Performance Report

May 2020, Ver 7

CHEMetrics, Inc. Indigo Ozone Vacu-vials® Kit

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 Indigo 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 unsnapped and snapped ampoule is used to determine the ozone concentration of the sample. Kit instructions are presented in Appendix 1.

CHEMetrics, Inc. offers an Ozone Single Analyte Photometer (SAM), I-2022, which is programmed and calibrated for use with the K-7433 Indigo 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. Instructions for use of the I-2022 Photometer are presented in Appendix 2.

Alternatively, the K-7433 Indigo 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.

Method Calibration

Calibration validation data for the I-2022 Ozone SAM Photometer are presented in Table 1 and Figure 1. Four concentration levels of ozone were generated in distilled water with a Model AIM 20 SS Ozonizer (Serial No. AE 105) from Ozotech Inc. using pure oxygen gas standard as input. The ozone was measured with a Lambda 25 UV/Visible Spectrophotometer (Serial No. 101N7073005; certification date October 2013) at 258 nm using matched 10 cm cells. Absorbance values were converted to ppm ozone using the molar absorptivity value (2950 M^{-1} cm^{-1}) and the formula weight (48 g/mole) of ozone. Three replicate K-7433 ampoules from two or three different manufacturing lots (six to nine ampoules per ozone concentration level), were measured on three Ozone SAM Photometers. The calibration for spectrophotometers was generated in a similar manner using a Model DR3900 Spectrophotometer (Serial No. 1392969; certification date August 2014) from Hach Company. Critical analytical instrumentation, including the Lamda 25 and DR3900 spectrophotometers, are subject to annual or biennial calibration inspections using NIST traceable standards according to CHEMetrics' Calibration and Inspection QMS Program.

Method Validation

Comparative Testing

Comparison testing was performed between the CHEMetrics K-7433 Indigo Ozone Vacu-vials® Kit, the Hach Indigo Ozone AccuVac® Ampules, MR (Hach Product No. 2517025) and the CHEMetrics

Performance Report

K-7423 DPD Ozone Vacu-vials® Kit. Four concentration levels of ozone were generated in DASANI® Bottled Water and were analyzed with the three test kits. Data are presented in Figure 2 and Tables 2 through 4. In addition, four concentration levels of ozone were generated in distilled water and were analyzed with the CHEMetrics K-7433 Indigo Ozone Vacu-vials® Kit and the Hach Indigo Ozone AccuVac® Ampules, MR (Figure 3 and Table 5).

Evaluation of Effect of Chlorine

The K-7433 Indigo Ozone Vacu-vials® reagent is formulated with malonic acid to prevent interference from up to at least 10 ppm chlorine. The effect of various concentrations of chlorine was evaluated in the absence of ozone and at approximately 0.67 and 0.14 ppm ozone (Tables 6 through 8 and Figure 4).

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-O_3 B - 1997

Method Applications

Potable water, bottled water

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

Shelf Life

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

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Simplicity in Water Analysis

Table 1: Calibration Validation Data and Statistical Analysis

Ozone I-2022 Single Analyte Photometer Using K-7433 Indigo Ozone Vacu-vials® Kit

	Ozone Concentration		Absorbance Change with I-2022			Test Result, ppm O_3			% Error		
K-7433 Lot #	Abs. with Lambda 25, SN 101N7073005	ppm O_3 = 1.627 * Abs.	SN 13/09943	SN 13/09944	SN 13/09942	SN 13/09943	SN 13/09944	SN 13/09942	SN 13/09943	SN 13/09944	SN 13/09942
83443	0.000	0.00	0.004	0.004	0.004	0.03	0.03	0.03			
83443	0.000	0.00	0.004	0.008	0.008	0.03	0.04	0.04			
83443	0.000	0.00	0.000	0.004	0.004	0.02	0.03	0.03			
83443	0.000	0.00	0.004	0.008	0.008	0.03	0.04	0.04			
83443	0.000	0.00	0.000	-0.004	0.000	0.02	0.01	0.02			
83550	0.000	0.00	0.000	0.000	0.004	0.02	0.02	0.03			
83550	0.000	0.00	0.000	0.004	0.000	0.02	0.03	0.02			
83550	0.000	0.00	0.000	0.004	0.004	0.02	0.03	0.03			
83550	0.000	0.00	0.000	0.004	0.000	0.02	0.03	0.02			
83550	0.000	0.00	-0.008	0.000	-0.004	0.00	0.02	0.01			
83577	0.000	0.00	-0.004	-0.004	-0.004	0.01	0.01	0.01			
83577	0.000	0.00	0.000	0.004	0.004	0.02	0.03	0.03			
83577	0.000	0.00	0.000	0.008	0.004	0.02	0.04	0.03			
83577	0.000	0.00	-0.004	-0.004		0.01	0.01	"LO"			
83577	0.000	0.00	0.004	0.008	0.004	0.03	0.04	0.03			
83443	0.103	0.17	0.055	0.059	0.059	0.16	0.17	0.17	-4.5	1.5	1.5
83443	0.103	0.17	0.062	0.062	0.062	0.18	0.18	0.18	7.5	7.5	7.5
83443	0.103	0.17	0.059	0.059	0.062	0.17	0.17	0.18	1.5	1.5	7.5
83443	0.103	0.17	0.059	0.062	0.051	0.17	0.18	0.15	1.5	7.5	-10.4
83443	0.103	0.17	0.051	0.047	0.047	0.15	0.14	0.14	-10.4	-16.4	-16.4
83550	0.114	0.19	0.062	0.059	0.062	0.18	0.17	0.18	-3.3	-8.7	-3.3
83550	0.114	0.19	0.062	0.062	0.062	0.18	0.18	0.18	-3.3	-3.3	-3.3
83550	0.114	0.19	0.062	0.059	0.059	0.18	0.17	0.17	-3.3	-8.7	-8.7
83550	0.114	0.19	0.066	0.062	0.059	0.19	0.18	0.17	2.0	-3.3	-8.7
83550	0.114	0.19	0.055	0.055	0.055	0.16	0.16	0.16	-14.1	-14.1	-14.1
83577	0.094	0.15	0.059	0.055	0.059	0.17	0.16	0.17	11.6	5.0	11.6
83577	0.094	0.15	0.051	0.051	0.047	0.15	0.15	0.14	-1.6	-1.6	-8.1
83577	0.094	0.15	0.059	0.055	0.055	0.17	0.16	0.16	11.6	5.0	5.0
83577	0.094	0.15	0.047	0.047	0.051	0.14	0.14	0.15	-8.1	-8.1	-1.6
83577	0.094	0.15	0.051	0.047	0.047	0.15	0.14	0.14	-1.6	-8.1	-8.1
83443	0.344	0.56	0.177	0.180	0.173	0.52	0.53	0.51	-7.2	-5.4	-9.0

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	Ozone Concentration		Absorbance Change with I-2022			Test Result, ppm O_3			% Error		
K-7433 Lot #	Abs. with Lambda 25, SN 101N7073005	ppm O_3 = 1.627 * Abs.	SN 13/09943	SN 13/09944	SN 13/09942	SN 13/09943	SN 13/09944	SN 13/09942	SN 13/09943	SN 13/09944	SN 13/09942
83443	0.344	0.56	0.183	0.180	0.186	0.54	0.53	0.55	-3.6	-5.4	-1.8
83443	0.344	0.56	0.173	0.173	0.167	0.51	0.51	0.49	-9.0	-9.0	-12.6
83443	0.344	0.56	0.183	0.180	0.183	0.54	0.53	0.54	-3.6	-5.4	-3.6
83443	0.344	0.56	0.173	0.170	0.167	0.51	0.5	0.49	-9.0	-10.8	-12.6
83550	0.334	0.54	0.177	0.177	0.177	0.52	0.52	0.52	-4.4	-4.4	-4.4
83550	0.334	0.54	0.170	0.170	0.173	0.50	0.50	0.51	-8.1	-8.1	-6.2
83550	0.334	0.54	0.170	0.167	0.167	0.50	0.49	0.49	-8.1	-9.9	-9.9
83550	0.334	0.54	0.180	0.180	0.180	0.53	0.53	0.53	-2.6	-2.6	-2.6
83550	0.334	0.54	0.167	0.170	0.161	0.49	0.50	0.47	-9.9	-8.1	-13.6
83443	0.450	0.73	0.227	0.233	0.236	0.69	0.71	0.72	-5.8	-3.1	-1.7
83443	0.450	0.73	0.221	0.221	0.224	0.67	0.67	0.68	-8.5	-8.5	-7.2
83443	0.450	0.73	0.244	0.247	0.244	0.75	0.76	0.75	2.4	3.8	2.4
83443	0.450	0.73	0.230	0.233	0.230	0.70	0.71	0.70	-4.4	-3.1	-4.4
83443	0.450	0.73	0.230	0.233	0.230	0.70	0.71	0.70	-4.4	-3.1	-4.4
83550	0.429	0.70	0.227	0.227	0.224	0.69	0.69	0.68	-1.0	-1.0	-2.5
83550	0.429	0.70	0.216	0.221	0.216	0.65	0.67	0.65	-6.8	-3.9	-6.8
83550	0.429	0.70	0.221	0.224	0.221	0.67	0.68	0.67	-3.9	-2.5	-3.9
83550	0.429	0.70	0.218	0.218	0.221	0.66	0.66	0.67	-5.3	-5.3	-3.9
83550	0.429	0.70	0.207	0.210	0.204	0.62	0.63	0.61	-11.1	-9.6	-12.5
83577	0.449	0.73	0.236	0.233	0.239	0.72	0.71	0.73	-1.5	-2.9	-0.1
83577	0.449	0.73	0.236	0.239	0.239	0.72	0.73	0.73	-1.5	-0.1	-0.1
83577	0.449	0.73	0.230	0.233	0.233	0.70	0.71	0.71	-4.3	-2.9	-2.9
83577	0.449	0.73	0.230	0.230	0.230	0.70	0.70	0.70	-4.3	-4.3	-4.3
83577	0.449	0.73	0.224	0.221	0.227	0.68	0.67	0.69	-7.0	-8.4	-5.6

SN = Serial Number

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Figure 1: Best Fit Line for Data Generated with Three I-2022 Ozone SAM Photometers Using CHEMetrics K-7433 Indigo Ozone Vacu-vials® Kit

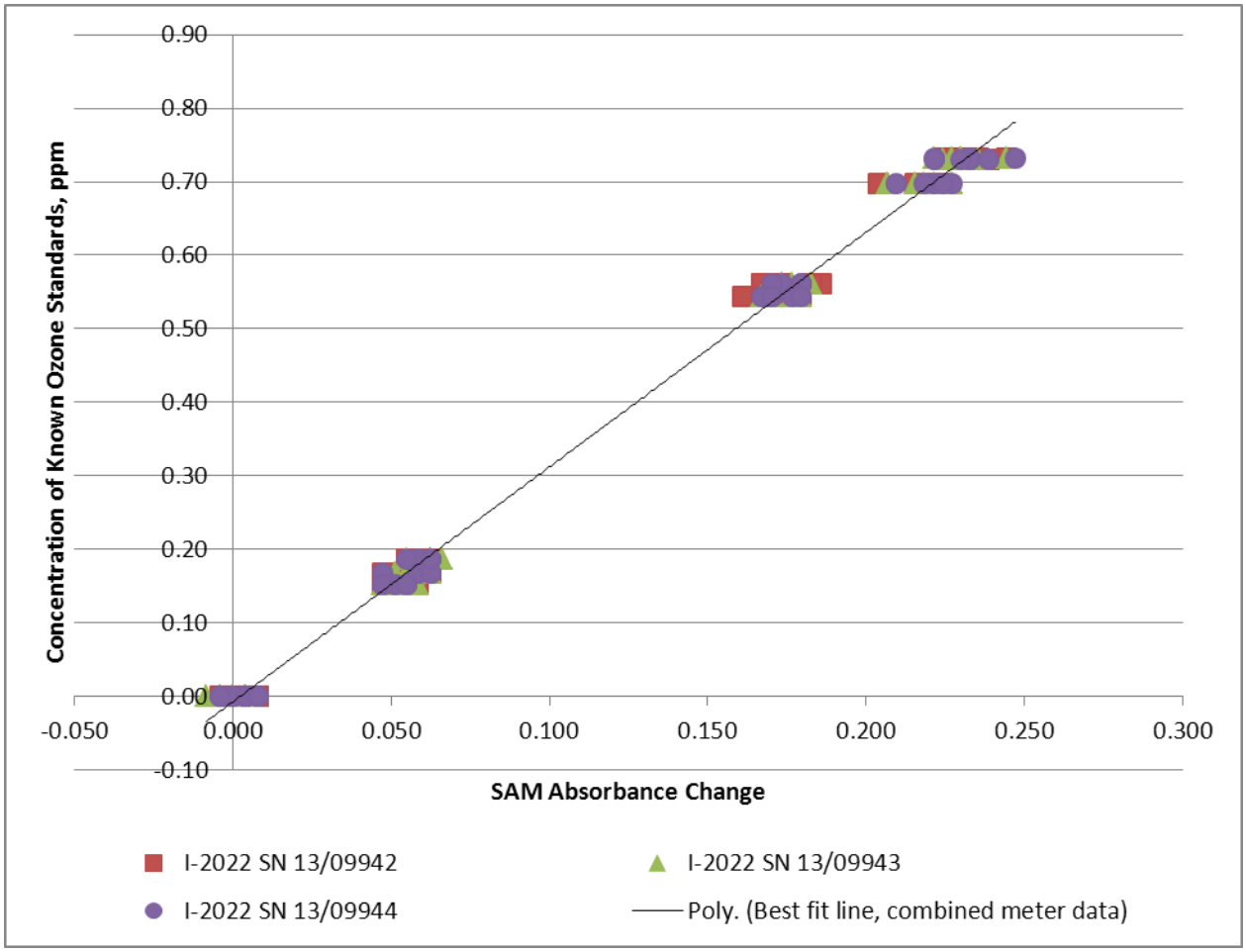

Figure 2: Analysis of DASANI® Bottled Water with Three Ozone Test Kits

CHEMetrics Indigo Vacu-vials®, CHEMetrics DPD Vacu-vials®, Hach Indigo AccuVacs®

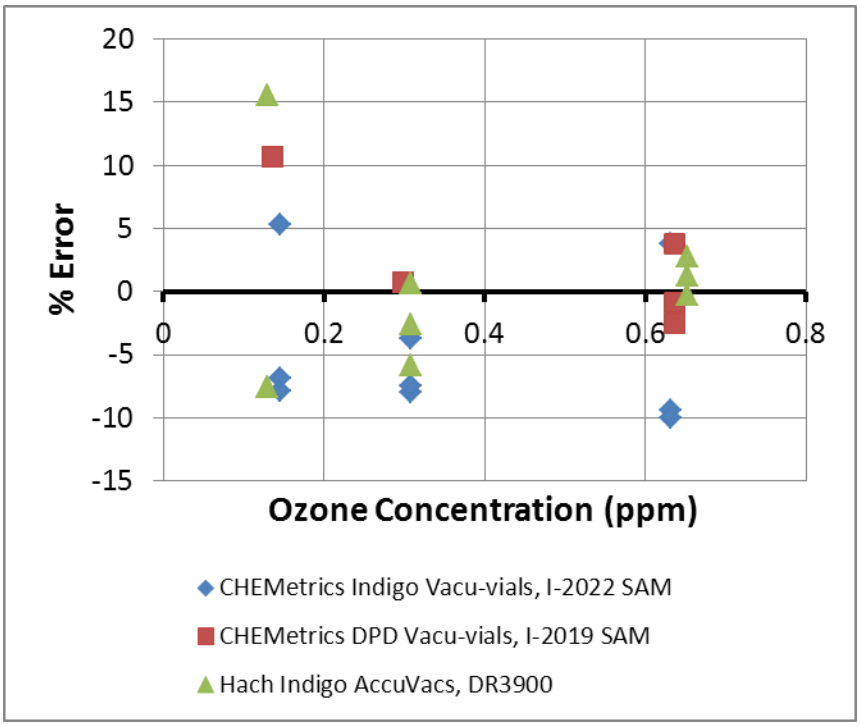

Table 2: Analysis of DASANI® Bottled Water with CHEMetrics Indigo Vacu-vials®

K-7433, Lot # 83443

	DR3900 Spectrophotometer, SN 1392969			I-2022 SAM, SN 13/09943	
Ozone Conc. ppm	**Abs. Change @ 600 nm**	**Result, ppm 2.87*abs change**	**% Error**	**Direct Read Result, ppm**	**% Error**
0.000	-0.003	-0.01		0.01	
	-0.007	-0.02		0.01	
	-0.007	-0.02		0.01	
0.145	0.046	0.13	-10.3	0.13	-10.3
	0.053	0.15	3.4	0.15	3.4
	0.047	0.13	-10.3	0.13	-10.3
0.308	0.114	0.33	7.1	0.30	-2.6
	0.108	0.31	0.6	0.28	-9.1
	0.118	0.34	10.4	0.29	-5.8
0.632	0.216	0.62	-1.9	0.57	-9.8
	0.216	0.62	-1.9	0.57	-9.8
	0.240	0.69	9.2	0.66	4.4

Table 3: Analysis of DASANI Bottled Water with Hach Indigo AccuVac® Ampules

Hach Cat. No. 2517025, Lot # A3311

	DR3900 Spectrophotometer, SN 1392969	
Ozone Conc. ppm	**Direct Read ppm Ozone (Program 455)**	**% Error**
0.000	-0.03	
	-0.04	
	-0.01	
0.130	0.12	-7.5
	0.12	-7.5
	0.15	15.6
0.308	0.29	-5.8
	0.31	0.7
	0.30	-2.6
0.652	0.67	2.8
	0.65	-0.3
	0.66	1.2

Table 4: Analysis of DASANI Bottled Water with CHEMetrics DPD Vacu-vials® Kit

K-7423, Lot # 81059

	DR3900 Spectrophotometer, SN 1392969			I-2019 SAM, SN 11/03298	
Ozone Conc. ppm	**Abs. @ 515 nm**	**Result, ppm $0.67(abs)^2 + 3.10(abs) - 0.04$**	**% Error**	**Direct Read Result, ppm**	**% Error**
0.000	0.008	-0.02		0.05	
	0.011	-0.01		0.03	
0.136	0.051	0.12	-11.8	0.15	10.7
	0.049	0.11	-19.1	0.15	10.7
	0.052	0.12	-11.8	0.15	10.7
0.298	0.106	0.30	0.7	0.30	0.7
	0.103	0.29	-2.7	0.30	0.7
	0.102	0.28	-6.0	0.30	0.7
0.636	0.198	0.60	-5.6	0.63	-0.9
	0.204	0.62	-2.5	0.66	3.8
	0.207	0.63	-0.9	0.62	-2.5

Figure 3: Analysis of Distilled Water with CHEMetrics and Hach Indigo Ozone Kits

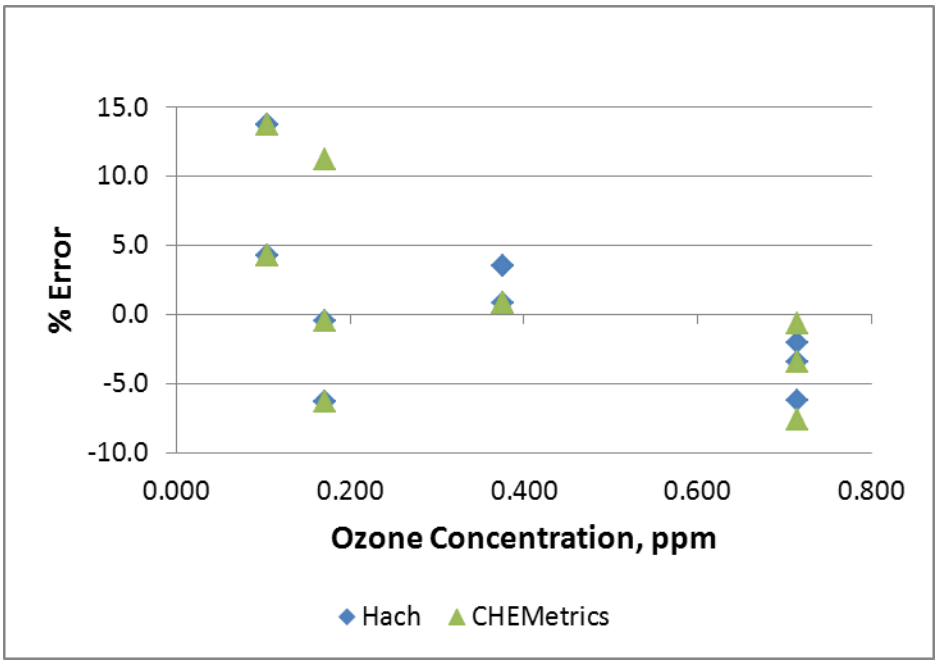

Table 5: Analysis of Distilled Water with CHEMetrics and Hach Indigo Ozone Kits

	Hach AccuVac®, lot # A3166 DR3900, SN 1392969		CHEMetrics K-7433, lot #071113C I-2022, SN 13/09944	
Ozone Conc (ppm)	Direct Read ppm ozone (Program 455)	% Error	Direct Read ppm ozone	% Error
0.105	0.12	13.8	0.12	13.8
	0.12	13.8	0.11	4.3
	0.11	4.3	0.11	4.3
	0.11	4.3	0.11	4.3
	0.12	13.8	0.12	13.8
0.171	0.17	-0.5	0.19	11.3
	0.16	-6.3	0.16	-6.3
	0.16	-6.3	0.17	-0.5
0.377	0.38	0.9	0.38	0.9
	0.39	3.5	0.38	0.9
	0.39	3.5	0.38	0.9
0.715	0.67	-6.2	0.66	-7.6
	0.70	-2.0	0.71	-0.6
	0.69	-3.4	0.69	-3.4

Table 6: Effect of Chlorine on Indigo Ozone Vacu-vials® at 0.67 ppm Ozone

			DR3900, SN 1392969		
Chlorine Conc, ppm	K7433 lot #	Ozone Conc, ppm	Abs Change @ 600 nm	Result, ppm 2.87*Abs Change	% Error
0	X071113A	0.658	0.216	0.62	-5.7
	X071113A		0.235	0.68	3.3
	X071113A		0.246	0.71	7.1
0	X050713B	0.658	0.236	0.68	3.3
	X050713B		0.225	0.65	-1.8
	X050713B		0.224	0.64	-2.2
3	X071113A	0.676	0.232	0.67	-0.9
	X071113A		0.222	0.64	-5.8
	X071113A		0.234	0.67	-0.9
3	X050713B	0.676	0.229	0.66	-2.7
	X050713B		0.244	0.70	3.7
	X050713B		0.226	0.65	-4.2
10	X071113A	0.667	0.212	0.61	-8.5
	X071113A		0.206	0.59	-11.4
	X071113A		0.218	0.63	-6.4
10	X050713B	0.667	0.212	0.61	-8.5
	X050713B		0.208	0.60	-10.5
	X050713B		0.214	0.61	-8.5

Figure 4: Effect of Chlorine on Indigo Ozone Vacu-vials® at 0.67 ppm Ozone

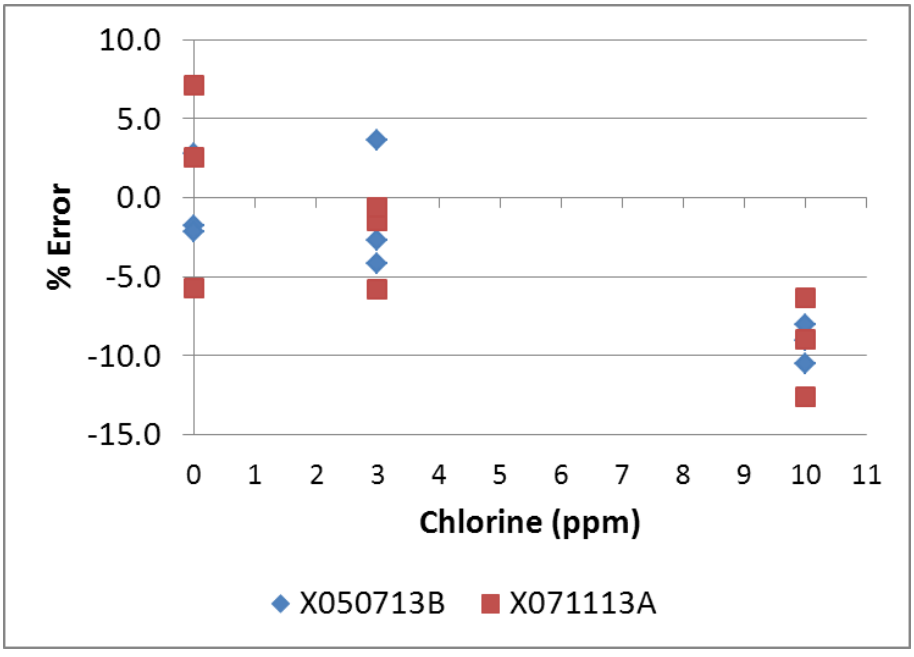

Table 7: Effect of Chlorine on Indigo Ozone Vacu-vials® at 0 ppm Ozone

		DR3900, SN 1392969	
Chlorine Conc, ppm	K7433 lot #	Abs Change @ 600 nm	Result, ppm 2.87*Abs Change
0	X101813A	-0.018	-0.05
	X101813A	-0.017	-0.05
	X101813A	-0.011	-0.03
3	X101813A	-0.018	-0.05
	X101813A	-0.008	-0.02
	X101813A	-0.011	-0.03
10	X101813A	-0.001	0.00
	X101813A	-0.001	0.00
	X101813A	-0.010	-0.03
20	X101813A	-0.017	-0.05
	X101813A	-0.020	-0.06
	X101813A	-0.002	-0.01

Table 8: Effect of Chlorine on Indigo Ozone Vacu-vials® at 0.14 ppm Ozone

			DR3900, SN 1392969		
Chlorine Conc, ppm	K7433 lot #	Ozone Conc, ppm	Abs Change @ 600nm	Result, ppm 2.87*Abs Change	% Error
0	X050713A	0.135	0.045	0.13	-3.7
	X050713A		0.045	0.13	-3.7
	X050713A		0.042	0.12	-11.1
0	X050713B	0.135	0.050	0.14	7.2
	X050713B		0.041	0.12	-11.1
	X050713B		0.044	0.13	-3.7
3	X050713A	0.140	0.048	0.14	0.0
	X050713A		0.048	0.14	0.0
	X050713A		0.052	0.15	7.1
3	X050713B	0.140	0.054	0.15	7.1
	X050713B		0.046	0.13	-7.1
	X050713B		0.047	0.14	0.0
10	X050713A	0.146	0.052	0.15	2.7
	X050713A		0.053	0.15	2.7
	X050713A		0.054	0.16	9.6
10	X050713B	0.146	0.051	0.15	2.7
	X050713B		0.048	0.14	-4.1
	X050713B		0.052	0.15	2.7

Ozone Vacu-vials® Kit

K-7433: 0 - 0.75 ppm

Instrument Setup

For CHEMetrics photometers, follow the **Setup and Measurement Procedures** in the operator's manual.

For spectrophotometers with a beam height (Z dimension) of 15 mm or less, follow the manufacturer's instructions to set the wavelength to 600 nm and to zero the instrument using the ZERO ampoule supplied.

Obtaining a Reagent Blank Absorbance Value

A reagent blank absorbance value must be obtained for **each ampoule** prior to using it to perform the test procedure below. Insert the **unsnapped ampoule** into the instrument cell holder and obtain an absorbance value for the reagent. CHEMetrics pre-programmed photometers will retain this reagent blank value. If using a spectrophotometer, record the value for later use. This is the Unsnapped Absorbance. Proceed with the **Test Procedure** using this ampoule.

Test Procedure

1. Fill the sample cup to the 25 mL mark with the sample to be tested, being careful to minimize turbulence (fig. 1).
   NOTE: Ozone loss from sample occurs rapidly. Do not transfer sample to other containers.
2. Immediately place the Vacu-vial ampoule from which the reagent blank value was generated, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig. 2).
3. Invert the ampoule **continuously for a full 30 seconds**, allowing the bubble to travel from end to end in the ampoule with each inversion.

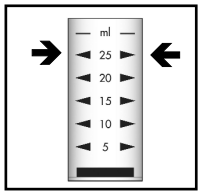

Figure 1

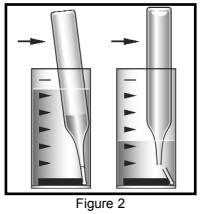
Figure 2

4. Dry the ampoule and insert it into the photometer, flat end first, and obtain a reading.
   NOTE: CHEMetrics pre-programmed photometers will deliver a test result in ppm Ozone (O_3). If using a spectrophotometer, record the value obtained in Step #4 (Snapped Absorbance), then use the equation below or the concentration calculator found under the support tab at www.chemetrics.com to obtain a test result.

   (Unsnapped Abs/3.6) - Snapped Abs = Adjusted Abs

   ppm O_3 = 1.68(Adjusted Abs)² + 2.45(Adjusted Abs) + 0.02

Test Method

The Ozone Vacu-vials®[1] test kit employs the indigo chemistry.[2,3] Indigo trisulfonate reagent reacts quantitatively with ozone, bleaching the blue color in direct proportion to the amount of ozone present. Malonic acid is included in the ampoule to prevent interference from up to 10 ppm chlorine.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. Bader, H. and Hoigne, J. "Determination of Ozone in Water by the Indigo Method," Water Research Vol. 15, 449-456, 1981.
3. APHA Standard Methods, 23rd ed., method 4500-O_3 B - 1997

Safety Information

Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

Visit www.chemetrics.com to view product demonstration videos.
Always follow the test procedure above to perform a test.

CHEMetrics
Simplicity in Water Analysis

www.chemetrics.com
4295 Catlett Road, Midland, VA 22728-0214 U.S.A.
Phone: (800) 356-3072; Fax: (540) 788-4856
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Sept. 19, Rev. 6

Ozone SAM
with K-7433 Vacu-vials®[1] Kit

I-2022

0 to 0.75
PPM (mg/Liter)

CHEMetrics

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To Set Zero

1. Press the ON/OFF key on the SAM.
2. The display will show "O3".
3. Insert the ZERO ampoule, flat end first, into the sample cell compartment with enough force to ensure that it is fully seated.
4. Place the light shield over the ZERO ampoule.
5. Press the Zero/Test key. The "O3" symbol will flash for approximately 8 seconds, then the display will show "SEt".

Test Procedure

1. Insert an **unsnapped K-7433 ozone Vacu-vial ampoule**, flat end first, into the sample cell compartment of the SAM with enough force to ensure that it is fully seated.
2. Place the light shield over the ampoule.
3. Press the Zero/Test key. The "O3" symbol will flash for approximately 8 seconds, then the display will show "tESt".
   Note: The instrument has stored a reagent blank value for this ampoule.
4. Fill the sample cup to the 25 mL mark with the sample to be tested, being careful to minimize turbulence (fig. 1).
   Note: Ozone loss from sample occurs rapidly. To minimize ozone loss, a snapper that can be used directly in the bottle of water being tested is available for sale (Cat # A-0214). See alternate steps 4 and 5 below.

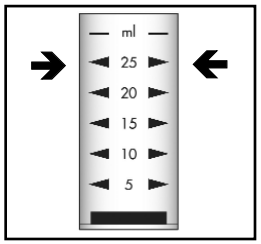


Figure 1

5. Immediately place the Vacu-vial ampoule used in Step #1, tip first, into the sample cup. Snap the tip. The ampoule will fill leaving a bubble for mixing (fig. 2).
6. Invert the ampoule **continuously for a full 30 seconds**, allowing the bubble to travel from end to end in the ampoule with each inversion.
7. Dry the ampoule and insert it, flat end first, into the sample cell compartment with enough force to ensure that it is fully seated.

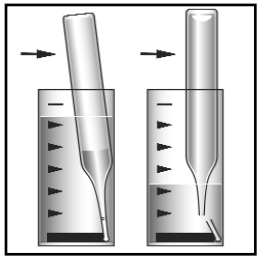


Figure 2

8. Place the light shield over the test ampoule.
9. Press the Zero/Test key. The "O3" symbol will flash for approximately 3 seconds, then the sample test result will appear in the display as ppm (mg/Liter).
10. To perform the next test (as long as the SAM has not powered off), remove the test ampoule from the sample cell compartment. Press the Zero/Test key. The display will show "SEt". Repeat Test Procedure Steps 1-9.

Alternate Steps 4 and 5 for Snapper use

4. Place the Vacu-vial ampoule used in Step # 1 above, tip first, into the snapper. Open the bottle of water to be tested and place the snapper with ampoule into the bottle (fig. 3).
   Note: There must be enough water in the bottle to cover at least the bottom half of the snapper.
5. Immediately apply gentle downward pressure to the bottom of the ampoule to snap the tip. The ampoule will fill leaving a bubble for mixing.

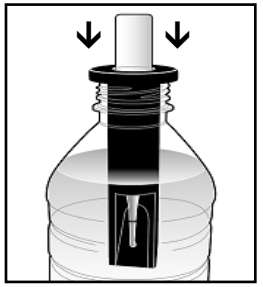


Figure 3

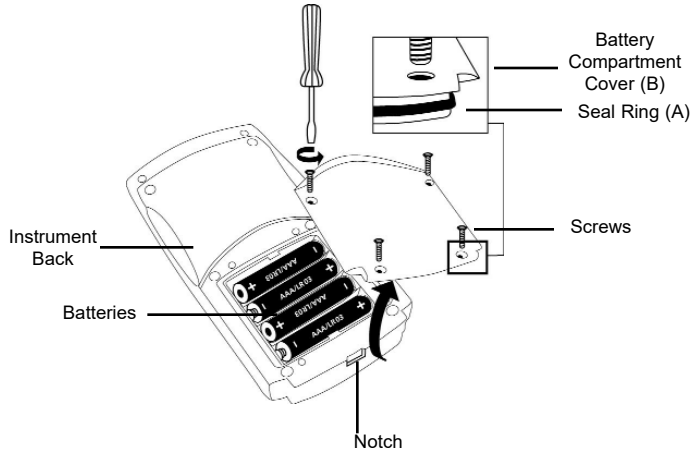
Operating Tips

- Upon startup, the photometer automatically proceeds to the zeroing process. Every time the photometer powers on, it must be re-zeroed.
- To re-zero the photometer, it must be turned off and back on again.
- A series of readings can be taken without re-zeroing, as long as the photometer stays on during the series.
- Protect photometer from extreme humidity, corrosive fumes and dusty areas. Store in a cool, dry place.
- Remove the batteries when photometer is not in use.
- Press the **!** key to turn the display back light on or off.
- When moving the photometer from one temperature extreme to another, wait at least 10 minutes before use to allow photometer to come to temperature equilibrium.
- Contamination of the optics in the sample chamber will result in incorrect measurements. The windows in the sample chamber should be checked at regular intervals and cleaned as necessary. Use a soft moist cloth or cotton swab for cleaning purposes.
- If the sample cell adapter has been removed, it must be replaced with proper orientation, aligning the triangle on the adapter with the triangle on the photometer.
- The SAM calibration is factory set and the LED should not change under normal use conditions. However, it is good quality protocol to routinely verify the performance of any LED photometer. A verification kit (Cat. No I-7433) that can be used to verify the performance of this photometer is sold separately.

Displays and Troubleshooting

E01: Light absorption too great (dirty optics)
E20/E21: Too much light reaching detector
E22 or Battery Icon: Battery should be replaced
E27/E28/E29: Instrument zeroed incorrectly, misaligned adapter, vial not properly seated, dirty optics or failing light source.
Hi/E03: Measuring range exceeded or excessive turbidity
Lo: Test result has a negative value (less than 0 ppm)

Battery Replacement



To ensure that the instrument is waterproof:

- seal ring (A) must be in position
- battery compartment cover (B) must be fixed with the four screws

Specifications

Auto Shutoff: After 15 minutes of non-use
Optics: 610 nm LED/interference filter and photosensor in transparent sample chamber
Operating Temp.: 5 to 40°C (41 to 104°F)
Battery: 4 AAA batteries (approx. 5,000 tests or 17 hours)
Waterproof: Floating, IP68 (1 hour at 0.1 meter)
Wavelength Accuracy: ± 1 nm
Photometric Accuracy: 3% full scale (T = 20 - 25° C / 68 - 77° F)
Photometric Resolution: 0.01 A
Ambient Conditions: Temperature 5 - 40° C / 41 - 104° F
Rel. humidity 30 - 90 % (non-condensing)
CE: Certificate of Declaration of CE-Conformity available upon request.

Menu Selection

Setting Date and Time

Upon initial start-up, the SAM will display "Set", "dAtE", and "YYYY", then a 4 digit number. Proceed to Step 4 in the procedure below to set the date and time, or power the instrument off and on again to bypass this process. At any time that the time and/or data need to be reset, follow steps 1-6 of the procedure below.

1. Press the Mode key and hold. Turn the instrument on by pressing and releasing the ON/OFF key. Once three decimal points appear in the display, release the Mode key. The display will show "di 5".
2. Press and release the ! key until the display shows arrows in the upper right and lower left corners of the display, pointing to "Time" and "Date".
3. Press the Mode key. "Set", "dAtE" will briefly appear in the display.
4. Date and time settings are displayed in the following order: Year ("YYYY"), Month ("MM"), Day ("dd"), Hour ("hh"), Minutes ("mm"). Increase the displayed value for each setting by pressing the Mode key or decrease the value by pressing the Zero/Test key until the desired value is displayed.
5. Press the ! key to save the displayed value and to proceed to the next setting.
6. After setting the minutes, press the ! key. The display will flash "iS" "SEt" and then will return to the measurement mode.

Recall of Stored Data

The SAM photometer automatically stores the last 15 data sets. To recall stored data:

1. Press the Mode key and hold. Turn the instrument on by pressing and releasing the ON/OFF key. Once three decimal points appear in the display, release the Mode key. The display will show "di 5".
   Note: If the instrument is already on, press and hold the ! key for at least 4 seconds and release to access the stored data.
2. Press the Mode key. The photometer will display the stored data sets in the following format:
   a. Sample Number: nXX (e.g. n15, n14, … n1)
   b. Year: XXXX (e.g. 2017)
   c. Date: mm.dd (e.g. 03.15)
   d. Time: hh.mm (e.g. 12:05)
   e. Analyte
   f. Result
3. Press the Zero/Test key to repeat the current data set.
4. Press the Mode key to proceed to the next data set.
5. Press the ! key to return to the measurement mode.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038