent amount of sample liquid (g/min)	Recovery rate (%)
Dextrin (solution)	20% solution	140	85	0.48	147(1.5)	8.8	66
Drug suspension	10% suspension	145	80	0.42	196(2.0)	8.2	82
Black tea extract	20%solution	155	100	0.4	147(1.5)	7.8	72
Silica gel	20%solution	150	75	0.48	147(1.5)	12.6	70
Iron oxide	3%suspension	175	90	0.4	127(1.3)	9.5	75

Example of implementation (Pulvis mini bed GB-210B)

Sample		Binder			Test conditions					Results	
Name	Weight (min)	Name	Concentration (%)	Spray amount (min)	Inlet temp. (°C)	Liquid sending rate (g/min)	Spray pressure kPa (kg/cm²)	Spray times (times)	Nozzle height (cm)	Average dia. (μm)	12~115 mesh recovery rate(%)
Silicon	200	PVA	5.0	77	125	15	59 (0.6)	4	27	339	58
Oxidized iron	160	PVA	2.5	50	120	15	98 (1.0)	4	21	205	62
Ceramics	200	PVA	3.0	106	120	15	78 (0.8)	3	22	404	82
Alumina	160	PVA	3.0	60	110	15	59 (0.6)	4	22	311	88
Silica	150	CMC	1.0	100	120	15	78 (0.8)	4	22	306	60
Lactose	200	Sorbitol	70.0	10	100	14	98 (1.0)	4	25	390	80
Black tea essence	250	Guar gum	0.5	24	85	6	59 (0.6)	10	28	333	77
Grease containing powder	200	Glucose	30.0	11	85	4	59 (0.6)	7	22	236	82

Binder category and features

Category	Features
Gelatin	Gelatin Low density and weak bonding strength. No need to heat.
Dextrin	While it has excellent disintegrating and formability, the binding strength is weak.
Potato starch	Good granulation properties and inexpensive. Used in the pharmaceutical and food sector.
Arsinic acid soda	Suitable as a binder for the high viscosity samples. Used primarily in the food sector.
Gum arabic	Warm and spray. Need large amount of binder.
CMC (Carboxymethyl cellulose)	High viscosity at low temperatures. High amount of powder remains.
HPC (hydroxypropyl cellulose)	Good cohesion and is suitable for hydrophilic material.
MC (methyl cellulose)	Strong binding strength, is suitable for rough particles.
PVA (Polyvinyl alcohol)	Excellent in granulation properties but somewhat difficult to disintegrate granulated products.
PVP (Polyvinylpyrrolidone)	High molecular weight and strong binding strength, is suitable for hydrophobic material.

Repeatability of spray drying test (Pulvis mini spray GB-210A)

Test No.	Sample name	Sample density (%)	Drying conditions							Yield (g)	Recovery rate (%)
			Inlet temp. (°C)	Outlet temp. (°C)	Dry air amount (m³/min)	Spray air pressure kPa(kg/cm²)	Test sample amount (g/min)	Sent amount of sample liquid (g/min)	Test time (min)		
1	Coffee solution	5.00	150	80	0.45	147(1.5)	198.0	6.6	30	8.1	81.8
2	Coffee solution	5.00	150	80	0.45	147(1.5)	198.7	6.6	30	8.1	81.5
3	Coffee solution	5.00	150	80	0.45	147(1.5)	200.6	6.7	30	8.0	79.8
4	Coffee solution	5.00	150	80	0.45	147(1.5)	198.1	6.6	30	8.2	82.8
5	Coffee solution	5.00	150	80	0.45	147(1.5)	199.3	6.6	30	8.4	84.3

Example of implementation Pulvis mini spray GB-210A, organic solvent recovery unit GAS410

Sample	Sample density (%)	Inlet temp. (°C)	Outlet temp. (°C)	Drying nitrogen (m³/min)	Spray pressure (kg/cm²)	Sent rate of sample liquid (g/min)	Dispersion medium or solution	Results			
								Powdered	Recovery rate (%)	Solution recovery rate (%)	Others
Hydroxypropyl methylcellulose	10	90	55	0.5	1.0	9.9	*	G	65.3	92.5	*Chloroform1: Ethanol1
Cellulose polymer	5.0	70	47	0.5	1.0	8.3	Methylene chloride	G	72.3		
Polymer	2.0	100	64	0.5	1.0	8.4	*	G	77.8	80.7	*Ethanol95: Water5
Resin	23.5	80	55	0.5	1.0	4.2	*	G	81.9	96.7	*(Methanol4:Water1) Distributed
Carbon + resin	5.8	100	70	0.5	1.0	5.3	IPA	G	85.1	94.1	
Polymer + inorganic salt	10.2	140	98	0.5	1.0	3.8	*	G	97.6	97.4	*Dimethylacetamide
Polyvinylpyrrolidone (K30)	10.0	80	55	0.5	1.0	7.7	Ethanol	G	79.4	95.0	
Polyvinyl pyrrolidone + drug	10.0	80	55	0.5	1.0	7.7	Ethanol	G	75.9	95.4	
Botanical extract	3.0	130	71	0.5	1.0	9.1	*	G	96.5	91.9	*Ethanol6: Water4
Silicon carbide	38.5	150	84	0.5	1.0	12.1	Ethanol	G	89.9	99.9	*Use nozzle 3S
Aluminum nitride	13.2	150	99	0.5	1.0	12.9	Butyl acetate	G	92.2	86.7	*Use nozzle 3S
Nitride ceramic	60.5	120	83	0.5	1.0	11.3	MEK	G	74.7	88.7	
Superconducting material	33.3	80	60	0.5	1.0	15.7	Acetone	G	66.6	99.6	
Drug	3.61	100	68	0.6	1.0	10.0	*	Yes	73.6	87.2	*Ethanol+Methylene chloride
Drug	13.2	60	45	0.32	1.25	6.0	*	Yes	87.6	94.7	*Methylene chloride+Ethanol
W-Cu	50.0	100	62	0.5	0.5	20.7	Ethanol	Yes	60.3	91.9	
Metamorphic polystyrene	48.7	140	60	0.45	1.0	22.3	Water	Yes	67.6	91.7	
Polymer	0.5	150	88	0.5	1.0	8.5	*	Yes	83.1	97.6	*Methanol3+Water1
Organic matter	50.0	150	88	0.4	1.0	8.3	Methanol	Yes			
Silica dispersion	10.0	100	88	0.5	1.0	4.8	*	Yes	96.2	99.5	*Ethanol+Water(little)