Tank Volume with Dished Ends (Torispherical, Ellipsoidal)

Volume of a cylindrical tank or vessel with 2:1 ellipsoidal, torispherical or hemispherical dished ends, with the depth and volume of each head.

Method: Geometry of ellipsoidal; torispherical and hemispherical heads (volume of revolution)

Input parameters

Unit system: SI

Parameter	Value	Unit
Type of dished end	2:1 semi-ellipsoidal	
Inside diameter	2.0000	m
Straight shell length, tangent to tangent	5.0000	m
Number of dished ends	Two	
Crown radius as a multiple of D	1.0000	
Knuckle radius as a multiple of D	0.10000	

Calculated results

Parameter	Value	Unit
Depth of one dished end	500.00	mm
Volume of one dished end	1.0472	m³
Volume of the straight shell	15.708	m³
Total volume	17.802	m³
Overall inside length	6.0000	m

Notes for this case

- Inside dimensions; the straight flange of each head belongs in the shell length.

Formula and method

$$V_h = \frac{\pi D^3}{24}\ (2:1\ \text{ellipsoidal}), \quad V_h = \frac{\pi D^3}{12}\ (\text{hemispherical})$$

$$V_h = \pi \int_0^h x(y)^2\, dy \quad (\text{torispherical}:\ \text{knuckle arc then crown arc})$$

$$V = \frac{\pi D^2}{4} L + n V_h, \quad L_t = L + nh$$

Variables

head	Type of dished end	-
D	Inside diameter	m
L	Straight shell length, tangent to tangent	m
n	Number of dished ends	-
R/D	Crown radius as a multiple of D	-
r/D	Knuckle radius as a multiple of D	-
h	Depth of one dished end	m
V_h	Volume of one dished end	m³
V_s	Volume of the straight shell	m³

V	Total volume	m³
L_t	Overall inside length	m
R, r	Crown and knuckle radii of a torispherical head	m
$x(y)$	Inside radius of the head profile at height y above the tangent line	m

Method and standards

Head volumes are solids of revolution of their inside profile. The torispherical head is integrated exactly in closed form: knuckle of radius r centred D/2 − r from the axis, crown of radius R, tangent where the line of centres meets the knuckle arc.

Assumptions and limits

- Inside dimensions; head thickness not included.
- Full volume only; for partial levels use the partial-volume calculators.

References

- Geometry of ellipsoidal
- torispherical and hemispherical heads (volume of revolution)

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/mechanical/vessels/dished-end-tank-volume

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.