

C O P Y

Copy: Mr. L. C. Garrett (3)

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Dr. R. L. Jenkins

LIQUID DIELECTRICS

Dr. Samaras has asked me to reply to your letter of September 10 concerning the standardization of your equipment for determining power factor and dielectric constant of liquids.

We recently had occasion here at Springfield to construct and calibrate a cell for liquid dielectric measurements. Thiophene-free benzene makes an ideal standardizing fluid in many ways. It has a very low power factor (about 0.04%) and a dielectric constant which has been determined with high precision. Furthermore, its dielectric properties vary only slightly with temperature. The International Tables give 2.283 ± 0.002 for the dielectric constant of pure benzene at 20°C . and the temperature coefficient is listed as minus 0.001 per degree C.

As an alternative to benzene, one could use m-xylene, which has the following characteristics:

$$k \text{ (at } 20^{\circ}\text{C)} = 2.374$$

$$\frac{dk}{dT} = -0.0019 \text{ per degree C}$$

By means of one capacitance measurement with one of the above standardizing liquids as dielectric and another with air as dielectric (empty cell), it is possible to calculate the cell constant.

For empty cell

$$C_0 \text{ (empty)} = C \text{ (cell const.)} + \left(C_1 \text{ (leads)} \right) \leftarrow \text{blank -}$$

For cell filled with benzene at 25°C .

$$C_b \text{ (Benzene)} = 2.277 C \text{ (cell const.)} + C_1 \text{ (leads)}$$

These two equations may be solved simultaneously for the two unknowns - C, the cell constant and C_1 , the capacitance of the leads. The dielectric constant of an unknown liquid, k , is then

$$k_x = \frac{C_x - C_1}{C}$$

where C_x is the measured capacitance with the cell filled with the unknown and C_1 and C have the same meaning as before.

We use a small coaxial-cylinder type of cell which has a cell constant of 37.6 mmf. and lead capacitance of 1.2 mmf. We found it necessary to gold plate the cell electrodes in order to minimize electrostatic effects.

If you would find it more convenient to send us your cell for calibration, we shall be glad to do so. I know of now liquid with low power factor and dielectric constant of about 4 which could be used simply as a comparative standard, but see no necessity for such standardization if the cell is dimensionally stable and the measuring equipment reliable.

/pgc
AB
9/25/45

D. Telfair

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