

Ozarks Environmental and Water Resources Institute (OEWRi)
Missouri State University (MSU)

Standard Operating Procedure for:

Conductivity

Using Cole-Parmer Traceable Portable Conductivity Meter

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Identification of the method

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

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 1999 $\mu\text{S}/\text{cm}$.

Detection Limit

Detection ranges from 0 to 1999 $\mu\text{S}/\text{cm}$ with a resolution of 0.01, 0.1, or 1 $\mu\text{S}/\text{cm}$ of range depending on the range calibrated. Other ranges can be achieved if calibrated for that specified range, see user manual.

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 between 0.00 to 1999 $\mu\text{S}/\text{cm}$.

Summary of 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 25°C 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 next sample.

Definitions

1. Analytical batch: The set of samples processed at the same time
2. Laboratory reagent blank (LRB): An aliquot of deionized water treated as a sample in all aspects, except that it is not taken to sampling site. The purpose is to determine if analytes or interferences are present in laboratory environment, the reagents, or the apparatus. Analyze one LRB for every twenty samples analyzed.
3. 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.
4. Method detection limit (MDL): Lowest level at which an analyte can be detected with 99 percent confidence that the analyte concentration is greater than zero.

Interferences

When measuring low conductivity levels (approximately 2 $\mu\text{S}/\text{cm}$ or less), sample must be protected from atmospheric gases such as carbon dioxide or ammonia. These gases dissolve readily in water and could cause a rapid change in conductivity readings.

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 with clean disposable gloves and washing their hands frequently.

Personnel qualifications

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

Equipment and supplies

1. Cole-Parmer Traceable Portable Conductivity Meter, EW-19601-03, with ColeParmer 4362 Conductivity Probe, EW-19601-07.
2. Laboratory glassware: 250 mL beakers

Reagents and Standards

1. Deionized water (DI).
2. Purchased conductivity standard: 1000 μ S/cm purchased from Fisher Scientific. Catalog number 2243-1. This is 495 ppm TDS as NaCl.

Sample collection, preservation, shipment, and storage

1. See the SOP for water sample collection procedures (OEWRI-SOP-1040R01 Water Sampling.doc).
2. Samples should be refrigerated as soon as possible after collection.
3. The sample holding time for conductivity is 28 days (Standard Methods, 2005).

Quality Control

1. Demonstration of capability; a new analyst should:
 - a. Read this standard operating procedure,
 - b. Demonstrate to a previously trained analyst that the procedures outlined here are being followed, and
 - c. Successfully complete a report using data collected with these procedures.
2. Duplicate reproducibility:
 - a. Measure two replicates on the same sample.
 - b. The relative percent difference (RPD) between the two pH values should be $\leq 20\%$ of their average value.
 - c. Use equation 1 to calculate RPD:

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

Where: A = first measurement, and
 B = duplicate measurement

- d. Analyze one set of duplicates for every 10 samples analyzed.

3. Blank (LRB): At least one blank should be measured with each set of samples.
 - a. The conductivity value for the blank should be less than 2 $\mu\text{S}/\text{cm}$. If it is not, evaluate the procedure and correct sources of error.
 - b. Analyze one blank for every 10 samples analyzed.

Calibration and standardization

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
1. 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
2. automatically detect the conductivity value of the solution and blinks the value on
3. the LCD).
8. Press the '**UP/DOWN**' keys to change the value on the primary display to match
4. the value to the standard. (Can be adjusted up to $\pm 20\%$, if difference is greater, it
5. means cleaning or replacing probe is needed). Press '**ENTER**' once correct
6. reading is selected.
9. Check calibration with DI water to ensure its below 2.0 $\mu\text{S}/\text{cm}$.

Procedure

A. Sample Analysis

- 1) Pour approximately 150mL of sample into a 250mL beaker.
- 2) Press the POWER I key and CND key. Verify that the LO BAT indication does not appear.
- 3) 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.
- 4) Allow time for the reading to stabilize (about 30 seconds).

- 5) Rinse the probe thoroughly with DI after each measurement.
- 6) Record the conductivity value on the bench sheet.

B. Measuring Dilute Samples

- 1) If the conductivity of the sample exceeds the range of the instrument, the sample can be diluted, and the conductivity calculated.
- 2) The effects of diluted water must be considered.
- 3) Determine the conductivity of the dilution water.
- 4) Calculate using equation 2.

$$\text{Equation 2: } CS = (VT \times CM) - [CD \times (VT - VS)] / VS$$

Where:

- CS = Conductivity of sample
- VT = Total Volume (sample + dilution water)
- CM = Conductivity measured (sample + dilution water)
- CD = Conductivity of dilution water
- VS = Volume of sample (total – dilution water)

Data Acquisition, Calculations, and Reporting

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

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.

Computer Hardware and Software

Word: This document and attached bench sheet are prepared using Microsoft Word.

Method performance

1. The desired performance criteria for this measurement are:
 - a. Detection limit: 2 $\mu\text{S/cm}$
 - b. Precision: $\pm 20\%$ RPD

Data assessment and acceptable criteria for quality control measures

1. Lab analyst should review all data for correctness (e.g., calculations).
2. Precision values are calculated for pairs of duplicate analyses.
3. Record the precision values as a percent on the bench sheet.
4. The desired precision is $\pm 20\%$ RPD.
5. The desired detection limit is $2 \mu\text{S}/\text{cm}$
6. Completed bench sheet is reviewed by lab analyst's supervisor or OEWR Laboratory Manager

Corrective actions for out-of-control or unacceptable data

1. The results for precision and blank data are compared to the acceptable values for this analysis; $\pm 20\%$ and $2 \mu\text{S}/\text{cm}$, respectively.
2. 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%).
3. If a blank value exceeds $2 \mu\text{S}/\text{cm}$, 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 $2 \mu\text{S}/\text{cm}$."
4. The samples can be reanalyzed because the sample volume will not have been depleted after the initial analysis.
5. If data are unacceptable for any reason, the analyst should review their analytical technique prior to conducting this analysis again.
6. Any maintenance steps taken to correct the operation of the instrument should be recorded in the instrument logbook.

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.

References

1. Cole-Parmer Traceable Portable Conductivity Meter Specifications. ColeParmer. Web. 16 Sept. 2015.
2. Hach Model 44600 Conductivity/TDS Meter manual. Hach Company, Loveland, CO. 1989.
3. Standard Methods for the Examination of Water and Wastewater. Method 2510. APHA, 21st Edition, 2005.

4. OEWRI. Standard Operating Procedure for: Water Sample Collection. Ozarks Environmental and Water Resources Institute, Missouri State University. 2007. 1040R03.

Tables, Diagrams, and Flowcharts

1. See page 10 for the pH/Conductivity calibration log sheet. The analyst should make a copy of this form for each batch of samples analyzed.
2. See page 11 for the Conductivity lab bench sheet.
3. See page 12 for the Conductivity bench procedures 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 # _____

pH 10 (pH standard check) Is it between 9.8 and 10.2? Yes No

Cole-Parmer Conductivity Meter

Conductivity ($\mu\text{S}/\text{cm}$) Pre _____ Post _____ Lot # _____

DI Check is it $<2.0 \mu\text{S}/\text{cm}$? Yes No

Comments _____

Date of Calibration: _____ Analyst: _____

Oakton pH Meter

pH 4 Pre _____ Post _____ Lot # _____

pH 7 Pre _____ Post _____ Lot # _____

pH 10 (pH standard check) Is it between 9.8 and 10.2? Yes No

Cole-Parmer Conductivity Meter

Conductivity ($\mu\text{S}/\text{cm}$) Pre _____ Post _____ Lot # _____

DI Check is it $<2.0 \mu\text{S}/\text{cm}$? Yes No

Comments _____

**Ozark Environmental and Water Resource Institute (OEWRI)
Lab Bench Sheet**

Project: _____ Date: _____ Analyst: _____

Sample ID	Sp. Cond ($\mu\text{S/cm}$)	pH (std.)
DI Blank		
DI Blank		
Lab Dup _____		
DI Blank		

*Lab duplicates need to be $\leq 20\%$ relative percent difference (RPD)

** DI blank should have SC <2 uS/cm and pH of around 7.0

Conductivity – Bench Procedures

Conductivity Calibration Procedure

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 $\pm 20\%$, 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).