350h An Improved Polarographic Apparatus to Determine Oxygen Permeability (Dk), Diffusivity (D), and Solubility (K) of Highly Oxygen-Permeable Contact Lenses

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The cornea is an avascular tissue and must depend on an external supply of oxygen (mainly air in open eye) for carrying out cellular respiration. However, the presence of a contact lens reduces the supply of oxygen to the cornea; thus, highly oxygen-permeable contact lenses are desirable for a healthy cornea. Development of new contact lens materials requires a detailed understanding of how lens microstructure controls oxygen permeability. The oxygen diffusion coefficient, D, is sensitive to the detailed path(s) by which oxygen migrates through the lens, and is, therefore, quite sensitive to microstructure. The oxygen solubility, k, however, is sensitive primarily to the relative composition of constituents and not primarily on how they are distributed in space. The goal is to maximize the product, Dk, the oxygen permeability of the contact lens. We have designed an improved polarographic apparatus to determine permeability, diffusivity and solubility of oxygen through contact lenses.

The electrolytic-cell-based polarographic technique involves placing a contact lens on a curved electrode assembly, which has a gold cathode (working electrode) at the center and silver anode surrounding it. Voltage-current data are used to fix limiting voltage across the electrodes so as to maintain limiting current (mass transfer regime) conditions. A steady state experiment is carried out at physiological temperature (35^{o}C) to determine the oxygen permeability (Dk) through the contact lenses. The apparatus is calibrated with a contact lens of known oxygen permeability. An unsteady-state experiment is performed to determine both diffusivity (D) and solubility (k) in the same experiment. Here, the calibration is done using a membrane of known oxygen diffusivity and solubility. For the first time, values of D and k are determined for new high-Dk silicone-hydrogel soft contact lenses as well as more traditional HEMA-based soft contact lenses.