

Determining Oxygen Permeability (Dk) Using the Polarographic Method (FATT Method)

The Polarographic method for testing contact lens material was pioneered by Dr. Irving Fatt, which resulted in the ISO 9913.1 and ISO 9339.2 standards. Createch and Rehder Development Company (RDC) worked closely with Dr. Fatt to design the Createch 201T Permeometer, the Rehder Polarographic Cells and the Rehder Electronic Thickness Gauge. This equipment is now widely used by major contact lens manufacturing and research facilities around the world.

Transmissibility of the sample (Dk/t) may be determined by data taken from the Permeometer and Polarographic Cells. Thickness of the sample (t) must be precisely known to determine Permeability of the material (Dk). Thickness is measured with the Rehder Electronic Thickness Gauge.

RDC and Createch do not test lenses and we do not provide training or installation of the equipment we provide. Our equipment is designed primarily for the research and development community. It is assumed that the purchasers of this equipment are technical experts and are familiar with the scientific principals and test methods employed for using this equipment. Our customers use this equipment in various ways so we cannot warranty its fitness for any particular use. The purchaser will have to decide if this equipment is suitable for their requirement.

Dr. Fatt and others have published many articles in the contact lens industry technical journals that describe the techniques employed. (See below)

The Polarographic testing method measures Oxygen Transmissibility (Dk/t) of the Sample by detecting the small amount of electrical current produced between the two dissimilar metals of the Polarographic Cell (gold & silver) via an electrolyte (saline). The amount of electrical current that is produced is proportional to the amount of oxygen available at the interface of the sample and polarographic cell.

Temperature, humidity, the amount of saline, etc. are all critical in the system. All components must be stabilized before data is recorded. Temperature variations or other variables will create data variations. The Polarographic Cell, Sample and Cell Mounting Fixture should be enclosed in an environmental chamber to control temperature and humidity and allowed to stabilize before taking measurements.

Mounting of the sample is also critical. Some practice is normally required to master the proper mounting technique in order to collect reliable data. The sample must be properly centered on the Polarographic Cell and there can be no wrinkles, gaps, pockets or bubbles

under the sample when mounted in the Cell Mounting Fixture. The operator must mount the lens exactly the same way each time to get repeatable results.

After mounting the sample and starting the test, it takes some time for residual oxygen to be consumed. This progression may take 45 minutes or longer. It is not practical for the operator to watch the current readings on the digital display to determine when the test is complete as it's the rate of change that is important. If the Permeometer has the RS-232 computer interface installed, data being produced can be plotted in a window on your computer using the 201T Software. If the Permeometer does not have the RS-232 computer interface installed a chart recorder is used to monitor the data. After the residual oxygen has been consumed, the current readings will reach a steady state that represents the oxygen flowing through the sample. The final current reading is recorded and calculations made to convert the electronic data to Oxygen Transmissibility (Dk/t) of the sample. The thickness of the sample (t) should be measured with the Rehder ET-3 Electronic Thickness Gauge so Oxygen Permeability (Dk) of the material can be calculated.

This is only a very basic explanation of the system and its intended function. This brief description is not intended to be an operations manual of any type. Refer to ISO 9913.1 and ISO 9339.2 and to articles written by Dr. Irving Fatt and others for details on measurement methods, formulas and techniques and related matters.

The following equipment is required for taking Dk measurements:

Model 201T, Oxygen Permeometer

The Permeometer provides the excitation voltage to the Polarographic Cell and reads the current that is produced by the polarographic action. The Permeometer also displays the temperature for Polarographic Cells that have the Solid State Temperature Sensor. The optional RS-232 Computer Interface and Data Acquisition Software can be purchased for the Permeometer. This option eliminates the necessity of connecting a chart recorder to the Permeometer to monitor the consumption of oxygen during testing. The Software has a charting feature that takes the place of the chart recorder. Current and Temperature data are taken from the Permeometer when the oxygen consumption reaches a steady state.

The Permeometer Software operates on Windows.

Rehder Development Company and/or Createch do not supply computers or chart recorders.

A set of three Test Modules are available that are used to verify the Permeometer is in calibration and is functioning properly.

Polarographic Cells

Polarographic Cells are available with either a flat or curved working surface. The Flat Cell is normally used for testing flat samples of rigid material or soft lenses. The Curved Cell is normally used for testing rigid contact lenses or soft lenses. The customer must

specify the radius for the Curved Cell's surface. If using the Curved Cell for rigid samples the radius should fit the inside radius of the sample with allowance for the saline saturated paper, if that will be used.

Cell Mounting Fixture

The cell mounting fixture is used to hold the sample on the Cell. The user will need to attach nylon mesh (not supplied) to the appropriate end of the Cell Mounting Fixture tube. One end is used for Flat Cells and the other for Curved Cells.

The Cell Mounting Fixture will fit any cell from RDC.

The Permeometer is capable of operating two Cells simultaneously. Each Cell in operation will need its own mounting fixture.

ET-3, Electronic Thickness Gauge

The ET-3 provides thickness readings in one micron (.001 mm) increments over a 1000 micron range and is designed for measuring soft contact lenses.

The ET-3 can be purchased with an RS-232 Computer Interface and Software. This Option will allow you to collect thickness data directly in your computer. The data can be exported to a database or spreadsheet program for further manipulation.

The ET-3 can also be purchased with a Motorized Sensor Drive. This helps eliminate variability in readings between different operators.

A Ball Anvil Adapter is available for the ET-3. This option allows the operator to rotate the sample under the sensor to make successive measurements over the profile.

A calibration set is available for the ET-3. The set consists of four precision gauge blocks of the appropriate sizes to properly calibrate the Zero to 1000 micron measuring range of the ET-3. The set also includes a Precision Dynamometer that is used to verify the force applied to the sample by the sensor.

Minimum Equipment Required for determining Oxygen Permeability

1. Model 201T, Oxygen Permeometer
2. Polarographic Cell
3. Cell Mounting Fixture
4. ET-3, Electronic Thickness Gauge

Additional equipment required to complete the system that is not provided by Rehder Development Company or Createch.

5. If the Permeometer or the Electronic Thickness Gauge is purchased with the computer interface, a computer with serial com ports capable of running "Windows" will be needed. If running both instruments simultaneously, separate computers would be needed.
6. If the Permeometer is purchased without the computer interface a chart recorder will be needed.
7. A chamber or incubator to control the Temperature and Humidity of the Polarographic Cell and samples will be needed.

Equipment and Options that are Recommended:

13. 201T Permeometer with RS-232 Computer interface
14. 201T Permeometer Software
10. A Set of three Test Modules for the Permeometer.
11. ET-3 Electronic Thickness Gauge with Motorized Sensor Drive
12. ET-3 RS-232 Computer interface option
13. ET-3 Electronic Thickness Gauge Software
14. Ball Anvil Adaptor, 8.00mm, 8.73mm or 9.00mm Radius
15. Calibration Set for the ET-3.

Current prices and additional information for this equipment can be found on the Rehder Development Company Web site: <http://www.rehder-dev.com>

Technical Articles:

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