



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  $\text{H}_2\text{O}_2$ ). 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.

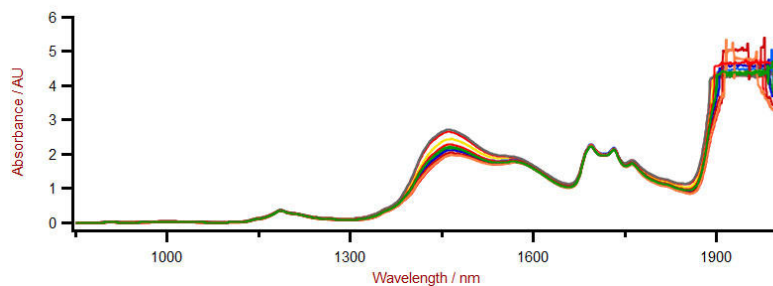
**Table 1.** Hardware and software equipment overview

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

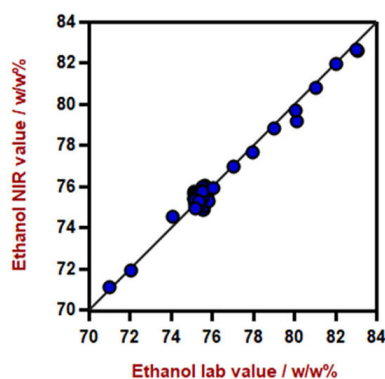
## RESULTS

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.



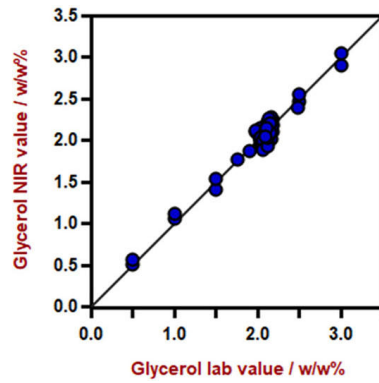
**Figure 2.** Vis-NIR spectra hand sanitizer gel samples analyzed on a DS2500 Liquid Analyzer.



**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.

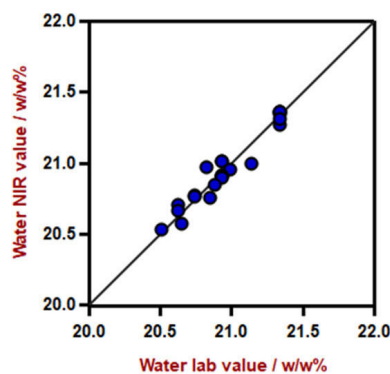
Figures of Merit	Value
$R_2$	0.9832
Standard Error of Calibration	0.33 w/w%
Standard Error of Cross-Validation	0.37 w/w%



**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.

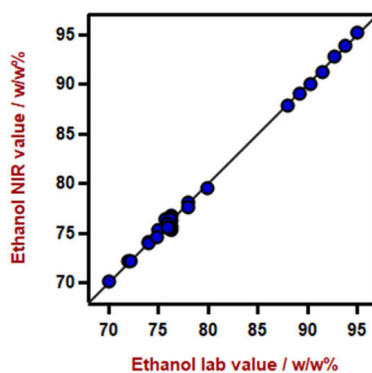
Figures of Merit	Value
$R_2$	0.9632
Standard Error of Calibration	0.08 w/w%
Standard Error of Cross-Validation	0.11 w/w%



**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.

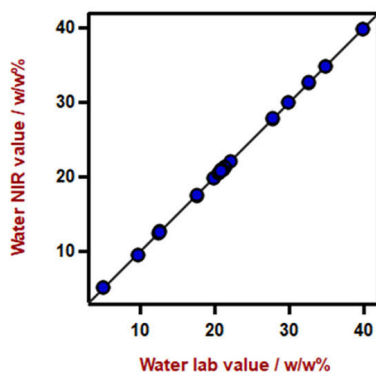
Figures of Merit	Value
$R_2$	0.941
Standard Error of Calibration	0.07 w/w%
Standard Error of Cross-Validation	0.09 w/w%



**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.

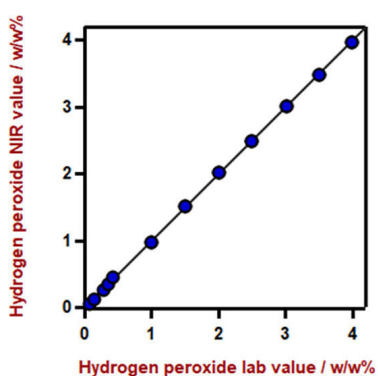
Figures of Merit	Value
$R_2$	0.9964
Standard Error of Calibration	0.36 w/w%
Standard Error of Cross-Validation	0.36 w/w%



**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

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### DS2500 Liquid Analyzer

Spectroscopie proche infrarouge robuste pour le contrôle qualité en laboratoire et en environnement de production.

L'analyseur DS2500 Liquid Analyzer est la solution éprouvée et souple destinée aux analyses de routine d'échantillons liquides, tout au long de la chaîne de fabrication. Sa conception robuste fait du DS2500 Liquid Analyzer un appareil insensible à la poussière, à l'humidité et aux vibrations, et donc particulièrement adapté aux rudes conditions d'un environnement de production.

Le DS2500 Liquid Analyzer couvre l'ensemble de la gamme spectrale de 400 à 2500 nm, chauffe les échantillons jusqu'à 80 °C et est compatible avec divers flacons à usage unique et cuves en quartz. Le DS2500 Liquid Analyzer, lequel s'adapte à vos exigences individuelles en matière d'échantillons, vous permet d'obtenir des résultats précis et reproductibles en moins d'une minute. Avec sa détection du support d'échantillon intégrée et le logiciel Vision Air intuitif, un maniement simple et sûr est également garanti pour l'utilisateur.

En présence de grandes quantités d'échantillons, l'utilisation d'une cellule à flux continu associée à un robot passeur d'échantillons Metrohm peut augmenter considérablement la productivité.





### Vision Air 2.0 Complete

Vision Air - logiciel universel de spectroscopie.

Vision Air Complete est une solution logicielle moderne et simple d'utilisation pour une application dans un environnement réglementé.

Aperçu des avantages de Vision Air :

- Des applications logicielles individuelles avec interface utilisateur adaptée sont le garant d'un maniement intuitif et simple
- Établissement et suivi simples des procédures de travail
- Base de données SQL pour une gestion sûre et simple des données

La version Vision Air Complete (66072208) comprend toutes les applications d'assurance qualité par spectroscopie Vis-NIR :

- Application de gestion des instruments et des données
- Application de développement de méthodes
- Application d'analyse de routine

Autres solutions Vision Air Complete :

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



### DS2500 - Support pour flacons à usage unique 8 mm

Support intelligent pour flacons en verre à usage unique de 8 mm de diamètre