Bulk density/ Grain density/ Dry density

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1 Bulk density

Density of a freely-settled material with its original humidity. Dimension g/cm³. Symbol ρ.

2 Grain density

$$\rho_s = \frac{m_d}{V_S} [g/cm^3]$$

ρ_S	grain density	[g/cm3]
m_d	mass of dry sample	[g]
V_S	solid volume (grain volume)	[cm3]

3 Dry density

$$\rho_d = \frac{\rho}{1 + \frac{w}{100}} [g/cm^3]$$

ρ_d	dry density	[g/cm3]
ρ	bulk density	[g/cm3]
w	water content DS	[%]

4 Examples of bulk density

- mixed waste 0.3 to 0.7 (depending on ash content)
- biowaste 0.1 to 0.9 (shrubbery/ kitchen waste)
- glass (centrally located containers) 0.2 to 0.8 (mixture/ containers/ shards)
- paper (centrally located containers) 0.1 to 0.35 (mixture/ newspapers/ magazines)
- garden waste
  - branches 0.1 to 0.4
  - plant parts/ grass clippings 0.4 to 0.9 (plant parts/ grass clippings)
- lightweight fraction (from German dual system DSD) 0.01 to 0.2 (depending on container volume 240 / 80 Liters)

container contents		Minimum/Maximum	Median
mixed waste	80l container:	0.06 – 0.71 kg/l	0.19 kg/l
	120l container:	0.02 – 0.53 kg/l	0.14 kg/l
	240l container:	0.03 – 0.35 kg/l	0.11 kg/l
lightweight fraction (DSD)	80l container:	0.04 – 0.26 kg/l	0.09 kg/l
	120l container:	0.01 – 0.13 kg/l	0.07 kg/l
	240l container:	0.03 – 0.12 kg/l	0.05 kg/l
biowaste	80l container:	0.30 – 0.90 kg/l	0.50 kg/l
	120l container:	0.30 – 0.66 kg/l	0.50 kg/l
	240l container:	0.02 – 0.53 kg/l	0.49 kg/l

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Examples for various collection systems

Municipal Waste	**Industrialized Country**	**Developing Country**
Dust bin	0.091 to 0.10	
Collection vehicle without compaction	-	
Collection vehicle with compaction	0.45	
Bunker	0.30 to 0.50	
Bio Waste		
Dust bin	0.10 to 0.80 average 0.50	
Collection vehicle without compaction	0.40 to 0.80	
Bunker	0.40 to 0.80	
DSD		
Dust bin	0.03 to 0.10	
Collection vehicle with compaction	0.30	
Bunker	0.10 to 0.20	
Bulky Waste		
At the Street	0.05 to 0.50	
Collection vehicle with compaction	0.30	
Bunker	0.20 to 0.60	
Green Waste		
Dust bin	0.10 to 0.60	
Collection vehicle without compaction	0.25 to 0.70	
Bunker	0.20 to 0.40	
Depot Container		
Paper	0.10 to o.25	
Glass	0.25 to 0.35	
Glass & Metal Bins	0.15 to 0.30	
Compost		
Fresh Compost	0.30 to 0.50	
Matured Compost	0.40 to 0.70	
Digestate		

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Municipal Waste	Industrialized Country	Developing Country
Liquid	1.00	
Solid	0.70 to 0.90	
Residues Incineration		
Ash	0.80	
Clinker	0.70	

Examples for wastes before collection

The bulk density of waste is strongly influenced by the delivery method. The degree of compaction is of significance here. The table presents mean, minimal and maximal values for some waste types. The diagram illustrates the ranges.

Density values of different material groups, determined at time of delivery [kg/m³]

Material group	min	max	mean
Paper	80	195	152
Cardboard	70	160	119
Plastic sheet	75	180	124
Hard plastics	115	290	214
Styrofoam	20	35	28
Rubber	195	335	258
Solid wood	200	420	305
Light wood	200	375	294
Lumber / demolition wood	255	425	338
Glass	300	535	404
Heavy metal scrap	755	900	829
Light metal scrap	300	540	413
Electronic scrap	280	535	400
Furniture/ mattresses	105	350	255
Textiles	115	195	158
Construction waste / road construction waste	535	1,000	715
Excavated soil	805	1,410	1,187
Renovation waste	300	600	442
Ash from heating	870	1,130	1,002
Windows	270	545	418
Cables	625	1,130	875
Cables	250	470	350
Packaging composites	125	195	160
Industrial slurry	895	1,095	992
Sewage sludge	845	1,100	985
Screenings	265	385	322
Kitchen waste	265	385	325
Garden/ green wastes	160	260	211
Not classifiable	100	275	212

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Material group	min	max	mean
Others	185	375	285

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5 Densities (at 20 ^{o}C) g/cm^{3}

Pure water	0.9982
Seawater	1.0400
Quicksilver	13.5460
Kerosene (app.)	0.8000
Paraffin wax (m.p. 52-52 ^{o}C)	0.9120
Microcrystalline wax (m.p. 60-63 ^{o}C)	0.9150