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Oxygen permeability of silicone hydrogel contact lens materials

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Purpose and background

The oxygen permeability (Dk) of silicone hydrogel contact lens materials is known to be higher than previous-generation soft contact lens materials. However, there are few independent reports of Dk values for current silicone hydrogel materials. In this project, we measured the Dk of five marketed silicone hydrogel contact lens materials using the polarographic method. An additional aim for this work was to evaluate the suitability of this method for the measurement of hyperpermeable contact lens materials.

Methods

Dk was measured by the same investigator, in a randomised and masked manner, for the contact lens materials shown in Table 1.

Lens	Material	Claimed Dk
Acuvue Advance	Galyfilcon A	60
Acuvue Oasys	Senofilcon A	103
Focus Night & Day	Lotrafilcon A	140
O2 Optix	Lotrafilcon B	110
PureVision	Balafilcon A	99
SeeQuence	pHEMA	7.5
1.Day Acuvue	Etafilcon A	21

Table 1: Lens materials evaluated.

Methods

The ISO 9913-1:1996 method[1] was used; this can be summarised as follows:

- Lenses stored overnight at 35 ± 0.5°C.
- Placed on a polarographic sensor (Rehder Development Company, California).
- Current measured in conjunction with a polarographic amplifier and solid state temperature sensor.
- Measures taken after 20 and 40 mins settling.
- Repeated for stacks of 1, 2, 3, 4, 5 and 6 lenses (each measured twice) to overcome boundary error.
- Stack thickness measured using an electromechanical gauge (Rehder Development Company, California).
- Oxygen transmissibility for each stack = current (μA) X 2.854 x 10^{-9}.
- Resistance values (t/Dk) calculated and edge corrected using:

$$\left(\frac{t}{Dk}\right)_{corrected} = \left(\frac{t}{Dk}\right)_{measured} \times \left(1 + \frac{2.35t}{D}\right)$$

Equation 1: Edge correction; t is lens centre thickness in mm, D is the diameter of the cathode in mm.

- Plots of t/Dk vs. t generated; Dk = 1/gradient

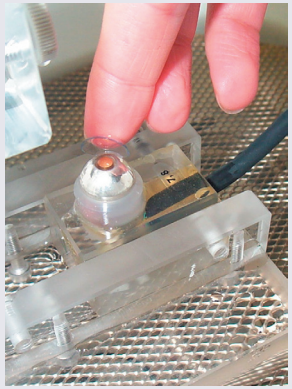

Figure 1: Lens placed on polarographic sensor.

Results

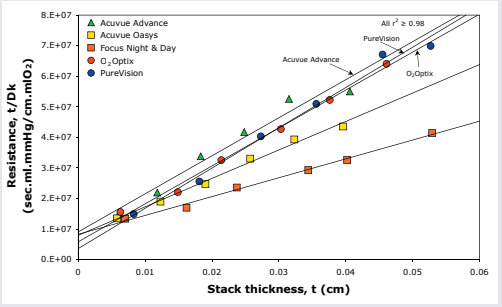

Figure 2: Resistance vs. stack thickness data for silicone hydrogel lenses.

Lens	Claimed Dk	Measured Dk (± 95% CI)
Acuvue Advance	60	75.2 ± 9.8
Acuvue Oasys	103	107.4 ± 7.4
Focus Night & Day	140	162.0 ± 9.8
O2 Optix	110	80.5 ± 4.9
PureVision	99	75.9 ± 6.6
SeeQuence	7.5	8.2 ± 0.7
1.Day Acuvue	21	21.0 ± 1.0

Table 2: Claimed and measured Dk values.

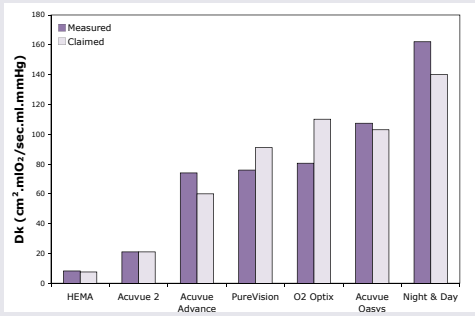

Figure 3: Claimed and measured Dk values.

Discussion

Our data were in good agreement with the puublished values for the two reference materials and the Acuvue Oasys lens. It is unclear whether some manufacturers have accounted for edge and/or boundary effects, and some manufacturers may have used a different measurement methodology (coulometric); these factors may account for discrepancies between our data and those of manufacturers. Our data for Night & Day agree with that published in the literature[2,3]

The methodology described here (of using additional multiple stacks for the measurement of high-Dk lenses) affords increased accuracy and therefore represents an improvement over ISO 9913-1.[1]

References

1. ISO 9913-1 1996. Determination of oxygen permeability by the Fatt method.
2. Alvord L, Court J, Davis T et al. Oxygen permeability of a new type of high Dk soft lens material. Optom Vis Sci 1998; 75: 30-36.
3. Young MD and Benjamin WJ. Oxygen permeability of the hypertransmissible contact lenses. Eye Contact Lens 2003; 29 (1s): S17-S21.

Contact

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