Tank Draining Time through an Orifice

Time to drain a vertical cylindrical tank from one level to another through a bottom orifice or nozzle, by Torricelli's law with a discharge coefficient.

Method: Torricelli's law with a discharge coefficient

Input parameters

Unit system: SI

Parameter	Value	Unit
Tank inside diameter	3.0000	m
Starting liquid level above the outlet	4.0000	m
Final liquid level above the outlet	0	m
Outlet orifice or nozzle diameter	50.000	mm
Discharge coefficient About 0.61 for a sharp-edged orifice; 0.8 for a short pipe stub; 0.95–0.98 for a rounded nozzle.	61.000	%

Calculated results

Parameter	Value	Unit
Draining time	88.839	min
Initial outflow	38.192	m³/h
Volume drained	28.274	m³

Notes for this case

- Tank open to air (or vented) and discharging to air; outlet pipe friction and a vortex at low level would lengthen the time.

Formula and method

$$t = \frac{A_t}{C_d\, a}\sqrt{\frac{2}{g}}\left(\sqrt{h_1} - \sqrt{h_2}\right) \qquad Q_1 = C_d\, a\sqrt{2gh_1} \qquad V = A_t(h_1 - h_2)$$

Variables

D_t	tank diameter	m
h_1	starting level	m
h_2	final level	m
d	outlet diameter	m
C_d	discharge coefficient	–
t	draining time	s
Q_1	initial outflow	m³/s
V	volume drained	m³
A_t, a	tank and outlet areas	m²
g	standard gravity	m/s²

Method and standards

Torricelli's law integrated over the falling level of a constant-area tank.

Assumptions and limits

- The velocity of the falling liquid surface is neglected: the exact Torricelli result divides the outflow velocity by √(1 − (C_d a/A_t)²). The error is below 1 % while the outlet is under about 0.3 of the tank diameter; the page warns above that.
- Vented tank; discharge to atmosphere; quasi-steady flow.

References

- Torricelli's law with a discharge coefficient

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

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

This calculator online

https://calc.firecad.com/mechanical/fluid-mechanics/tank-draining-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.