

# CLEANING LABORATORY EVALUATION SUMMARY

SCL #: 2016

DateRun: 11/18/2016

Experimenters: Jason Marshall, Vanessa Harripersaud

ClientType: Chemical Company

ProjectNumber: Project #1

Substrates: Liquid

PartType: Coupon

Contaminants: None

Cleaning Methods:

Analytical Methods: pH, ORP - Oxidation-reduction potential readings , Dissolved Oxygen

Purpose: To evaluate ozone levels over time for CleanCore Aqueous Ozone solution (ozonated water) Times = 0, 2 & 4 hrs and compare different methods of measuring aqueous ozone.

Experimental Procedure: The CleanCore Aqueous Ozone kiosk machine was turned on and run to generate ozonated water. Ozonated water was collected into the supplied CleanCore spray bottle.

Prior to running any cleaning trials, the system was used to compare the analytical devices to determine how comparable values would be from each system. The comparison of ORP (mV) readings between Clean Core Aqueous Ozone On-Demand Ati Q45H In-Line Meter and HANNAH HI 98121 Hand-held Meter was done by measuring ORP values after the system was operating at a steady state. Values were recorded and compared.

Properties of tap water and the ozonated water (directly from the spray hose and the CleanCore Spray Bottle) were measured and recorded throughout the procedure, as necessary, including temperature, ORP values (mV), dissolved ozone levels (ppm), pH and water hardness.

Instrumentation used for measurements:  
on-machine: dissolved ozone meter - ATi Q45H (ozone in ppm and temp in °F); ORP meter - Black Stone BL982411 ORP Controller (ORP in mV)  
handheld instruments: Hanna HI 98121 meter (ORP & temp in °C); Chemetrics Meter with vacu-vials (dissolved ozone in ppm)

At the appropriate time interval, based on the age of the ozonated solution in the CleanCore Spray Bottle (t= 0 hr, t=2 hr, t=4 hr), the cleaning solution from the CleanCore Spray Bottle was analyzed for ozone level and ORP values.

Water hardness was measured to be around 150 ppm in all trials.

Chemistries Evaluated: CleanCore Aqueous Ozone Solution (at t=0 hr, t=2 hr, t=4 hr) generated by CleanCore Aqueous Ozone Kiosk model machine, stored in CleanCore Spray Bottle;

Results: The initial data for the two ORP units were tabulated and a correlation equation was established. The resulting equation was found to have an R<sup>2</sup> value of 0.9978 indicating a very good fit of the equation to the data collected.

Table of ORP values in mV Date: Oct 5 2016

| In-Line  | Hand Held     |         |         |
|----------|---------------|---------|---------|
| ATi Q45H | HANNAH-HI9812 | Temp °F | Temp °C |
| 283      | 243           | 59.3    | 15.2    |
| 278      | 242           | 59.3    | 15.2    |
| 265      | 233           | 58.6    | 14.8    |
| 266      | 234           | 58.6    | 14.8    |
| 267      | 233           | 58.6    | 14.8    |
| 290      | 233           | 59.1    | 15.1    |
| 306      | 237           | 59.2    | 15.1    |
| 345      | 245           | 59.3    | 15.2    |
| 389      | 265           | 59.4    | 15.2    |
| 419      | 282           | 59.4    | 15.2    |
| 453      | 302           | 59.5    | 15.3    |
| 483      | 316           | 59.5    | 15.3    |
| 509      | 337           | 59.6    | 15.3    |
| 530      | 361           | 59.7    | 15.4    |
| 553      | 380           | 59.8    | 15.5    |
| 582      | 404           | 60.0    | 15.5    |

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|     |     |      |      |
|-----|-----|------|------|
| 602 | 422 | 60.2 | 15.7 |
| 617 | 440 | 60.3 | 15.7 |
| 635 | 470 | 60.7 | 15.9 |

In each of the four cleaning trials (bathroom -B, DCC 17 -D, glass -G and Hucker's soil -H), the ORP readings taken from the CleanCore spray bottle dropped down to an average of 357 mV (tap water average 242 mV), after two hours the average were nearly identical to tap water (264 to 231 mV) and at four hours the difference was even smaller (238-225 mV)

|                              |                   |                       |                   |                |                |
|------------------------------|-------------------|-----------------------|-------------------|----------------|----------------|
| Date: 9<br>Nov 2016          |                   |                       |                   |                |                |
| Reading<br>from<br>CleanCore | HANNA<br>Handheld |                       |                   |                |                |
| In-Line<br>Instruments       | Meter             | Temp<br>wall<br>meter | Temp<br>hand held |                |                |
| Dissolved<br>Oxygen          |                   |                       |                   |                |                |
| (ppm)                        | ORP (mV)          | ORP<br>(mV)           | Calculated        | Deg<br>F (C)   | Deg<br>F (C)   |
| 1.164                        | 917               | 908                   | 860               | 62.8<br>(17.1) | 61.9<br>(16.6) |
| 1.111                        | 919               | 897                   | 864               | 62.5<br>(16.9) | 61.9<br>(16.6) |
| 1.111                        | 919               | 912                   | 864               | 62.4<br>(16.9) | 61.7<br>(16.5) |
| 1.177                        | 919               | 908                   | 864               | 62.3<br>(16.8) | 61.7<br>(16.5) |
| Date: 10<br>Nov 2016         |                   |                       |                   |                |                |
| Reading<br>from<br>CleanCore | HANNA<br>Handheld |                       |                   |                |                |
| In-Line<br>Instruments       | Meter             | Temp<br>wall<br>meter | Temp<br>hand held |                |                |
| Dissolved<br>Oxygen          |                   |                       |                   |                |                |
| (ppm)                        | ORP (mV)          | ORP<br>(mV)           | Calculated        | Deg<br>F (C)   | Deg<br>F (C)   |
| 1.063                        | 941               | 909                   | 908               | 69.4<br>(20.8) | 70.0<br>(21.1) |
| 1.214                        | 943               | 907                   | 912               | 69.4<br>(20.8) | 70.0<br>(21.1) |
| 0.992                        | 942               | 910                   | 910               | 69.4<br>(20.8) | 70.2<br>(21.2) |
| 1.051                        | 942               | 900                   | 910               | 69.4<br>(20.8) | 70.2<br>(21.2) |
| Date: 15<br>Nov 2016         |                   |                       |                   |                |                |
| Reading<br>from<br>CleanCore | HANNA<br>Handheld |                       |                   |                |                |
| In-Line<br>Instruments       | Meter             | Temp<br>wall<br>meter | Temp<br>hand held |                |                |
| Dissolved<br>Oxygen          |                   |                       |                   |                |                |
| (ppm)                        | ORP (mV)          | ORP<br>(mV)           | Calculated        | Deg<br>F (C)   | Deg<br>F (C)   |
| 0.996                        | 933               | 880                   | 892               | 67.1<br>(19.5) | 66.4<br>(19.1) |
| 1.003                        | 934               | 871                   | 894               | 66.9<br>(19.4) | 66.2<br>(19.0) |
| 1.006                        | 934               | 920                   | 894               | 66.8<br>(19.3) | 66.2<br>(19.0) |

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|       |     |     |     |                |                |
|-------|-----|-----|-----|----------------|----------------|
| 1.007 | 935 | 883 | 896 | 66.7<br>(19.3) | 66.0<br>(18.9) |
|-------|-----|-----|-----|----------------|----------------|

For the dissolved ozone in parts per million, the initial value from the unit ranged from 1.01 - 1.24 ppm. When measured from the CleanCore spray bottle at time zero, the ppm levels were 0.19-0.46 ppm for the four trials. After two hours the ppm levels were ranged from 0.03-0.1, at or equal to tap water levels. It appears that the use of the supplied spray bottle reduces the ozone level in solution under these laboratory conditions.

| ORP - mV                           | t=0<br>hrs | t=2<br>hrs | t=4<br>hrs | Deg<br>F | Deg<br>C |
|------------------------------------|------------|------------|------------|----------|----------|
| Hannah meter                       |            |            |            |          |          |
| Bathroom<br>(spray)                | 254        | 224        | 223        | 71.8     | 22.1     |
| Hannah meter<br>DCC 17<br>(spray)  | 365        | 342        | 233        | 72.0     | 22.2     |
| Hannah meter<br>Glass<br>(spray)   | 402        | 248        | 274        | 70.8     | 21.6     |
| Hannah meter<br>Huckers<br>(spray) | 409        | 244        | 223        | 75.1     | 23.9     |
| Hannah meter<br>Tap water          |            |            |            |          |          |
| Bathroom run                       | 205        | 211        | 205        | 72.5     | 22.5     |
| Hannah meter<br>Tap water          |            |            |            |          |          |
| DCC 17 run                         | 262        | 238        | 242        | 71.7     | 22.1     |
| Hannah meter<br>Tap water          |            |            |            |          |          |
| Glass run                          | 214        | 242        | 242        | 69.8     | 21.0     |
| Hannah meter Tap water             |            |            |            |          |          |
| Hucker run                         | 287        | 236        | 212        | 73.5     | 23.1     |
| Unit meter Bath                    | 930        |            |            | 73.9     | 23.3     |
| Unit meter DCC                     | 930        |            |            | 70.2     | 21.2     |
| Unit meter Glass                   | 930        |            |            | 68.1     | 20.1     |
| Unit meter<br>Huckers              | 930        |            |            | 74.3     | 23.5     |

A similar trend was shown for the Vacu Vial (VV) measurements.

| Dissolved<br>Ozone - PPM | t=0 hrs          | t=2<br>hrs | t=4<br>hrs | Deg<br>F | Deg<br>C |
|--------------------------|------------------|------------|------------|----------|----------|
| VV - Bathroom<br>(spray) | 0.21             | 0.05       | 0.01       | 71.8     | 22.1     |
| VV - DCC 17<br>(spray)   | 0.19             | 0.03       | 0.02       | 72.0     | 22.2     |
| VV - Glass<br>(spray)    | 0.23             | 0.1        | 0          | 70.8     | 21.6     |
| VV - Huckers<br>(spray)  | 0.46             | 0.04       | 0.01       | 75.1     | 23.9     |
| VV - Tap water<br>B      | 0.04             |            |            | 72.5     | 22.5     |
| VV - Tap water<br>D      | 0.04             |            |            | 71.7     | 22.1     |
| VV - Tap water<br>G      | 0.02             |            |            | 69.8     | 21.0     |
| VV - Tap water<br>H      | 0.03             |            |            | 73.5     | 23.1     |
| meter B                  | 1.044 -<br>1.23  |            |            | 73.9     | 23.3     |
| meter D                  | 1.103 -<br>1.149 |            |            | 70.2     | 21.2     |
| meter G                  | 1.141 -<br>1.236 |            |            | 68.1     | 20.1     |

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|                  |                  |  |  |      |      |
|------------------|------------------|--|--|------|------|
| meter H          | 1.010 -<br>1.200 |  |  | 74.3 | 23.5 |
| VV - Fill hose B | 0.85             |  |  | 71.8 | 22.1 |
| VV - Fill hose D | 0.76             |  |  | 72.0 | 22.2 |
| VV - Fill hose G | 0.89             |  |  | 70.8 | 21.6 |
| VV - Fill hose H | 1.06             |  |  | 75.1 | 23.9 |

Summary:

|                      |                                 |               |                    |                          |                      |
|----------------------|---------------------------------|---------------|--------------------|--------------------------|----------------------|
| <b>Substrates:</b>   | Liquid                          |               |                    |                          |                      |
| <b>Contaminants:</b> | None                            |               |                    |                          |                      |
| <b>Company Name:</b> | <b>Product Name:</b>            | <b>Conc.:</b> | <b>Efficiency:</b> | <b>Effective:</b>        | <b>Observations:</b> |
| CleanCore            | CleanCore queous Ozone Solution | 100           |                    | <input type="checkbox"/> |                      |
| Water                | Water                           | 100           |                    | <input type="checkbox"/> |                      |

Conclusion:

Each of the analytical tools used to measure ozone levels in the supplied unit showed that the level of ozone in solution drastically dropped when sprayed through the supplied CleanCore bottle and over the four hour testing period.

When comparing the ORP meters from the wall unit and hand held device showed that even though both systems had different mV values, the hand held unit could be used in the field as an assessment tool supplying relative ORP values as compared to the wall system. For the Vacu-Vial comparison, values were consistently lower than the wall system values as well. However, the vials could still be used to provide in-field measurement in the same way as the hand held ORP unit.

Both surrogate measurement systems demonstrated the downward trend of ozone levels overtime. Both showed that the use of the spray unit degraded ozone levels significantly.