Bulk Density and Porosity by Archimedes' Method

Bulk density, open porosity, water absorption and total porosity of a refractory or ceramic from dry, saturated and suspended masses.

Method: Archimedes' principle as in ASTM C20 and ISO 5017 (refractories)

Input parameters

Unit system: SI

Parameter	Value	Unit
Dry mass	100.00	g
Saturated mass (in air)	108.00	g
Suspended mass (in water)	62.000	g
Water density	998.00	kg/m³
True (solid) density	2,700.0	kg/m³

Calculated results

Parameter	Value	Unit
Bulk density	2,169.6	kg/m³
Apparent (open) porosity	17.391	%
Water absorption	8.0000	%
Apparent solid density	2,626.3	kg/m³
Total porosity	19.646	%

Notes for this case

- Boil or vacuum-saturate the specimen so open pores fill. Closed porosity = total − apparent porosity.

Formula and method

$$\rho_b = \frac{m_d \rho_w}{m_s - m_i}, \quad P_a = \frac{m_s - m_d}{m_s - m_i}, \quad WA = \frac{m_s - m_d}{m_d}, \quad P_t = 1 - \frac{\rho_b}{\rho_t}$$

Variables

m_d	Dry mass	kg
m_s	Saturated mass (in air)	kg
m_i	Suspended mass (in water)	kg
ρ_w	Water density	kg/m³
ρ_t	True (solid) density	kg/m³
ρ_b	Bulk density	kg/m³
P_a	Apparent (open) porosity	-
WA	Water absorption	-
ρ_a	Apparent solid density	kg/m³
P_t	Total porosity	-

Method and standards

Archimedes' principle: the loss of mass in water gives the bulk volume of the saturated specimen; open porosity is the water taken up over that volume, and total porosity compares the bulk density with the true (solid) density.

Assumptions and limits

- Open pores fully filled.
- The true density must be at least the bulk density; otherwise the total porosity is not shown.

References

- Archimedes' principle as in ASTM C20 and ISO 5017 (refractories)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/properties/archimedes-porosity-density

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.