Great Ships Initiative

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STANDARD OPERATING PROCEDURE
Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm

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1	02/21/2011	Revised "Background". Added applicability of SOP to "Introduction". Separated "Equipment List" into equipment and supplies. Added text to "Sample Collection" ¶3. Added text throught "Sample Analysis" procedure to specify instrument warm-up time, sample temperature, and wiping cuvette.	7		
2	05/23/2011	Moved filtration apparatus from supplies to equipment. Formated and edited § "Sample Collection" ¶3. Added text to § "Sample Analysis" ¶5. Added text to § "QA/QC" ¶3 and ¶4.	8		
3			9		
4			10		
5			11		
6			12		

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BACKGROUND

The Great Ships Initiative (GSI) is a regional effort devoted to ending the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System and globally. In support of that goal, the GSI has established superlative freshwater ballast treatment evaluation capabilities at three scales—bench, land-based, and on board ship. Each scale is dedicated to addressing specific evaluation objectives. These include:

GSI Bench-Scale Tests

- Range finding for effective treatment dose against diverse freshwater taxa and water quality conditions;
- Generation of freshwater relevant chemical degradation curves; and
- Estimation of residual toxicity given diverse freshwater taxa and water quality conditions.

GSI Land-Based Tests

- Pre-certification testing, i.e., operational and biological performance (including residual toxicity) status-testing given scale-up and a range of challenge conditions; and
- Certification/verification testing, i.e., formal assessment of performance against international and other discharge standards.

GSI Shipboard Tests

- Confirmation of biological and operational treatment performance as expected in the ship environment;
- U.S. Coast Guard Shipboard Technology Evaluation Program (STEP) testing;
- Shipboard type approval testing;
- Ship discharge monitoring; and
- Methods development.

GSI awards its independent status-testing services to candidate systems only if technical and programmatic criteria are met. Decisions are based on third party technical assessments as well as GSI Advisory Committee programmatic input. Testing services are currently offered at no cost to the developer with the exception of transportation and system installation/removal costs. Instead, tests are supported by general project funds which derive from federal and state agency grants, Great Lakes port contributions, and in-kind contributions by local governments and universities.

GSI has no involvement, intellectual or financial, in the mechanics, design or market success of the actual treatment systems it tests. To ensure GSI remains completely independent and is uncompromised by any real or perceived individual or project bias, GSI subjects itself to rigorous quality management policies and procedures. In addition, GSI test activities are subject to rigorous QAQC procedures and documentation. This attention to quality management and QAQC assures the high quality and credible evaluation of both GSI and its findings.

INTRODUCTION

This GSI Standard Operating Procedure (SOP) describes the procedure used to determine the percent transmittance (%T) of light in water at a wavelength of 254 nm. This procedure is applicable to bench-scale testing, as well as, land-based performance evaluation/certification testing of ballast water treatment systems. Organic compounds, especially aromatic organics, absorb ultraviolet (UV) light with a wavelength of 254 nm. Because other analyses such as total organic carbon (TOC), dissolved organic carbon (DOC), biological oxygen demand (BOD), and chemical oxygen demand (COD) are time consuming and costly, UV transmittance at 254 nm is frequently used as an indicator of the concentration of organic matter in water. Using this method, good correlations between DOC values and %T at 254 nm can be obtained. Filtration of samples may need to be considered because suspended solids present in water samples will cause blockage and scattering of light resulting in elevated %T values. This would result in an over-estimation of the organic content of the water.

DEFINITIONS

Biological/Biochemical Oxygen Demand (BOD): A measure of the rate of molecular oxygen utilization by biological organisms for the degradation of organic material in water (Eaton *et al*., 2005).

Brackish Water (BW): Synthetic water created from laboratory water (LW) with the addition of commercially prepared salts, such as Instant Ocean, to obtain a salinity of 16 parts per thousand (as measured by a refractometer).

Chemical Oxygen Demand (COD): A measure of the oxygen required to oxidize all organic and inorganic compounds in water (US EPA, 2009)

Dissolved Organic Carbon (DOC): The fraction of total organic carbon (TOC) present in water that passes through a 0.45 μm pore diameter filter (Eaton *et al*., 2005).

High Organic Content Laboratory Water (HOC-LW): Synthetic water created from laboratory water (LW) and used as a surrogate in place of Duluth-Superior Harbor water.

Laboratory Water (LW): City of Superior, Wisconsin municipal water that has been dechlorinated by passage through an activated carbon filter. Note: Based on data from previous testing, background levels of chlorine from below the limit of detection -10 μg/L are expected in dechlorinated laboratory water, depending on the source of the water.

Prospective Ballast Treatment System (BTS): A system containing an active substance and/or component that mechanically, physically, chemically, or biologically serves to remove, render harmless, or avoid the uptake or discharge of potentially invasive organisms within ballast water (IMO, 2005).

Total Organic Carbon (TOC): All carbon atoms present in water that are covalently bonded in organic molecules (Eaton *et al*., 2005).

Salt Water (SW): Synthetic water created from laboratory water (LW) with the addition of commercially prepared salts, such as Instant Ocean, to obtain a salinity of 32 parts per thousand (as measured by a refractometer).

EQUIPMENT

- Spectrophotometer capable of analysis at 254 nm.
- UV transparent cuvettes (quartz or silica), 1 cm.
- Filtration apparatus (filter holder, filtration flask, vacuum pump, vacuum tubing, and forceps)

SUPPLIES

- Kimwipes.
- Wash bottle with deionized water.
- Containers for sample collection.
- Personal protective equipment.Glass fiber filters without organic binder (i.e. Whatman 934-AH).

PROCEDURE

Sample Collection

1. Collect sample water in beakers or sample bottles from the appropriate location(s) depending on the type of test being conducted.

2. Collect a minimum of 10 % of samples in duplicate.

3. Filter samples if they contain suspended solids prior to analysis. The filtration is done so that the %T value obtained can be used to provide a good estimate of the dissolved organic carbon concentration present in the sample.
    a. If desired or if specified in the Test/Quality Assurance Plan (TQAP), an aliquot of the unfiltered sample can also be analyzed to provide information on the effect of particulates on the %T. This may be important for systems that use UV light as part of the ballast water treatment system.

4. Conduct analysis as soon as possible after sample collection. If samples cannot be analyzed immediately, they should be refrigerated and analyzed within 24 hours of collection.

Sample Analysis

1. Turn spectrophotometer on and allow the instrument to warm up for at least 10 minutes.

2. Ensure the samples are at room temperature prior to analysis.

3. When the instrument is ready, set the wavelength of analysis to 254 nm and the readout mode to %T.

4. Place deionized water in the reference and sample cuvettes, dry the outside of the cuvettes with a Kimwipe™, place them in their respective compartments in the spectrophotometer, and adjust the readout to 100% T.

5. Empty the sample cuvette, rinse with several small portions of the room temperature sample water, then fill cuvette at least two-thirds full with sample, making sure there are no air bubbles present. If analyzing an unfiltered sample, be sure that the sample is well mixed before transferring the sample to the cuvette. Dry the outside of the cuvette with a Kimwipe™ before placing it in the sample compartment of the spectrophotometer.

6. Read and record the %T value of the sample.

7. Repeat steps 5 and 6 for each sample.

QUALITY ASSURANCE/QUALITY CONTROL

1. Conduct all quality assurance/quality control procedures according to the *GSI/QAQC/QAPP/LB/1 - Quality Assurance Project Plan (QAPP) for Great Ships Initiative (GSI) Land-Based Tests* (2011) or *GSI/QAQC/QAPP/BS/1 – Quality Assurance Project Plan for Great Ships Initiative (GSI) Bench-Scale Tests*. Analyze data to ensure that all applicable data quality criteria are met.

2. Collect and analyze in duplicate at least 10 % of the samples to document sampling and analytical variability.

3. Follow all procedures outlined in this SOP. Any amendments known ahead of time must be approved by the GSI Lead Investigator for Land-Based or Bench-Scale Studies (depending upon the scale of the testing) and communicated to the GSI Senior QAQC Officer. Any deviations made during the experiment must be recorded, approved by the GSI Lead Investigator for Land-Based or Bench-Scale Studies (depending upon the scale of the testing) and communicated to the GSI Senior QAQC Officer as soon as practicable.

4. Record data on data collection forms or in specific laboratory notebooks. All instrument data output and data forms must be stored in a project-specific three-ring binder. Ensure hard copies of instrument data output and data collection forms are scanned and stored electronically.

DATA STORAGE AND ARCHIVING

1. Store and archive data according to *GSI/QAQC/QAPP/LB/1 - Quality Assurance Project Plan (QAPP) for Great Ships Initiative (GSI) Land-Based Tests (2011)* or *GSI/QAQC/QAPP/BS/1 – Quality Assurance Project Plan for Great Ships Initiative*

(GSI) Bench-Scale Tests.

2. Archive all hard- and electronic-copies of data and records generated for a period of at least seven years.

REFERENCES AND RELATED DOCUMENTS

Eaton, AD, Clesceri, LS, Rice, EW, and AE Greenberg, Eds. (2005). Ultraviolet Absorption Method, 5910B. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC, pp 5-72 to 5-74.

Great Ships Initiative Standard Operating Protocols: http://www.nemw.org/GSI/protocols.htm.

Great Ships Initiative website: www.greatshipsinitiative.org

GSI/QAQC/QAPP/BS/1 – Quality Assurance Project Plan for Great Ships Initiative (GSI) Bench-Scale Tests

GSI/QAQC/QAPP/LB/1 - Quality Assurance Project Plan (QAPP) for Great Ships Initiative (GSI) Land-Based Tests (2011).

International Maritime Organization (IMO) (2005). Guidelines for Approval of Ballast Water Management Systems (G8) Adopted by Resolution MEPC.125 (53). London, England.

United States Environmental Protection Agency (2009). Performance Track Results: Non-Target Discharges to Water. http://www.epa.gov/performancetrack/results/outputs/nontoxic-back.htm, June 9, 2009.