Standard Operating Procedure for:

Conductivity
Using Cole-Parmer Traceable Portable Conductivity Meter

Missouri State University

and

Ozarks Environmental and Water
Resources Institute (OEWRI)

Prepared by: ____________________________________ Date: ______________
OEWRI Laboratory Manager

Approved by: ____________________________________ Date: ______________
OEWRI Director

September 30, 2015

OEWRI-SOP-004

Table of Contents

1 Identification of the test method

Laboratory analysis of water samples for conductivity using the Cole-Parmer Traceable Portable Conductivity Meter.

2 Applicable matrix or matrices

This method is suitable for the determination of conductivity in potable and surface waters and wastewaters with a conductivity of up to 199.9 mS/cm.

3 Detection Limit

The manufacturer claims a range of detection from 0.00 to19.99 µS, 0.0 to 199.9 µS, 0 to 1999 µS, 0 to 19.99 mS, and 0 to 199.9 mS, with a resolution of 0.05% of range.

4 Scope of the test method

This standard operating procedure provides the Missouri State University (MSU) laboratory personnel with guidance on the procedure for determining conductivity in water samples. This method is limited to the determination of conductivity in water samples collected from natural bodies of water with conductivity values of <20 mS/cm.

5 Summary of test method

Conductivity is the ability of a solution to pass an electric current. Current is carried by inorganic dissolved solids, such as chloride, nitrate, sulfate and phosphate ions in the solution, as well as such cations as sodium, calcium, magnesium, iron and aluminum. Organic materials like oils, phenol, alcohols and sugars do not carry electric current well (Hach 1989). Conductivity is performed by measuring the voltage drop, or resistance, between two electrodes immersed in a test solution.

In the Cole-Parmer Traceable Portable conductivity meter, temperature compensation is automatic. The temperature compensation circuit measures the temperature of the sample and from the deviation from 25ºC calculates and correct the reading 2% for each degree of deviation (Hach 1989)(Cole-Parmer 2015).

A 150 mL aliquot of sample is decanted into a clean 250 mL beaker. The conductivity probe is inserted into the sample. Allow time for the reading to stabilize and record reading. Rinse probe thoroughly with deionized water before analyzing the next sample.

6 Definitions

6.1 Analytical batch: The set of samples processed at the same time

6.2 Field duplicates (FD): Two samples taken at the same time and place under identical circumstances and that are treated identically throughout field and laboratory procedures. Analysis of field duplicates indicates the precision associated with sample collection, preservation, and storage as well as laboratory procedures. Collect one set of field duplicates for every ten samples collected.

6.3 Laboratory reagent blank (LRB): An aliquot of deionized water treated as a sample in all aspects, except that it is not taken to the sampling site. The purpose is to determine if the analytes or interferences are present in the laboratory environment, the reagents, or the apparatus. Analyze one LRB for every twenty samples analyzed.

6.4 Laboratory duplicates (LD): Two aliquots of the same environmental sample treated identically throughout a laboratory analytical procedure. Analysis of laboratory duplicates indicates precision associated with laboratory procedures but not with sample collection, preservation or storage procedures. Analyze one set of LDs for every ten samples analyzed.

6.5 Method detection limit (MDL) -- The lowest level at which an analyte can be detected with 99 percent confidence that the analyte concentration is greater than zero.

7 Interferences

When measuring very low conductivity levels (approximately 2 µS/cm or less), the sample must be protected from atmospheric gases such as carbon dioxide or ammonia. These gases dissolve readily in water and would cause a rapid change in conductivity readings.

8 Health and safety

This analysis involves handling freshwater samples that may contain live microorganisms and therefore pose some threat of infection. Laboratory personnel who are routinely exposed to such water samples are encouraged to protect themselves from water borne illnesses by wearing clean disposable gloves and washing their hands frequently.

9 Personnel qualifications

Laboratory and field personnel shall have a working knowledge of this analytical procedure and will have received training from an MSU employee knowledgeable of the proper sample analysis procedures. Prior to the first batch of sample analyses, the analyst will complete a demonstration of capability exercise as described below in the Quality control section.

10 Equipment and supplies

10.1 Cole-Parmer Traceable Portable Conductivity Meter, EW-19601-03, with Cole-Parmer 4362 Conductivity Probe, EW-19601-07.

10.2 Laboratory glassware: 250 mL beakers

11 Reagents and standards

11.1 Deionized water (DI)

11.2 0.001 *M* Potassium chloride solution: Weigh 74.55 mg of KCl. Dissolve with deionized water having a conductivity value of close to 0 µs/cm. Dilute to 1L with DI. The conductivity of this solution should be 146.9 µS/cm.

11.3 Purchased conductivity standard: 1000µS/cm purchased from Fisher Scientific. Catalog number 2243-1. This is 495 mg/L as NaCl.

12 Sample collection, preservation, shipment and storage

12.1 See the SOP for water sample collection procedures.

12.2 Samples should be refrigerated as soon as possible after collection.

12.3 The holding time for conductivity is 28 days (Standard Methods, 2005).

13 Quality control

13.1 Laboratory duplicates (LD) and Field duplicates (FD) reproducibility:

- a. Carry out two replicates on the same sample.
- b. The relative percent difference (RPD) between the two conductivity values should be ≤ 20% of their average value.
- c. Use equation 1 to calculate RPD:

Equation 1: $$\text{RPD (\%)} = \frac{(A - B)}{(A + B)/2} \times 100\%$$

Where: A = conductivity of first aliquot (µS/cm), and
B = conductivity of duplicate aliquot (µS/cm)

- d. Analyze one set of duplicates for every 10 samples analyzed.
- e. Record the RPD on the bench sheet.

13.2 Blank (LRB): At least one blank should be measured with each set of samples.

- a. For the blank measurement analyze 150mL of deionized water.
- b. The conductivity value for the blank should be less than 2 µS/cm. If it is not, evaluate the procedure and correct sources of error.
- c. Analyze one blank for every 10 samples analyzed.

14 Calibration and standardization

14.1 Clean the probe using deionized water.

14.2 Soak the probe in DI for 30 minutes.

14.3 Remove the probe from the water and fling out drops clinging inside the probe.

14.4 Immerse the probe to or beyond the vent holes in a beaker containing the calibration solution. Agitate vertically to remove entrapped air.

14.5 Repeat steps 14.3 and 14.4 one more time.

14.6 Press the **POWER I** key and **CND** key. Verify that the **LO BAT** indication does not appear.

14.7 Record the final reading in the instrument log book.

15 Procedure

15.1 Sample Analysis

- a. Pour approximately 150mL of sample into a 250mL beaker.
- b. Press the **POWER I** key and **CND** key. Verify that the **LO BAT** indication does not appear.
- c. Insert the probe into the sample. Immerse the tip to or beyond the vent holes and agitate vertically to be sure air bubbles are not entrapped in the probe.

d. Allow time for the reading to stabilize (about 30 seconds).
e. Rinse the probe thoroughly with DI after each measurement.
f. Record the conductivity value on the bench sheet.

15.2 Measuring Dilute Samples
a. If the conductivity of the sample exceeds the range of the instrument, the sample can be diluted and the conductivity calculated.
b. The affects of the dilution water must be considered
c. Determine the conductivity of the dilution water.
d. Calculate using equation 2.

Equation 2: $C_S = (V_T \times C_M) - [C_D \times (V_T - V_S)] / V_S$

Where: C_S = Conductivity of sample
V_T = Total Volume (sample + dilution water)
C_M = Conductivity measured (sample + dilution water)
C_D = Conductivity of dilution water
V_S = Volume of sample (total – dilution water)

16 Data acquisition, calculations, and reporting

16.1 Record the conductivity values for each sample on the bench sheet (see below).
16.2 Record any other calculation results (e.g., dilution, duplicate RPD) in the comments section of the bench sheet.

17 Computer hardware and software

17.1 Word: This document and attached bench sheet are prepared using Microsoft Word. The Word document file name for this SOP is: OEWRI-Conductivity-SOP-003

17.2 Excel: Quality control charts are created using Excel.

18 Method performance

18.1 The desired performance criteria for this measurement are:
a. Detection limit: 2 μS/cm
b. Precision: ± 20% RPD
a. Minimum Quantification Interval: 0.1 μS/cm

19 Pollution prevention

All wastes from these procedures shall be collected and disposed of according to existing waste policies within the MSU Geography, Geology, and Planning Department. Volumes of reagents made should mirror the number of samples being analyzed. These adjustments should be made to reduce waste. Diluted potassium or sodium chloride solutions are not hazardous and can be disposed of in the laboratory sinks.

20 Data assessment and acceptable criteria for quality control measures

20.1 The analyst should review all data for correctness (e.g., calculations).

20.2 Precision values are calculated for pairs of duplicate analyses.

20.3 Record the precision values as a percent on the bench sheet.

20.4 The desired precision is ± 20% RPD.

20.5 The desired detection limit is 2 µS/cm

20.6 The completed bench sheet is reviewed by the analyst's supervisor or the OEWRI Laboratory Manager.

21 Corrective actions for out-of-control or unacceptable data

21.1 Quality control charts will be created for charting precision and blank values.

21.2 The results for precision and blank data are compared to the acceptable values for this analysis; ± 20% and 2 µS/cm, respectively.

21.3 If a precision value exceeds 20% RPD then the analyst should write in the comments section of the bench sheet: "These data are associated with an out-of-control duplicate analysis. The UCL = 20%." Note: "UCL" is the Upper Control Limit (i.e., 20%).

21.4 If a blank value exceeds 2 µS/cm then the analyst should write in the comments section of the bench sheet: "These data are associated with a blank value that exceeds the detection limit of 2 µS/cm."

21.5 The samples can be reanalyzed because the sample volume will not have been depleted after the initial analysis.

21.6 If data are unacceptable for any reason, the analyst should review their analytical technique prior to conducting this analysis again.

21.7 Any maintenance steps taken to correct the operation of the instrument should be recorded in the instrument log book.

22 Waste management

The wastes generated in this method are not hazardous. They can be discarded in the following manner: the water can be discarded in the laboratory.

23 References

23.1 Cole-Parmer Traceable Portable Conductivity Meter Specifications. Cole-Parmer. Web. 16 Sept. 2015.

23.2 Hach Model 44600 Conductivity/TDS Meter manual. Hach Company, Loveland, CO. 1989.

23.3 Standard Methods for the Examination of Water and Waste Water. Method 2510. APHA, 21st Edition, 2005.

23.4 Water Sample Collection. 2006. OEWRI SOP. Document name: OEWRI-Water Sample Collection-SOP-001.

24 Tables, diagrams, flowcharts and validation data

24.1 There are no tables, diagrams, flowcharts or validation data for this method.

24.2 See page 9 for the pH/Conductivity calibration sheet. The analyst should make a copy of this form for each batch of samples analyzed.

24.3 See page 10 for the pH/Conductivity analysis bench sheet. The analyst should make a copy of this form for each batch of samples analyzed.

24.4 See page 11 for the Conductivity bench procedure sheet.

Ozarks Environmental and Water Resources Institute (OEWRI) at Missouri State University

pH/SC Calibration Log

Date of Calibration: ____________________ Analyst: _______________________________________

Oakton pH Meter

pH 4 Pre__________ Post__________ Lot #__________

pH 7 Pre__________ Post__________ Lot #__________

Cole-Parmer Conductivity Meter

Conductivity (µS/cm) – Pre______________ Post______________ Lot #______________

Comments ____

____

Date of Calibration: ____________________ Analyst: _______________________________________

Oakton pH Meter

pH 4 Pre__________ Post__________ Lot #__________

pH 7 Pre__________ Post__________ Lot #__________

Cole-Parmer Conductivity Meter

Conductivity (µS/cm) – Pre______________ Post______________ Lot #______________

Comments ____

____

Date of Calibration: ____________________ Analyst: _______________________________________

Oakton pH Meter

pH 4 Pre__________ Post__________ Lot #__________

pH 7 Pre__________ Post__________ Lot #__________

Cole-Parmer Conductivity Meter

Conductivity (µS/cm) – Pre______________ Post______________ Lot #______________

Comments ____

Ozarks Environmental and Water Resources Instititute (OEWRI) at Missouri State University
pH, Conductivity, and Turbidity Bench Sheet

Project: ________________ Date:______________ Analyst: ____________________________

Site ID	**Temperature** (°C)	**Sp. Cond** (µS/cm)	**pH**	**DO** (ppm)	**Turbidity** (NTU)	**Stage** (cm)

Conductivity – Bench Procedures

Conductivity Calibration

1. Insert probe in DI water for ~30 minutes to rinse probe.
2. Select the conductivity standard for calibration.
3. Pour ~4cm of the solution into two separate containers.
4. Power on the meter
5. Rinse the probe into one of the two containers and then gently stir the probe.
6. Dip rinsed probe into the other container (Tap probe on the bottom of container to remove any bubbles). Let probe stabilize to the solution temperature.
7. Press 'CAL' key more than 2 seconds to enter the calibration (probe will automatically detect the conductivity value of the solution and blinks the value on the LCD).
8. Press the 'UP/DOWN' keys to change the value on the primary display to match the value to the standard. (can be adjusted up to ±20%, if difference is greater it means cleaning or replacing probe is needed). Press enter once correct reading is selected.

Analysis Procedure

1. Turn on the meter.
2. Rinse the probe with DI water.
3. Dip probe into sample making sure there are no air bubbles trapped on the slot of the probe.
4. Stir the probe gently in the sample to create a homogenous sample, allowing a few seconds for the temperature reading to approach the solution temperature
5. Take reading (when the reading is stable 'READY' will display on the left-middle of the LCD.