Capacitance Level Probe: Capacitance and Span

Capacitance of a coaxial (rod in tube) level probe empty and full from the dimensions and the dielectric constant of the liquid, with the change per metre.

Method: Capacitance of a coaxial capacitor; C = 2π ε₀ ε_r L / ln(D/d)

Input parameters

Unit system: SI

Parameter	Value	Unit
Rod (inner electrode) diameter	12.000	mm
Tube or vessel inside diameter (outer electrode)	50.000	mm
Active length	2.0000	m
Dielectric constant of the liquid About 2 for oils, 80 for water (water needs an insulated probe).	2.2000	
Level on the probe	1.0000	m

Calculated results

Parameter	Value	Unit
Capacitance empty	77.965	pF
Capacitance full	171.52	pF
Capacitance at the level	124.74	pF
Capacitance change for 1 m of level	46.779	pF

Notes for this case

- Bare coaxial probe in a non-conductive liquid. Conductive liquids need an insulated rod, where the insulation sets the capacitance.

Formula and method

$$C' = \frac{2\pi\varepsilon_0}{\ln(D/d)}, \quad C_h = C'\,[\varepsilon_r h + (L - h)], \quad \Delta C_{1m} = C'(\varepsilon_r - 1) \times 1\ \mathrm{m}$$

Variables

d	Rod (inner electrode) diameter	m
D	Tube or vessel inside diameter (outer electrode)	m
L	Active length	m
ε_r	Dielectric constant of the liquid	-
h	Level on the probe	m
C_0	Capacitance empty	F
C_1	Capacitance full	F
C_h	Capacitance at the level	F
ΔC_{1m}	Capacitance change for 1 m of level	F
C'	Capacitance per metre of probe in air, 2πε₀/ln(D/d)	F/m

Method and standards

Coaxial capacitor with a partly filled gap.

Assumptions and limits

- Concentric electrodes.

References

- Capacitance of a coaxial capacitor

- $C = 2\pi \varepsilon_0 \varepsilon_r L / \ln(D/d)$

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/instrumentation/pressure-level/capacitance-level-probe

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.