

SA - LAB - 3

LAB-3

Formula : $2 \pi \epsilon_0 (\epsilon_1 h_1 + \epsilon_2 h_2) / \ln (r_2/r_1)$

~~where,~~

* Measurement of Level Tank using Capacitive Type Level

Objective

- Review various methods of level measurement
- Understanding working of capacitance level transmitters

C = Capacitance in μF

r_1 = radius of inner cylinder / pipe for 'pipe in pipe' type probe

r_2 = radius of outer cylinder / pipe for 'pipe in pipe' type probe

ϵ_0 = permittivity of the space = 8.85×10^{-12}

ϵ_1 = permittivity of air = 1

ϵ_2 = Dielectric constant of the process fluid
~~selected selected service~~

h_1 = Height (level) of air column = span-liquid column height.

h_2 = Height (level) of liquid column

span = (Tank height * 0.9) - 5

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Fluid / Service	Dielectric
Water	80
Hydrochloric Acid	5
Coffee Beans	1.5
Grain of mustard seed	3.6
Skimmed milk powder	2.3

□

$$r_1 = 0.1 \text{ cm}$$

$$r_2 = 2.5 \text{ cm}$$

$$\epsilon_0 = 8.85 \times 10^{-12}$$

$$\epsilon_1 = 1$$

$$\epsilon_2 = 80$$

$$h_1 = 445 - 45 \approx 400$$

$$h_2 = 45$$

Substituting in formula

$$2\pi \times 8.85 \times 10^{-12} (1 \times 400 + 80 \times 45) \div \ln(2.5/0.1)$$

$$= 6.91 \times 10^{-12}$$

$$= 0.0691 \mu\text{F}$$

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$$\begin{aligned}
 2] \quad r_1 &= 0.1 \text{ cm} \\
 r_2 &= 2.5 \text{ cm} \\
 \epsilon_0 &= 8.85 \times 10^{-12} \\
 \epsilon_1 &= 1 \\
 \epsilon_2 &= 80 \\
 h_1 &= 445 - 90 = 355 \\
 h_2 &= 90
 \end{aligned}$$

Substituting in formula

$$\begin{aligned}
 & 2\pi \times 8.85 \times 10^{-12} (1 \times 355 + 80 \times 90) \div \\
 & \quad \ln(2.5 \div 0.1) \\
 & = \\
 & = 0.13 \mu\text{F}
 \end{aligned}$$

$$\begin{aligned}
 3] \quad r_1 &= 0.1 \text{ cm} \\
 r_2 &= 2.5 \text{ cm} \\
 \epsilon_0 &= 8.85 \times 10^{-12} \\
 \epsilon_1 &= 1 \\
 \epsilon_2 &= 80 \\
 h_1 &= 445 - 135 = 310 \\
 h_2 &= 135
 \end{aligned}$$

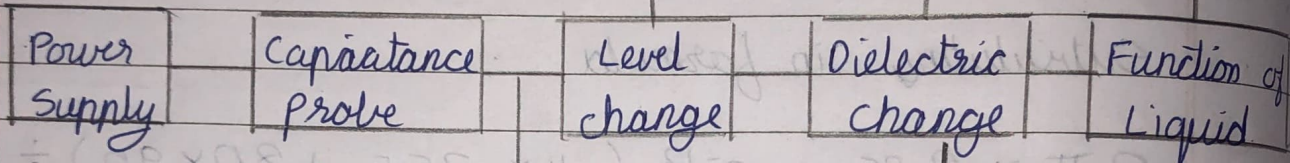
Substituting in formula

$$\begin{aligned}
 & 2\pi \times 8.85 \times 10^{-12} (1 \times 310 + 135 \times 80) \div \ln(2.5 \div 0.1) \\
 & = 0.19 \mu\text{F}
 \end{aligned}$$

Block Diagram Sensor working

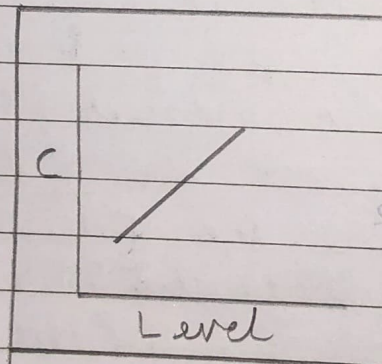
$$2\pi * \epsilon_0 (\epsilon_1 * h_1 + \epsilon_2 * h_2) / \ln$$

$$(\epsilon_2 / h_1)$$



change Developed on plates ($C = q/v$)

Overlapping Area changes



Change in capacitance

output in μF

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Date

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Block Diagram Level to Current Converter

