APPLICATION BRIEF

UV/Vis Spectroscopy

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Quantification of Sodium Hypochlorite in Disinfectants

Introduction

Figure 1. PerkinElmer LAMBDA 365 UV/Vis Spectrometer.

Sodium hypochlorite is one of the most common disinfectants used in both domestic and commercial settings due to its favorable properties including low cost and broad-spectrum antimicrobial activity.[1] In addition, it has been included on the environmental protection agency (EPA) list of disinfectants recommended for use against COVID-19. This has resulted in a sharp rise in the production and use of sodium hypochlorite for disinfecting household and workplace environments. While safe handling practices need to be implemented along with the use of personal protective equipment (PPE), there is also a need for quality control to ensure manufacturers stay within the acceptable limits of sodium hypochlorite in domestic and industrial-strength bleaches to limit exposure and damage to humans.[2]

The standard method for the determination of hypochlorite is an iodometric titration which, despite being very useful, requires several chemical reagents and can therefore be time consuming and costly when running many samples. In contrast to this, UV/Vis spectroscopy allows samples to be measured within 30 seconds and without the need for several different reagents. The PerkinElmer LAMBDA® 365 UV/Vis spectrometer (Figure 1) provides a simple and fast solution for the measurement of sodium hypochlorite in a QA/QC setting where speed and accuracy are vitally important.

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Experimental Conditions

Chemical reagents were purchased from Merck™ and used as received. In order to produce the calibration curve, an iodometric titration is required in order to standardize the stock sodium hypochlorite solution. In the case of this experiment, the solution was found to contain 8.13% sodium hypochlorite.

The calibration solutions were made, by volume to 50 mL, to cover a range of 0.001 – 0.05 % NaOCl. Each solution measured by UV/Vis also included a 1 mL aliquot of 10 % NaOH solution. This was added in order to ensure the equilibrium between hypochlorite and hypochlorous acid (shown below) was established on the side of hypochlorite (the species responsible for the instrument response).

$$HOCl \leftrightharpoons H^+ + ClO^-$$

In addition to the calibration solutions, three independent validation solutions were also produced using the same method. The test solution (a sample of commercial bleach) was prepared by 200-fold dilution and addition of the 1 mL aliquot of NaOH solution.

All samples were measured using the PerkinElmer LAMBDA 365 UV/Vis spectrometer using the instrumental parameters shown in Table 1. Quantification was carried out using the absorbance at 292 nm.

Table 1. Instrumental parameters used for the measurement of sodium hypochlorite in disinfectants.

Parameter	Value
Range	250 – 500 nm
Band Width	1.0 nm
Data Interval	1.0 nm
Scan Rate	600 nm/min

Calibration

The calibration curve was constructed by plotting the absorbance at 292 nm against concentration of sodium hypochlorite. The UV/Vis spectra of the calibration samples are shown in Figure 2.

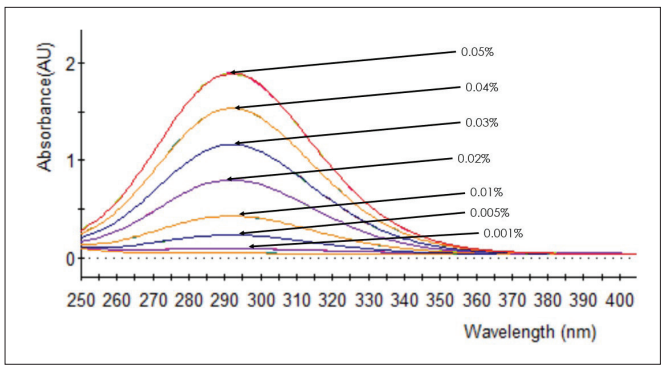

Figure 2. UV/Vis spectra of NaOCl calibration standards.

The calibration curve is shown in Figure 3. The R^2 value was found to be 0.9999, indicating a high degree of linearity.

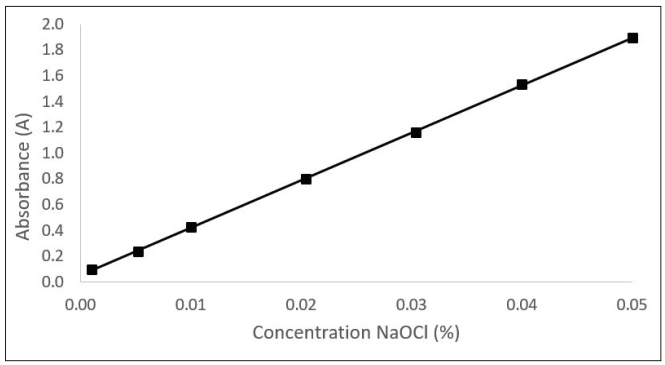

Figure 3. Plot of absorbance at 292 nm against concentration of NaOCl.

Validation

This method was validated with three independent validation samples as well as a sample of commercial bleach. The results from this validation are shown in Table 2.

Table 2. Validation Results.

Sample	Calculated Concentration (%)
0.003 %	0.0028 ± 0.00001
0.015 %	0.015 ± 0.00004
0.042 %	0.043 ± 0.0001
Bleach Sample	0.027 ± 0.00005

The concentration of sodium hypochlorite in the bleach sample was found to be 5.40% when corrected for dilution factor. 10 replicates of the 0.015% validation sample were measured in order to determine the precision of this method. The relative standard deviation (RSD) was found to be 0.07 %, indicating a high level of precision.

In addition, five replicates of a blank solution were measured in order to determine the limit of detection (LOD) of this method using the equation below.

$$LOD = yB + 3sB$$

The limit of detection was subsequently found to be 0.0002 % NaOCl, indicating a high level of sensitivity in this method.

Conclusion

UV/Vis spectroscopy provides a fast and accurate method for the quantification of sodium hypochlorite in disinfectants. This will allow analysts working in a QA/QC laboratory to save time and expenditure. The PerkinElmer LAMBDA 365 offers a rapid yet high performance solution for those aiming to quantify sodium hypochlorite in disinfectants and may be used in conjunction with either UVWinLab or UVExpress software. UVWinLab allows users to have maximum control over instrument parameters and offers advanced data analysis options. Conversely, less experienced users may use UVExpress which offers a simple point-and-click solution for both the instrumental control and data analysis.

References

1. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/disinfection-methods/chemical.html (accessed 12/08/2020).
2. https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19 (accessed 12/08/2020).

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