

Monsanto Chemical Company

Anniston Method No. 14-35-48

SUBJECT: Resistivity of Liquid Aroclors

METHOD: Resistance Measurements between Conductors

Apparatus

Megohm Bridge: General Radio Company Type 544B, AC operated - 500 volts, serial No. 171. This is a direct-current Wheatstone bridge for measuring high resistances, bridge balance being obtained thru use of a vacuum tube voltmeter. Range: 0.1 megohm to 10,000 megohms, covered by a dial and 5-position multiplier switch. A resistance of 1,000,000 megohms can be detected.

Test Electrodes: Two concentric nickel cylinders (or brass, nickel plated) with feet. Obtained from General Electric Company. The inner electrode has outside diameter of 2.8" and height of 3.25", with area of 184 sq. cm. The outer electrode has inside diameter of 3" and like height of 3.25", with area of 198 sq. cm. The distance between electrodes is therefore 0.1 inch or 0.254 cm. By theory the electrode constant, area/length, is $191/0.254$ or 752 where 191 is the average area. In practice the cell constant supplied by General Electric Company is used. For the electrodes now in use, the cell constant was given as 815.

Glass Plate: Pyrex, about 3-1/2" diameter with concentric grooves to assist in spacing the electrodes. Obtained from General Electric Company.

Oven: Cenco-DeKhotensky drying oven with two holes in back wall for porcelain tubes for lead wires. Holes must avoid oven heating elements which occupy 2" paths vertically and horizontally intersecting at the center of the circular wall.

Lead Wires: Provide 300 ohm Amphenol twin conductor cable to connect the electrodes in oven to the posts of the bridge. The portions exposed to oven temperature are bared and then covered with porcelain beads. Provide also a flexible lead to ground the bridge to a water pipe. Clean the leads, beads, and porcelain tubes periodically.

Assembly of Test Cell

The grooved glass plate is placed in an 800 cc. beaker. The clean electrodes are placed in the grooves of the glass plate with the connector posts directly opposite in order to give the widest possible spacing to reduce surface conductivity. The cylinders should be very close to equidistant. The apparatus should be dried for 2 hours at 100°C. before use.

Heat the sample to be tested to about 110°C. on a hot plate and pour into the electrode assembly until the level of the liquid is 1/4 to 1/2" above the electrodes. Care must be used to make sure that the

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lip of the container, from which the liquid is poured, is clean. Tilt the beaker in such manner that all air bubbles in the Arcelor will rise to the surface.

Air cool to 103-104°C. then without removing thermometer, transfer to the oven which is maintained at 100°C. and connect the electrodes to the two flexible wires which lead to the megohm bridge. When the Arcelor comes to temperature (100°C.), remove thermometer, check centering of electrodes, and proceed to measurements.

Measurement with Megohm Bridge

Connect the two lead wires to the megohm bridge with the lead from the outer electrode to the 10⁷ unknown post of the bridge, the inner electrode to the "+" unknown post. Connect the GROUND post on the left side to a water pipe. Swing the spring connector, pivoted on the "G" post, to the 10⁷ post. Connect the attachment cord to the 110 V power supply.

With the Arcelor at 100°C., turn the control knob (CHECK-OPERATE-CHARGE) to the CHECK position. Throw all 3 switches at the rear of the Panel to ON. After 2 minutes bring the galvanometer pointer to zero by means of the ZERO ADJUST knob.

Then turn the control knob to CHARGE for one minute. Turn the knob to OPERATE and return the galvanometer pointer to zero by adjustment of the MULTIPLY BY switch and the megohm dial. Read after one minute. Repeat the CHARGE and OPERATE positions for verification.

The resistivity of the Arcelor is the product of the "multiply by" reading times the dial reading times the electrode constant. Report in units of 10⁹ ohm cm, rounded off to two significant figures.

Example:

"Multiply by" reading:	100
Megohm dial reading	5.4 meg. ohms
Electrode Constant	815 cm

$$\begin{aligned}\text{Resistivity} &= 100 \times 5.4 \times 815 \\ &= 4.4 \times 10^5 \text{ meg. ohm cm} \\ &= 440 \times 10^9 \text{ ohm cm}\end{aligned}$$

Values for resistivity are qualified by designation of temperature and voltage. These are 100°C. and 500 volts for the test above. Like conditions are used at Plant B.

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Care of Apparatus

The "Operating Instructions", General Radio Form 458-B, which accompany the megohm bridge, recite details of installation, measurements, uses, and construction, illustrated by figures and circuit and wiring diagrams. No attempt is made to reproduce such information here. The operator should acquaint himself with the contents of the G.R. manual and refer to it for maintenance of tubes and parts. When not in use the megohm bridge should be closed and stored in cabinet.

Cleaning Electrodes

After the measurements are made the electrodes are removed from the tested liquid, and allowed to drain until the liquid stops running from the electrodes. While still hot they are placed in a beaker filled with benzene under a well ventilated hood and allowed to cool. Then cool, the electrodes are removed from the benzene and scrubbed with powdered tri-sodium phosphate and a benzene carbontetrachloride mixture (50-50 by volume). This scrubbing can be done with either a brush or the hands. The electrodes are then rinsed with acetone, followed by tap water and then distilled water. The electrodes should not be touched by the hands after the acetone wash. After final rinsing the electrodes are placed in an oven at 120°C. for one hour or until they are used again.

The glass spacer plates are cleaned and handled in the same manner as the electrodes except that they are wrapped in lens paper before being placed in the oven.

Calibration

For a rough check on the condition of the bridge, one or more cartridge-type resistances of known approximate value should be kept on hand for periodic or emergency verification of the meter itself.

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