FIELD APPLICATION REPORT

FT-IR Spectroscopy

Determination of Water Content of Contact Lenses Using FT-NIR

Introduction

Quality assurance of the water content of contact lenses is needed to ensure comfort and performance for the wearer. Historically, water content in contact lenses has been determined gravimetrically and analysis takes about twelve hours per sample. In contrast, FT-NIR determination takes about two minutes per sample. This paper describes how FT-NIR increases speed of analysis while maintaining equivalence with the gravimetric technique.

Experimental

Samples were run on a PerkinElmer® Spectrum™ 100N FT-NIR System. The instrument was fitted with a custom mount that used the lens mount on a sample card*. Samples were run in transmission mode. The background was run with fixture in place and then samples were run. The lens was taken out of the package and mounted on the fixture. Excess water was drawn off using a Kimwipe®. An accumulation of four scans was taken for each sample and were scanned from 10000 to 4000 cm^{-1}. Figure 2 shows the spectra of the six different lens types.

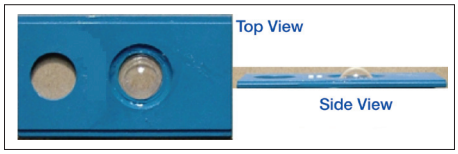

Figure 1. Contact lens mount.

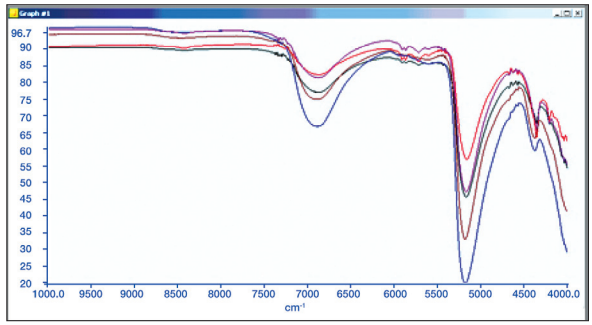

Figure 2. Spectra of 6 different lens types.

* The PerkinElmer Frontier system supercedes the Spectrum 100N.
The Frontier NIR configuration delivers equivalent capability to the Spectrum 100N.

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The samples were processed through the PerkinElmer QUANT+™ (Principle Component Analysis) program and results recorded. Calibration was done on five standards from different types of contact lenses ranging from 24-58% water.

Analysis was run using the PerkinElmer QUANT+ software package. This package is a multi-component quantitative analysis package based on principal component regression. For improved data pre-processing, extensive data pre-treatment algorithms are available within QUANT+ that have been further enhanced with Standard Normal Variate (SNV) and de-tending (DT), state-of-the-art algorithms for NIR method development. In addition to measuring concentrations, Spectrum QUANT+ can relate spectral data to physical properties of the sample being analyzed. Up to fifteen properties may be determined and up to 150 standards may be used in the calibration set. The analytical wavelength range was from 7957 to 4527 cm^{-1} (Figure 3).

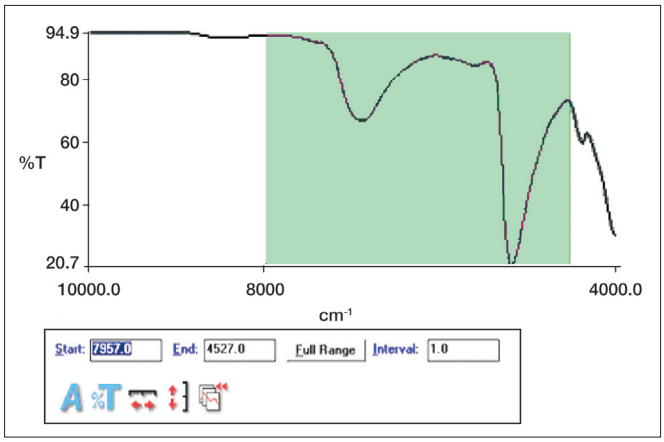

Figure 3. Analytical wavelength rage set from 7957 to 4527 cm^{-1}.

Table 1. **Results of Predicted vs. Specified Water Content Sample of Contact Lenses.**

Sample #	Type 1 (58%)	Type 2 (48%)	Type 3 (48%)	Type 4 (37%)	Type 5 (24%)
1	57.84	47.94	48.41	36.75	24.93
2	57.7	48.19	46.58	36.57	24.5
3	57.72	49.86	48.71	36.86	23.48
4	57.47	48.45	48	36.98	24.27
5	57.87	46.35	48.03	37.79	22.86
6	57.78	48.28	49.34	37.07	23.89
Average	**57.81**	**48.11**	**48.875**	**36.91**	**24.41**
StdDev	**0.143**	**1.123**	**0.926**	**0.423**	**0.744**

Results

The results of the principal component regression analysis are summarized in Figure 4.

Conclusion

The results were within 1% of the specified value. As expected, the greatest variation was at the lower end with 24% water content showing a standard deviation of .7 or about 3.4%. The remaining lenses showed ~1% variation or less. Accuracy is better than reported since all of the error in the analysis was assigned to the FT-NIR measurement technique. The samples were compared to the specified value and not an independently determined value of the standards. Samples can be run in about 2 minutes.

This NIR technique is a fast method for determining the water content of contact lenses to an accuracy of ~1% assuming precise mounting of the sample on the holder and removal of the excess surface water.

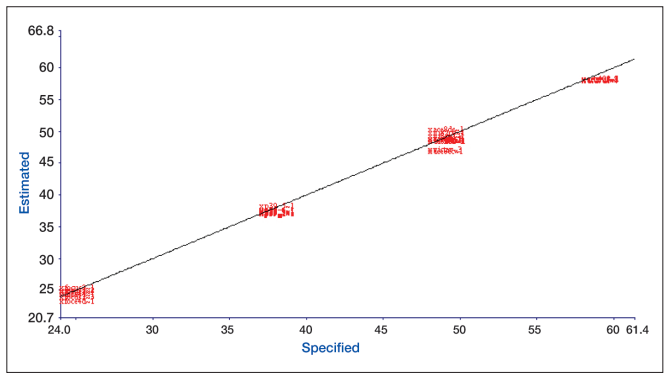

Figure 4. Principle component analysis of water content of contact lenses.

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