



Comparative Performance Study

July 2017, Ver 2

CHEMetrics, Inc. Indigo Ozone Vacu-vials® for Low Range Measurement

Executive Summary

Bottled water manufacturers routinely measure ozone levels at ≤ 0.25 ppm ozone. A study was conducted by CHEMetrics, Inc. to evaluate the performance of the K-7433 Ozone Vacu-vials® Test Kit (test range 0 - 0.75 ppm ozone) specifically at concentrations of interest in the bottled water industry. In this study, comparison testing was performed between the CHEMetrics K-7433 Ozone Vacu-vials® Kit and the Hach 2516025 Ozone AccuVac® Ampules, LR (test range 0.01 - 0.25 ppm).

This Comparative Performance Study is issued as a supplement to “CHEMetrics, Inc. Indigo Ozone Vacu-vials® Kit” Performance Report (July 2017, Ver 4, available at www.chemetrics.com).

Summary of Method

The CHEMetrics K-7433 Ozone Vacu-vials® method employs the indigo colorimetric chemistry packaged in vacuum-sealed, self-filling ampoules. In this method, indigo trisulfonate (blue dye) immediately reacts with ozone when the tip of the Vacu-vials® ampoule is snapped in the sample being tested. The color of the blue reagent in the ampoule decreases in intensity in proportion to the amount of ozone present in the sample. The test range for K-7433 is 0 - 0.75 ppm (mg/L) ozone (O_3).

The CHEMetrics K-7433 Ozone Vacu-vials® Kit employs an innovative “self-zeroing” feature to eliminate the need to generate a reagent blank. Each Vacu-vials® ampoule is measured before and after being snapped in sample. The change in color intensity, measured in absorbance, between reagent in the un-snapped and snapped ampoule is used to determine the ozone concentration of the sample.

CHEMetrics, Inc. offers an Ozone Single Analyte Photometer (SAM), I-2022, which is programmed and calibrated for use with the K-7433 Ozone Vacu-vials® Kit. When the K-7433 Vacu-vials® ampoules are read in the I-2022 photometer, the unit displays test results in parts per million (mg/L) ozone.

Alternatively, the K-7433 Ozone Vacu-vials® Kit can be used with any spectrophotometer that accepts a 13-mm diameter round cell and has a “Z dimension” (beam height) of 15 mm or less. Results are obtained at 600 nm. Instrument results in absorbance are converted to ppm ozone using the calibration equation provided in the test kit instructions or the Concentration Calculator available on the CHEMetrics website.

Low Range Performance Evaluation

Comparative Testing in Distilled Water and Hinckley Springs® Purified Water¹

Comparison testing was performed between the CHEMetrics Ozone Vacu-vials® Kit (Catalog No. K-7433) and the Hach Ozone AccuVac® Ampules, LR (Hach Product No. 2516025). Concentration levels of ozone were generated in both distilled water and Hinckley Springs® Purified Water with an Ozotech Inc. Model AIM 20 SS Ozonizer (Serial No. AE 105) with pure oxygen gas standard as input. The actual ozone concentrations were determined using a UV method as a reference; the ozone was measured with a Lambda 25 UV/Visible Spectrophotometer (Serial No. 101N7073005; certification date Nov. 2015) at 258 nm using matched 10 cm cells. Absorbance values were converted to ppm ozone using the molar absorptivity value ($2950 \text{ M}^{-1} \text{ cm}^{-1}$) and the formula weight (48 g/mole) of ozone.

Three replicates from a single manufacturing lot were measured at each ozone concentration. Testing with distilled water and Hinckley Springs® Purified Water was performed using Hach Models DR3900 and DR2800 Spectrophotometers. Testing with Hinckley Springs® Purified Water was also performed



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with three CHEMetrics I-2022 SAMs, using CHEMetrics Ozone Vacu-vials® Kit only. Data for distilled water testing are presented in Table 1 and Figure 1. Data for purified water testing are presented in Tables 2 and 3 and Figure 2.

Product Performance

Precision

The precision data below is based on replicate analysis of ozone standards prepared in deionized water. Standards were analyzed on a spectrophotometer or CHEMetrics Single Analyte Photometer (I-2022 SAM) during ideal testing conditions. The 95% confidence interval of the distribution was determined from the standard deviation.

Instrument Platform	Standard Concentration	Precision 95% Confidence Interval
Spectrophotometer	0.16 mg/L	0.15 - 0.17 mg/L
Spectrophotometer	0.54 mg/L	0.52 - 0.56 mg/L
I-2022 SAM	0.16 mg/L	0.15 - 0.17 mg/L
I-2022 SAM	0.54 mg/L	0.52 - 0.57 mg/L

Sensitivity with a spectrophotometer

Concentration change per 0.010 Abs change: 0.02 mg/L

Method References

Bader H. and J. Hoigné, "Determination of Ozone in Water by the Indigo Method," Water Research Vol. 15, pp. 449-456, 1981

APHA Standard Methods, 22nd ed., Method 4500-O₃ B - 1997

Method Applications

Potable water, bottled water

Shelf Life

When stored in the dark at room temperature, the shelf life of the K-7433 Vacu-vials® Kit is 1 year.

¹Bottled by DS Services of America, Inc., Atlanta, GA 30339. Minerals added for taste, 2.5 gallon bottle, bottled on 12/16/15 10:41, Best By Date: 06/16/17

Vacu-vials® is a registered trademark of CHEMetrics, Inc.

AccuVac® is a registered trademark of Hach Company.

Hinckley Springs® is a registered trademark of DS Services of America, Inc.

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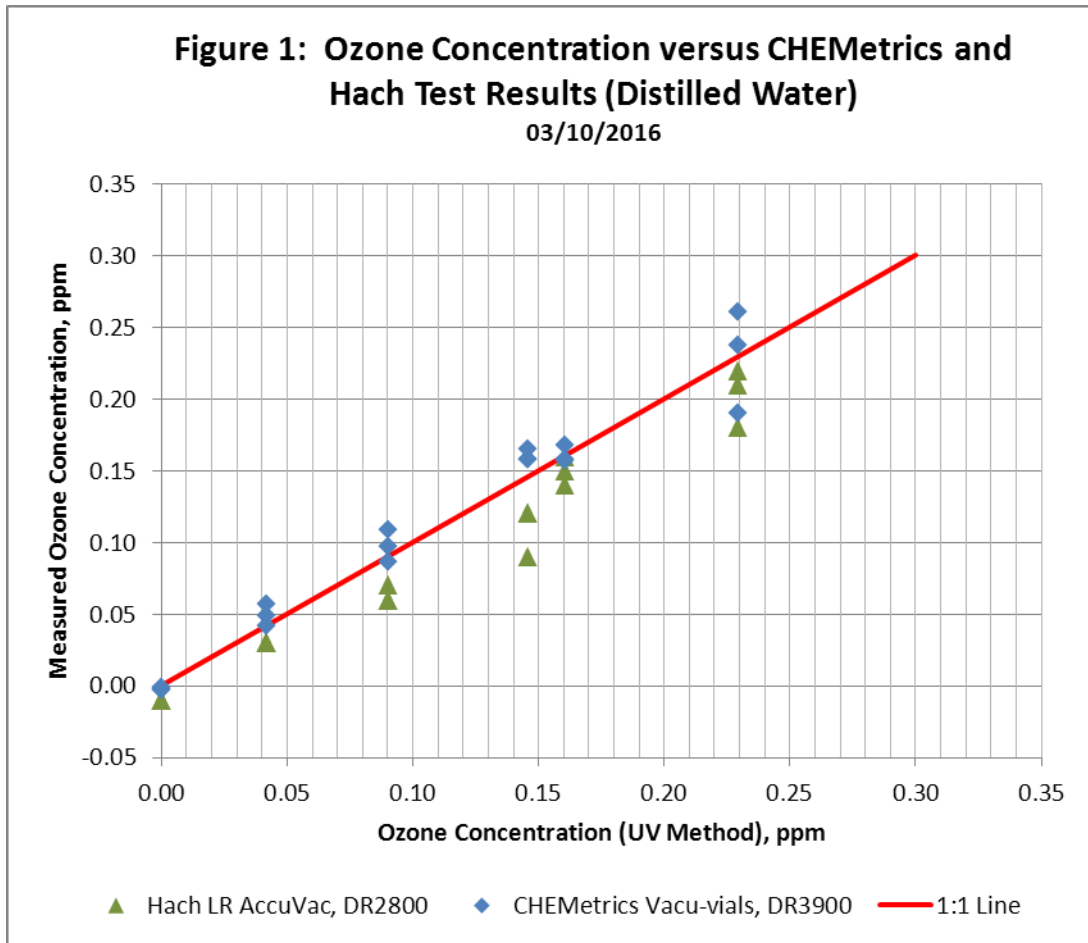
Table 1: Analysis of Distilled Water with CHEMetrics and Hach Ozone Test Kits

Analysis Date: 03/10/2016

	CHEMetrics K-7433 Vacu-vials® Kit, Lot # 86108 DR3900 Spectrophotometer, SN 1392969			Hach LR AccuVac®, Lot # A6015 DR2800 Spec., SN 1242726	
Ozone Conc. (UV Method) ppm	Absorbance Change @ 600 nm	Result, ppm 2.87 * Abs. Change	Error, ppm	Direct Read Result, ppm (Program 454)	Error, ppm
0.00	-0.001	0.00	0.00	-0.01	-0.01
0.00	-0.001	0.00	0.00	-0.01	-0.01
0.00	-0.001	0.00	0.00	-0.01	-0.01
0.04	0.020	0.06	0.02	0.03	-0.01
0.04	0.017	0.05	0.01	0.03	-0.01
0.04	0.015	0.04	0.00	0.03	-0.01
0.09	0.038	0.11	0.02	0.07	-0.02
0.09	0.030	0.09	0.00	0.06	-0.03
0.09	0.034	0.10	0.01	0.06	-0.03
0.15	0.058	0.17	0.02	0.09	-0.06
0.15	0.055	0.16	0.01	0.12	-0.03
0.14	0.055	0.16	0.02	0.12	-0.02
0.16	0.058	0.17	0.01	0.14	-0.02
0.16	0.055	0.16	0.00	0.16	0.00
0.16	0.055	0.16	0.00	0.15	-0.01
0.23	0.091	0.26	0.03	0.21	-0.02
0.23	0.083	0.24	0.01	0.22	-0.01
0.23	0.066	0.19	-0.04	0.18	-0.05



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Table 2: Analysis of Hinckley Springs® Purified Water Using CHEMetrics K-7433 Ozone Kit with I-2022 Single Analyte Photometer

Analysis Date: 05/02/2016

	CHEMetrics K-7433 Vacu-vials® Kit, Lot # 86108 I-2022 Direct Read Result, ppm			Error, ppm		
Ozone Conc. (UV Method) ppm	SN 13/09943	SN 13/09942	SN 15/25928	SN 13/09943	SN 13/09942	SN 15/25928
0.00	0.03	-0.03	0.00	0.03	-0.03	0.00
0.00	0.05	0.00	0.01	0.05	0.00	0.01
0.00	0.04	-0.01	0.00	0.04	-0.01	0.00
0.04	0.08	0.06	0.06	0.04	0.02	0.02
0.04	0.05	0.03	0.03	0.01	-0.01	-0.01
0.04	0.05	0.04	0.04	0.01	0.00	0.00
0.08	0.09	0.07	0.08	0.01	-0.01	0.00
0.08	0.10	0.08	0.08	0.02	0.00	0.00
0.08	0.10	0.08	0.08	0.02	0.00	0.00
0.14	0.16	0.13	0.13	0.02	-0.01	-0.01
0.14	0.18	0.15	0.16	0.04	0.01	0.02
0.14	0.14	0.12	0.13	0.00	-0.02	-0.01
0.19	0.19	0.14	0.16	0.00	-0.05	-0.03
0.18	0.17	0.13	0.14	-0.01	-0.05	-0.04
0.18	0.18	0.15	0.17	0.00	-0.03	-0.01
0.21	0.22	0.18	0.19	0.01	-0.03	-0.02
0.21	0.22	0.18	0.19	0.01	-0.03	-0.02
0.21	0.24	0.20	0.21	0.03	-0.01	0.00



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Table 3: Analysis of Hinckley Springs® Purified Water with CHEMetrics and Hach Ozone Kits

Analysis Date: 05/02/2016

	CHEMetrics K-7433 Vacu-vials® Kit, Lot # 86108 DR2800 Spectrophotometer, SN 1242726			Hach LR AccuVac®, Lot # A6085 DR3900 Spec., SN 1392969	
Ozone Conc. (UV Method) ppm	Absorbance Change @ 600 nm	Result, ppm 2.87 * Abs. Change	Error, ppm	Direct Read Result, ppm (Program 454)	Error, ppm
0.00	-0.012	-0.04	-0.04	-0.01	-0.01
0.00	-0.006	-0.02	-0.02	-0.01	-0.01
0.00	-0.008	-0.02	-0.02	-0.01	-0.01
0.04	0.013	0.04	0.00	0.02	-0.02
0.04	0.002	0.01	-0.03	0.03	-0.01
0.04	0.002	0.00	-0.04	0.03	-0.01
0.08	0.020	0.06	-0.02	0.06	-0.02
0.08	0.026	0.07	-0.01	0.05	-0.03
0.08	0.020	0.06	-0.02	0.06	-0.02
0.14	0.048	0.14	0.00	0.12	-0.02
0.14	0.057	0.16	0.02	0.12	-0.02
0.14	0.039	0.11	-0.03	0.12	-0.02
0.19	0.053	0.15	-0.04	0.17	-0.02
0.18	0.055	0.16	-0.02	0.17	-0.01
0.18	0.054	0.15	-0.03	0.17	-0.01
0.21	0.070	0.20	-0.01	0.19	-0.02
0.21	0.070	0.20	-0.01	0.18	-0.03
0.21	0.079	0.23	0.02	0.19	-0.02



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