2:1 Ellipsoidal Heads volume formula

tankvolumecalc.com/formulas/ellipsoidal-heads/

Total volume, exact partial fill, derivation, worked example and a copy-ready fill table.

TOTAL VOLUME

$$V = \pi r^2 L_{cyl} + (2/3)\pi r^2 a, \quad a = D/4$$

PARTIAL FILL AT LIQUID DEPTH H

$$V(h) = \text{seg}(r,h)\cdot L_{cyl} + \tfrac{1}{2}\cdot\pi h^2(3r-h)/3$$

Derivation

The head pair forms a spheroid: a sphere compressed along the tank axis to depth a = D/4. Compression is an affine map, which preserves volume ratios — so the pair's partial fill is exactly (a/r) = ½ times the spherical cap. Exact, not approximate; our tests confirm it against numerical integration to <0.2%.

Worked example

Take D = 40 in, Lcyl = 100 in. Total capacity: 616.5 gal. At a stick reading of 16 in (40% of the 40 in maximum depth), the filled volume is 228.7 gal — 37.1% of capacity. Check it live on the calculator.

Fill ratio: % of depth → % of volume (a vessel with shell length = 2.5×D)

Depth	Volume
5%	1.7%
10%	4.9%
15%	9%
20%	13.8%
25%	19.1%
30%	24.8%
35%	30.8%
40%	37.1%
45%	43.5%
50%	50%
55%	56.5%
60%	62.9%
65%	69.2%
70%	75.2%
75%	80.9%
80%	86.2%
85%	91%
90%	95.1%
95%	98.3%

Need the full inch-by-inch table for specific dimensions? The dip chart generator prints it as a laminate-ready PDF.

FAQ

Q. What is the formula for a 2:1 ellipsoidal heads volume?

Total: V = πr²Lcyl + (2/3)πr²a, a = D/4. Partial fill at depth h: V(h) = seg(r,h)·Lcyl + ½·πh²(3r–h)/3. Derivation and a worked example are

above.

Total: $V = \pi r^2 Lcyl + (2/3)\pi r^2 a$, $a = D/4$. Partial fill at depth h: $V(h) = seg(r,h)\cdot Lcyl + \frac{1}{2}\cdot\pi h^2(3r-h)/3$. Derivation and a worked example are above.

Q. Is the fill-ratio table exact?

Yes — computed by the same engine as our calculators (a vessel with shell length = 2.5×D), verified by the automated test suite described on the methodology page.

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Q. Can I use this in a spreadsheet?

Yes — the formulas are closed-form (acos and sqrt only). Copy the 5%-step table for quick interpolation, or implement the formula directly for exact values.

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