Vapour Displaced When Filling a Tank

Mass of product vapour pushed out of a fixed-roof tank by filling, from the volume filled, vapour pressure, molar mass and temperature, per fill and per year.

Method: Ideal-gas vapour content of displaced tank gas

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid volume filled	1,000.0	m³
True vapour pressure at storage temperature	30.000	kPa
Vapour molar mass	66.000	kg/kmol
Vapour space temperature	25.000	°C
Vapour saturation factor	80.000	%
Fills per year	30.000	
Vapour recovery efficiency	0	%

Calculated results

Parameter	Value	Unit
Vapour concentration in the displaced gas	0.63898	kg/m³
Vapour lost per fill	638.98	kg
Vapour lost per year	19.169	t

Notes for this case

• Displaced gas volume equals the liquid volume filled; it carries vapour at K_s·p_v partial pressure (ideal gas). Breathing losses from daily temperature swings come on top; emission inventories use the regulator's method and factors.

Formula and method

$$c_v = \frac{K_s p_v M}{RT}, \quad m = V_f c_v (1 - \eta_r)$$

Variables

V_f	Liquid volume filled	m³
p_v	True vapour pressure at storage temperature	Pa
M	Vapour molar mass	kg/kmol
T	Vapour space temperature	K
K_s	Vapour saturation factor	-
N	Fills per year	-
η_r	Vapour recovery efficiency	-
c_v	Vapour concentration in the displaced gas	kg/m³
m_1	Vapour lost per fill	kg
m_y	Vapour lost per year	kg

Method and standards

Displacement loss.

Assumptions and limits

- Ideal gas; uniform vapour concentration.

References

Ideal-gas vapour content of displaced tank gas

Report details

Report reference	FCC-G26T-5VFA (the same inputs always give the same reference)
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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/vessels/tank-vapour-displacement-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.