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Manufacturers & Exporters of Laboratory and Research Equipments

DIELECTRIC CONSTANT KIT FOR LIQUIDS(SI. No.: 2122103)

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DIELECTRIC CONSTANT KIT (LIQUIDS)

PRINCIPLE

The dielectric constant ε of a liquid is defined as the ratio of the electrical capacitance of a cell when the liquid / solution forms the dielectric medium (C_s) to the capacitance of the cell when air forms the dielectric medium (C_0) at a given temperature. Which is represented by the following equation.

$$\varepsilon = \frac{(C_s)}{(C_0)} \qquad \text{------------(1)}$$

The dielectric cell assembly consists of two circular discs of 25 mm diameter of special grade stainless steel. The cell has to be first standardized to measure the dielectric constant of unknown solutions. This is accomplished by considering a pure liquid (preferably doubly distilled) such as benzene as standard liquid. Then the dielectric constant of an unknown liquid (ε_x) can be determined by measuring the capacitance of the cell in air (C_0), the capacitance of cell in reference liquid, such as benzene (C_r) and the capacitance of the cell in liquid whose dielectric constant has to be measured (C_x) using the relation

$$\varepsilon = 1 + \left[\frac{(C_0 - C_x)}{(C_0 - C_r)}\right] \times (\varepsilon r - 1) \ldots\ldots\ldots\ldots\ldots 2$$

where ε_r is the dielectric constant of the reference liquid ($\varepsilon_{benzene} = 2.26$).

A special function generator chip is used to acts as an oscillator. The frequency of oscillations depends on the values of timing resistor R and timing capacitor C. When the value of R is kept constant, the dielectric cell acts as a capacitor C which varies with dielectric medium. Consequently the frequency of the oscillator also changes. The measurement of frequency of the oscillator enables one to measure the value of capacitance of the cell and thus the dielectric constant of the medium.

DIELECTRIC CELL

The dielectric cell consists of two circular discs (25 mm diameter) of special grade stainless steel whose faces are well machined and later fine polished using special technique. The two conducting plates are positioned parallel to each other at close proximity of about 3 mm diameter which are connected to a specially designed lid having BNC connector.

FUNCTION GENERATOR

The function generator incorporates integrated circuit capable of producing high quality sine waveforms of high-stability and accuracy.

The frequency of oscillation f_0 is determined by the external capacitor C and by the timing resistor R. The frequency is given as:

$$f = \frac{1}{RC} \qquad \ldots(3)$$

The timing resistor R is kept constant. The capacitances are measured in terms of the frequency.

PROCEDURE

1. Thoroughly rinse the lower part of the dielectric cell assembly & beaker with acetone and let it dry so that all the acetone is evaporated.

2. Connect the shielded cable to the main unit and dielectric cell assembly. Put assembly within empty beaker.

3. Switch ON the main unit and measure the frequency (in kHz) of the display. Calculate Capacitance in air C_0 as

$$C_0 = \frac{1}{Rf_0}$$

Note : If digits are varying after decimal point, please ignore the digits (i.e. take reading as XXX KHz instead of XXX.X KHz) as it won't affect the accuracy of the result.

4. Now pour the reference liquid (say benzene) into beaker (say upto mark 40 ml). Now insert the dielectric cell assembly from the top and measure the frequency. Calculate the capacitance C_r using relation :

$$C_r = \frac{1}{Rf_r}$$

5. Now remove the BNC cable and dielectric cell assembly and thoroughly rinse lower part of the dielectric cell assembly and beaker with acetone and let it dry.

6. Pour test liquid (whose dielectric constant has to be measured) into the beaker and again insert dielectric cell assembly from top and measure the frequency. Calculate the capacitance C_X using the relation

$$C_X = \frac{1}{Rf_X}$$

7. Calculate the dielectric constant ε_x of liquid using relation

$$\varepsilon = 1 + \left[\frac{(C_0 - C_x)}{(C_0 - C_r)}\right] \times (\varepsilon_r - 1)$$

substituting values of C_0 , C_X and C_r in above relation, we get

$$\varepsilon_X = 1 + \frac{f_r}{f_X}\left[\frac{(f_0 - f_x)}{(f_0 - fr)}\right] \cdot (\varepsilon r - 1)$$

COMPONENT VALUE: For S.No. 2122102

Timing Resistance R = 10 KΩ
Timing Capacitor C_t =100 pF