Hydrostatic Tank Gauging: Mass, Density and Level

Liquid mass, density and level in a vertical tank from bottom, middle and top pressure transmitters (hydrostatic tank gauging), for constant cross-section tanks.

Method: Hydrostatic tank gauging (Lipták, Instrument Engineers' Handbook, 4th ed. (CRC Press), vol. 1; API MPMS ch. 3.6 principle)

Input parameters

Unit system: SI

Parameter	Value	Unit
Bottom transmitter (absolute or gauge, same basis)	1.8500	bar
Middle transmitter	1.6900	bar
Top (vapour space) transmitter	1.0000	bar
Vertical distance bottom to middle transmitter	2.0000	m
Tank cross-section area	50.000	m²
Bottom transmitter height above tank floor	0.20000	m

Calculated results

Parameter	Value	Unit
Liquid density	815.77	kg/m³
Liquid mass above the bottom transmitter	433.38	t
Liquid level above tank floor	10.825	m
Liquid volume above the bottom transmitter	531.25	m³

Notes for this case

• Mass follows directly from the pressure difference times area, without knowing density: the strength of HTG for custody and inventory. The middle transmitter must be covered for density to be valid.

Formula and method

$$\rho = \frac{p_b - p_m}{g h_{bm}}, \quad M = \frac{A(p_b - p_t)}{g}, \quad L = \frac{p_b - p_t}{\rho g} + z_b$$

Variables

p_b	Bottom transmitter (absolute or gauge, same basis)	Pa
p_m	Middle transmitter	Pa
p_t	Top (vapour space) transmitter	Pa
h_{bm}	Vertical distance bottom to middle transmitter	m
A	Tank cross-section area	m²
z_b	Bottom transmitter height above tank floor	m
ρ	Liquid density	kg/m³
M	Liquid mass above the bottom transmitter	kg
L	Liquid level above tank floor	m
V	Liquid volume above the bottom transmitter	m³

Method and standards

Hydrostatics.

Assumptions and limits

- Uniform density; vertical-wall tank; the middle transmitter covered by liquid (otherwise the page reports failure).

- Standard gravity; custody-transfer HTG (API MPMS 3.6) uses local gravity, which changes the mass by up to about 0.3 %.

References

• Hydrostatic tank gauging (Lipták, Instrument Engineers' Handbook, 4th ed. (CRC Press), vol. 1; API MPMS ch. 3.6 principle)

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/instrumentation/pressure-level/hydrostatic-tank-gauging

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Reopens the calculator with the inputs of this report.