CONDUCTIVITY METER FOR CONTROLLING THE QUALITY OF DEIONIZED WATER

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Control of the deminerization of water involves the establishment of a threshold conductivity value corresponding to the technical requirements in a given production process [1].

We have developed conductivity meters, constructed on the ohmmeter principle and operating at the industrial frequency, and have used them successfully with ion-exchange columns. The instrument can be made in analytical and plant laboratories.

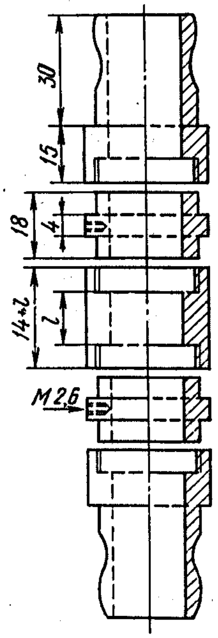

Fig. 1. Cell for conductivity meter.

The range of the instrument with cell constants equal to unity is subdivided into two subranges (0.1-1.0 and 1.0-10 mΩ), covering the most widely used degrees of water purity. The instrument is not provided with thermal correction, and temperature corrections can be made by means of nomograms [2].

Provision is made for the connection of five sensing units, and this makes it possible to control a group of columns. The sensing unit is a plastic tube with two ring electrodes of stainless steel (Fig. 1).

The cell components are screwed together on water-resistant cement. If it is necessary to extend the range of controlled resistivities, this is achieved by changing the cell constant (K_{ce}). It is determined by the distance between the ring electrodes l.

The approximate calculated l values for K_{ce} 0.5, 1, and 2 cm are 47, 18, and 5 mm, respectively. A newly made cell frequently has a constant different from the expected value. It is therefore determined experimentally by measuring a standard solution of known specific resistance in the cell at a fixed temperature.

Concentration of potassium chloride solutions recommended for calibration of the cells are given in Table 1.

TABLE 1. Specific Resistances of Potassium Chloride Solutions at Various Temperatures $\times 10^3$, Ω

Concn., g-eq/liter	15° C	18° C	20° C	25° C
$1 \cdot 10^{-3}$	8,45	7,96	7,58	6,81
$5 \cdot 10^{-4}$	16,8	15,6	15,05	13,52

The resistance of a cell with such a relatively highly conducting standard must be measured on a conductivity meter having an appropriate measuring range with a supply voltage frequency not less than 500 Hz. For this purpose it is possible to use an audio-frequency generator to control the potential applied to the cell and the current passing through it. The circuit of the conductivity meter is presented in Fig. 2. The measurement part of the circuit, which consists of cells 1-5, a microammeter, and the trimming resistors R_5 and R_6, is fed from a common divider R_3 and R_4. By means of the switch S_2 it is possible to include the calibrated resistor R_7

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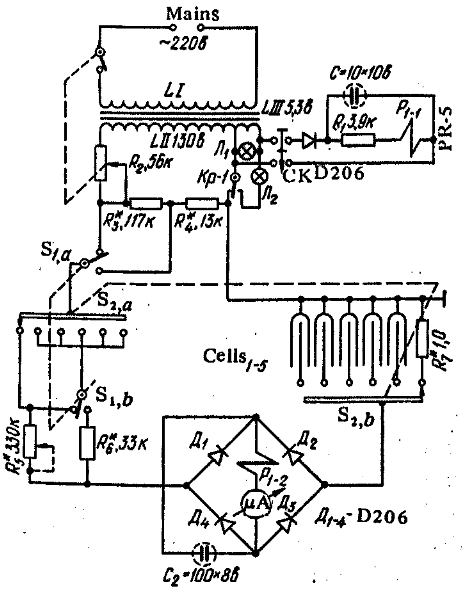

Fig. 2. Electrical Circuit of the conductivity meter.

Some of the following Russian abbreviations may be found in the figure: Л = tube, Д = diode, Тр = transformer, Др or др = choke, Вк = switch, в = V, М = MΩ, к = kΩ, мк = μF or μH, п = pF or pH, and н = nF or nH.

in the circuit in place of the cell. To calibrate the circuit the pointer of the microammeter is positioned at the end of the scale by means of the reostat R_2. With a value of 1 mΩ for the calibrated resistance R_7 it is possible to measure resistances exceeding this limit (in the subrange 1-10 mΩ). To work in the range of 0.1-1 mΩ the voltage supply to the circuit and the value of the trimming resistor R_5 are reduced by a factor of 10 by means of the switch S_1:

$$\frac{R_3+R_4}{R_4} : \frac{R_5}{R_6} = 10\pm0{,}1\%.$$

The circuit to protect the microammeter against overloading consists of the polarized relay PR-5, diode D206, resistor R_1, capacitor C_1, control knob CK, signal lamps L_1 and L_2, and an additional transformer winding LIII. The instrument is assembled in a plastic case measuring 220 × 200 × 120 mm. All the resistors of BLP or ULI type have an accuracy of 0.1%. Four cells can be connected to the rear wall. The fifth cell is connected to a pair of sockets on the front panel of the instrument. These sockets are also used for calibration of the instrument and for control of the readings with a known resistance.

The distance between the instrument and the cells should not be more than 10-12 m. The capacitance between two separate leads is about 8 pF/m, and the capacitance between two twisted leads is 25 pF/m. If the lead is 10-m long, an error in a resistance measurement of 10 mΩ amounts to 2.5% in the first case and 20% in the second. This error would be quickly reduced with decrease in the value of the measured resistances.

A set of nonreactive resistances of 0.1 class are used to calibrate the instrument. The scale of the instrument can be expressed in ohms or in conductivity or resistivity units [3]. The main error in the instrument lies within the limits of ±2.5 rel.%, and the mean-square error from 13 measurements is 33 kΩ, i.e., about 1.5%.

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