## Field Measurement of Salinity

##### Use in conjunction with:

###### FT 1000 General Field Testing and Measurement

###### FT 1200 Field Measurement of Specific Conductance and Conductivity

###### FQ 1000 Field Quality Control Requirements

###### FS 1000 General Sampling Procedures

###### FD 1000 Documentation Procedures

##### Introduction: Salinity is an important property of industrial and natural waters. This field parameter is also important for assessing the source or origin of effluents and of the mixing between fresh and marine waters in coastal regions, in both surface water and groundwater.

##### Salinity is a unit-less parameter since by definition it is the ratio of the mass of dissolved salts to the total mass of a given volume of water. Thus, salinity values are commonly expressed as “grams of salt/kilograms of water”, parts per thousand (o/oo) or Practical Salinity Units (PSU).

##### Salinity is determined by using indirect methods involving the measurement of a related physical property such as conductivity, density, sound speed, or refractive index. The commonly used procedures in the field are determination of conductivity or density of the sample.

##### The sample salinity is calculated from an empirical relationship between salinity and the physical property as determined from a standard solution. Refer to the referenced method SM 2520 (2011) for further discussions on these topics.

##### Because of its high sensitivity and ease of measurement, the conductivity method is most often used to determine salinity. (Note – using a hydrometer to measure the density or the specific gravity to obtain an approximate salinity value is not recommended for reporting purposes.)

##### Equipment and Supplies

##### Field Instrument: Depending on the chosen method, use:

##### Any self-contained conductivity instrument with a platinum or graphite electrode type cell, and a temperature sensor. Some conductivity instruments have meter scales pre-calibrated for salinity and are sometimes referred to as “Salinometers”. For routine fieldwork use a conductivity meter accurate and reproducible to at least 5% or 1 mmho/cm (whichever is greater), and equipped with temperature-compensation adjustment; or

##### A precision “vibrating flow densimeter” and a field thermometer. For informational purposes, see Millero & Poisson, 1981a, International one-atmosphere equation of state of seawater. Deep-Sea Research 28:625–629.

##### Standards:

##### Purchased or laboratory-prepared Standard Seawater and/or potassium chloride (KCl) standards of appropriate equivalent salinities. Use standards that bracket the expected sample range.

##### See methods 2510, *Conductivity*, and 2520, *Salinity* (2011), in Standard Methods for the Examination of Water and Wastewater (see Standard Methods Online, http://www.standardmethods.org.

##### Deionized (DI) water for calibration of the densimeter (if used).

##### Recordkeeping and Documentation Supplies:

###### Field logbook (waterproof paper is recommended) or field forms

###### Indelible pens

##### Calibration and Use

##### Conductivity Method

##### Refer to FT 1200 and instructions in this section for the conductivity method.

##### Calibration: - Calibrate the instrument per manufacturer’s instructions using one calibration standard, either Standard Seawater or a KCl solution, as applicable, or follow the manufacturer’s specific instructions. The acceptance criterion for initial calibration and calibration verifications is that the instrument reading is within +/- 5% of the standard value. For example, when calibrating with Standard Seawater, S = 35, the meter must read in the 34 to 36 range in order to be acceptable.

##### Use Standard Seawater (S = 35) when measuring salinity in the open ocean or estuaries with a predominance of seawater.

##### KCl may be used in estuarine waters with low salinity (S = 0 – 40).

##### If the meter does not provide a direct reading of salinity, use the equation found in SM 2520 B (2011) to convert the readings to salinity.

##### Follow the calibration activities in FT 1000, section 2.2, including requirements for chronological and quantitative bracketing.

##### Do not reuse standards for initial calibrations.

##### If using conductivity standards for calibration and verification but recording environmental measurements for salinity, document both conductivity and measured salinity values of verification standards to ensure quantitative bracketing requirements are met.

##### Field Use: - Follow FT 1200, section 3.3 for measuring samples. Immerse the probe *in situ* at a representative sampling location. Allow readings to stabilize before recording the sample result. Follow the manufacturer’s instructions for temperature compensation, if needed.

##### General Concerns for Conductivity Method

##### Ensure stable sample and sensor temperature before calibrating or taking sample readings. Drifting sensor or sample temperature may produce erroneous sample measurements, calibrations, or verifications.

##### Any residual standard, sample, or DI water remaining on the conductivity (salinity) sensor may affect the measurement of the subsequent standard or sample. This is especially true when samples or low-concentration standards are measured after measuring high-concentration standards. Thoroughly rinse the conductivity (salinity) sensor with DI water and a small aliquot of fresh standard before calibrating the instrument and between standard solutions. For verifications, rinse the sensor with DI water and/or standard before each measurement and between standard solutions. For in-situ sample measurements, ensure adequate flushing of the sensor with fresh sample water prior to taking measurements.

##### Drifting readings or an inability to calibrate the sensor may also indicate a fouled electrode. Clean the electrode per the manufacturer’s instructions or replace.

##### When successful calibration and verification cannot be achieved after ensuring that temperatures have stabilized and the sensor electrodes are clean and free of residual sample or standard from the previous measurement, suspect opened containers of standards, especially after repeated openings, when near the manufacturer’s expiration date or when little standard volume remains in the container. Low-concentration conductivity standards are seldom stable for an extended period after opening.

##### Density Method

##### The vibrating flow densimeter is an instrument that allows for precise and rapid measurements of the density of a liquid, such as water. The principle of operation is the effect of the density of the sample on the frequency of a vibrating tube encased in a constant-temperature jacket. The measurement is made by passing the water (sample) through the vibrating tube and reading the period of vibration that is electronically sensed and displayed by the densimeter. The sample density (D) is proportional to the square of the period of vibration (T):

 D = a + bT2

Where a and b are terms determined by calibration, b being determined by calibration of the densimeter with Standard Seawater. The difference between the density of the sample (D) and that of pure water (D0) is given by:

 D – D0 = b (T2 – T02)

Where T and T0 are, respectively, the periods of the sample and that of pure (DI) water. Using this second equation, you only have to deal with the term b for calibration purposes. Hence, the system can be calibrated with two liquids: pure water and Standard Seawater. Follow the manufacturer’s instruction for calibration of the densimeter.

The salinity of the sample is determined by the one-atmosphere international equation of state for seawater. This equation relates the difference (D – D0) to the practical salinity as a function of the temperature of the sample (which is also measured by the densimeter or the field thermometer). For further details on this calculation read the referenced method SM 2520 C (2011).

##### Preventive Maintenance: Refer to FT 1000, section 3.

##### Documentation

##### Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications, and sample measurements.

##### Note the date of receipt, expiration date and date of first use for all standards and reagents. Document acceptable verification of any standard used after its expiration date.

##### Record the concentration or other value for the standard in the appropriate measurement units.

##### Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

##### Retain vendor assay specifications for standards as part of the calibration record.

##### Record the grade of standard or reagent used.

##### When formulated in-house, document all calculations used to formulate calibration standards. Record the date of preparation for all in-house formulations.

##### Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

##### Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

##### Retain vendor certifications of all factory-calibrated instrumentation.

##### Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.

##### Record the time and date of all initial calibrations and all calibration verifications.

##### Record the instrument reading (value in appropriate measurement units) of all calibration verifications to the level of resolution stated by the sensor manufacturer. Record both conductivity and salinity readings if applicable per 3.1.1.6 above.

##### Record the name of the analyst(s) performing the calibration or verification.

##### Document the specific standards used to calibrate or verify the instrument or field test with the following information:

##### Type of standard or standard name (e.g., salinity standard)

##### Value of standard, including correct units (e.g., salinity = 20 o/oo)

##### Conductivity and measured salinity value of a standard if using conductivity standards for calibration/verification but recording environmental measurements for salinity.

##### Link to information recorded according to section 5.1 above

##### Retain manufacturers’ instrument specifications.

##### Document whether successful initial calibration occurred.

##### Document whether each calibration verification passed or failed.

##### Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

##### Document date and time of any corrective action.

##### Note any incidence of discontinuation of use of the instrument due to calibration failure.

##### Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

##### Record all field-testing measurement data, to include the following:

###### Project name

###### Date and time of measurement or test (including time zone, if applicable)

###### Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)

* + Latitude and longitude of sampling source location (if required)

###### Analyte or parameter measured

###### Measurement or test sample value, recorded to the level of resolution stated by the sensor manufacturer (value in appropriate measurement units)

###### Reporting units

* + “J” qualifier code and explanatory comments if the sample measurement is not chronologically and quantitatively bracketed by acceptable calibrations and verifications per requirements in FT 1000, section 2.2

###### Initials or name of analyst performing the measurement

###### Unique identification of the specific instrument unit(s) used for the test(s)