



Application Note AN-NIR-095

Quality Control of Hand Sanitizers

Multiparameter determination within one minute

The most effective hand sanitizers contain between 62–95% alcohol. Alcohols are effective against most vegetative forms of bacteria, fungi, and enveloped viruses, but are ineffective against bacterial spores. The addition of hydrogen peroxide (3%) to the product may solve this, but due to its corrosive nature it must be handled with caution during production. Additionally, water and small amounts of emollient (e.g. glycerol) are added to protect the skin. Depending on the exact percentage of these constituents, hand sanitizer is either found in a liquid

or gel form. Determination of the concentrations of these reagents is typically performed with gas chromatography (for glycerol and ethanol), Karl Fischer titration (for water), and redox titration (for H_2O_2). The disadvantage is that two different methods are needed which are time-consuming and require chemical reagents. Near-infrared spectroscopy (NIRS) on the other hand allows for the **rapid and reliable simultaneous quantification** of ethanol, glycerol, hydrogen peroxide, and water content in hand sanitizer formulations.

EXPERIMENTAL EQUIPMENT

A total of 98 samples of hand sanitizer gel with different concentrations of glycerol (0.5–3 w/w %), ethanol (70–85 w/w %), and water (20–22 w/w %) were collected to create a prediction model for quantification. A total of 91 samples of liquid hand sanitizer used for sanitizing wipes were measured with different concentrations of ethanol (70–95 w/w %), water (2–40 w/w %), and hydrogen peroxide (0–4 w/w %). All samples were measured with a DS2500 Liquid Analyzer in transmission mode (400–2500 nm). Reproducible spectrum acquisition was achieved using the built-in temperature control at 40 °C: For convenience, disposable vials with a pathlength of 8 mm were used, which made cleaning of the sample vessels unnecessary. The Metrohm software package Vision Air Complete was used for all data acquisition and prediction model development.



Figure 1. DS2500 Liquid Analyzer and a sample filled in a disposable vial.

Table 1. Hardware and software equipment overview

| Equipment | Metrohm number |
|--------------------------|----------------|
| DS2500 Liquid Analyzer | 2.929.0010 |
| DS2500 Holder 8 mm vials | 6.7492.020 |
| Disposable vials, 8 mm | 6.7402.000 |
| Vision Air 2.0 Complete | 6.6072.208 |

RESULTS

All measured Vis-NIR spectra (**Figure 2**) were used to create a prediction model for quantification of the key quality parameters of gel and liquid sanitizer formulations. The quality of the prediction model was evaluated using correlation diagrams, which display a

very high correlation between the Vis-NIR prediction and the reference values. The respective figures of merit (FOM) display the expected precision of a prediction during routine analysis.

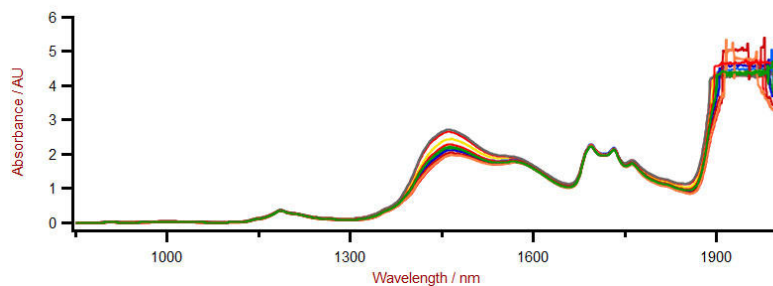


Figure 2. Vis-NIR spectra hand sanitizer gel samples analyzed on a DS2500 Liquid Analyzer.

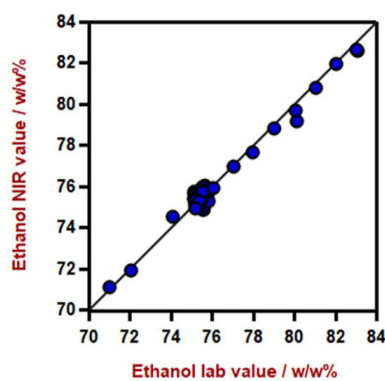


Figure 3. Correlation diagram for the prediction of ethanol content in hand sanitizer gel using a DS2500 Liquid Analyzer. The lab value was evaluated using gas chromatography.

Table 2. Figures of merit for the prediction of ethanol content in hand sanitizer gel using a DS2500 Liquid Analyzer.

| Figures of Merit | Value |
|------------------------------------|-----------|
| R^2 | 0.9832 |
| Standard Error of Calibration | 0.33 w/w% |
| Standard Error of Cross-Validation | 0.37 w/w% |

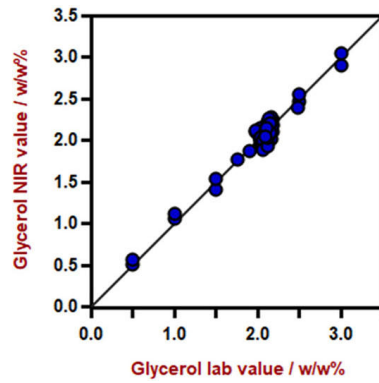


Figure 4. Correlation diagram for the prediction of glycerol content in hand sanitizer gel using a DS2500 Liquid Analyzer. The lab value was evaluated by gas chromatography.

Table 3. Figures of merit for the prediction of glycerol content in hand sanitizer gel using a DS2500 Liquid Analyzer.

| Figures of Merit | Value |
|------------------------------------|-----------|
| R^2 | 0.9632 |
| Standard Error of Calibration | 0.08 w/w% |
| Standard Error of Cross-Validation | 0.11 w/w% |

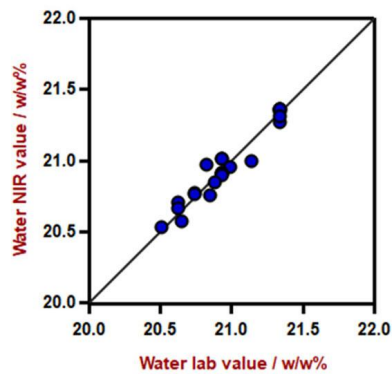


Figure 5. Correlation diagram for the prediction of water content in hand sanitizer gel using a DS2500 Liquid Analyzer. The lab value was evaluated by Karl Fischer titration.

Table 4. Figures of merit for the prediction of water content in hand sanitizer gel using a DS2500 Liquid Analyzer.

| Figures of Merit | Value |
|------------------------------------|-----------|
| R ² | 0.941 |
| Standard Error of Calibration | 0.07 w/w% |
| Standard Error of Cross-Validation | 0.09 w/w% |

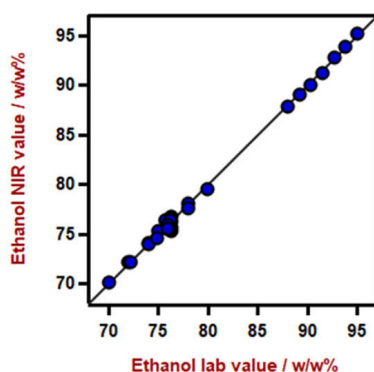


Figure 6. Correlation diagram for the prediction of ethanol content in hand sanitizer wipes using a DS2500 Liquid Analyzer. The lab value was evaluated by gas chromatography.

Table 5. Figures of merit for the prediction of ethanol content in hand sanitizer wipes using a DS2500 Liquid Analyzer.

| Figures of Merit | Value |
|------------------------------------|-----------|
| R ² | 0.9964 |
| Standard Error of Calibration | 0.36 w/w% |
| Standard Error of Cross-Validation | 0.36 w/w% |

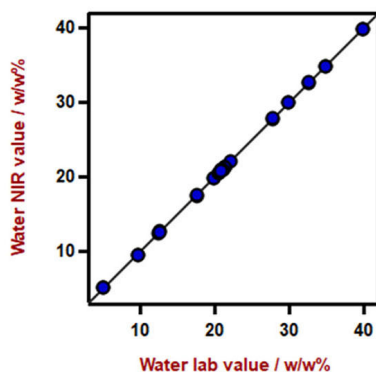


Figure 7. Correlation diagram for the prediction of water content in hand sanitizer wipes using a DS2500 Liquid Analyzer. The lab value was evaluated by Karl Fischer titration.

Table 6. Figures of merit for the prediction of water content in hand sanitizer wipes using a DS2500 Liquid Analyzer.

| Figures of Merit | Value |
|------------------------------------|-----------|
| R^2 | 0.9999 |
| Standard Error of Calibration | 0.12 w/w% |
| Standard Error of Cross-Validation | 0.18 w/w% |

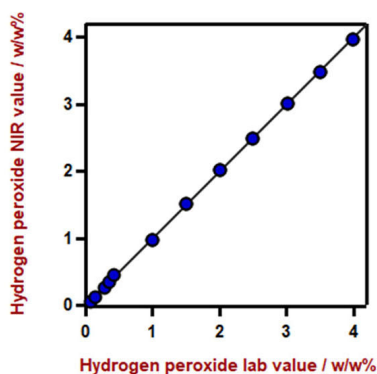


Figure 8. Correlation diagram for the prediction of hydrogen peroxide content in hand sanitizer wipes using a DS2500 Liquid Analyzer. The lab value was evaluated by permanganate titration.

Table 7. Figures of merit for the prediction of hydrogen peroxide content in hand sanitizer wipes using a DS2500 Liquid Analyzer.

| Figures of Merit | Value |
|------------------------------------|-----------|
| R ² | 0.9986 |
| Standard Error of Calibration | 0.05 w/w% |
| Standard Error of Cross-Validation | 0.06 w/w% |

CONCLUSION

This application note demonstrates the feasibility to determine multiple key parameters of the quality control of liquid and gel-type hand sanitizer products with NIR spectroscopy. Vis-NIR spectroscopy enables a

fast alternative to primary methods with high accuracy, and therefore represents a suitable alternative to the standard determination methods.

Table 8. Time to result overview for the different parameters

| Parameter | Metod | Time to result |
|-------------------|------------------------|--|
| Ethanol | GC | 5 minutes (preparation) + 5 minutes (GC) |
| Glycerol | GC | 5 minutes (preparation) + 5 minutes (GC) |
| Water | Karl Fischer titration | 5 minutes |
| Hydrogen peroxide | Permanganate titration | 5 minutes |

CONTACT

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DS2500 Liquid Analyzer

Robuste Nahinfrarotspektroskopie für die Qualitätskontrolle im Labor sowie im Produktionsumfeld.

Der DS2500 Liquid Analyzer ist die bewährte, flexible Lösung für die Routineanalytik von Flüssigkeiten entlang der gesamten Produktionskette. Das robuste Design macht den DS2500 Liquid Analyzer unempfindlich gegen Staub, Feuchtigkeit, und Vibrationen und damit hervorragend geeignet für den Einsatz im rauen Produktionsumfeld.

Der DS2500 Liquid Analyzer deckt den gesamten Spektralbereich von 400 bis 2500 nm ab, heizt Proben bis auf 80°C hoch und ist kompatibel mit verschiedenen Einwegvials und Quartzküvetten. Der somit auf Ihre individuellen Probenanforderungen anpassbare DS2500 Liquid Analyzer unterstützt Sie genaue und reproduzierbare Ergebnisse in weniger als einer Minute zu erhalten. Mit Hilfe der integrierten Probenhaltererkennung und der selbsterklärenden Vision Air Software wird ausserdem eine einfache und sichere Bedienung durch den Anwender gewährleistet.

Im Falle grösserer Probenmengen kann die Produktivität durch den Einsatz einer Durchflusszelle in Kombination mit einem Metrohm Probenroboter erheblich gesteigert werden.



Vision Air 2.0 Complete

Vision Air - Universelle Spektroskopie Software.

Vision Air Complete ist eine moderne und einfach zu bedienende Softwarelösung für den Einsatz im regulierten Umfeld.

Die Vorteile von Vision Air im Überblick:

- Individuelle Softwareanwendungen mit angepassten Nutzeroberflächen gewährleisten eine intuitive und einfache Bedienung
- Einfache Erstellung und Wartung von Arbeitsvorschriften
- SQL Datenbank für ein sicheres und einfaches Datenmanagement

Die Version Vision Air Complete (66072208) beinhaltet alle Anwendungen für die Qualitätssicherung mittels Vis-NIR Spektroskopie:

- Anwendung für das Instrumenten- und Datenmanagement
- Anwendung für die Methodenentwicklung
- Anwendung für die Routineanalyse

Weitere Vision Air Complete Lösungen:

- 66072207 (Vision Air Network Complete)
- 66072209 (Vision Air Pharma Complete)
- 66072210 (Vision Air Pharma Network Complete)



DS2500 Halter für 8 mm Einwegvials

Intelligenter Halter für die Einwegvials aus Glas mit 8 mm Durchmesser