Bermuda Biological Station For Research, Inc.
Bermuda Atlantic Time-series Study

Chapter 5. Salinity Determination

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Modified from: Guideline Instruments (1978)

1.0 Scope and field of application

This procedure describes the method for the determination of seawater salinity. The method is suitable for the assay of oceanic levels (0.005–42). This method is a modification of one published by Guildline Instruments (1978).

2.0 Definition

The method determines the practical salinity (S) of seawater samples which is based on electrical conductivity measurements. The Practical Salinity Scale 1978 (PSS 78) defines the practical salinity of a sample of seawater in terms of the conductivity ratio (K_{15}) of the conductivity of the sample at a temperature of 15°C and pressure of one standard atmosphere to that of a potassium chloride (KCl) solution containing 32.4356 g of KCl in a mass of 1 kg of solution.

3.0 Principle

A salinometer is used to measure the conductivity ratio of a sample of seawater at a controlled temperature. The sample is continuously pushed through an internal conductivity cell where electrodes initiate signals that are proportional to the conductivity of the sample. Using an internal preset electrical reference, these signals are converted to a conductivity ratio value. The number displayed by the salinometer is twice the conductivity ratio. The internal reference is standardized against the recognized IAPSO standard seawater.

4.0 Apparatus

Guildline model 8400A Autosal Salinometer. The Autosal has a 4 electrode cell which measures the conductivity ratio of a sample seawater in less than one minute. The salinity range of the instrument is about 0.005–42 and has a stated accuracy of ± 0.003 by the manufacturer. In practice, accuracies of 0.001 are possible.

5.0 Reagents

IAPSO Standard Seawater. Standard seawater for instrument calibration.

6.0 Sampling

6.1 Salinity samples are collected from OTE bottles at 35 depths from 0-4200m. Duplicate deep water samples are taken (>3000m).

6.2 The sample bottles are 250 ml clear borosilicate glass bottles with plastic screw caps. A plastic insert is used in the cap to form an effective airtight seal. Sample remaining after analysis is always left in the bottles to prevent salt crystal buildup due to evaporation and to maintain an equilibrium with the glass. When drawing a new sample, the old water is discarded and the bottle is rinsed three times with new sample water. The bottle is then filled to the shoulder and capped.

6.3 When sampling is complete, the set of salt bottles is taken into the temperature controlled laboratory. The cap of each bottle is momentarily removed, so that the inside of the cap and the threads of the bottle can be quickly dried with a Kimwipe and a clean plastic insert pressed in the bottle mouth. The cap is then replaced and firmly tightened. Samples are stored in the temperature controlled laboratory for later analysis (typically within 1-5 days of collection).

6.4 Every six months, the bottles are acid washed (1 M HCl), and rinsed and filled with Milli-Q water. After this cleaning they are rinsed five times with copious amounts of sample before filling.

7.0 Procedures

7.1 The samples are analyzed on a Guildline AutoSal 8400A laboratory salinometer using the manufacturer's recommended techniques. Samples are not run unless the ambient room temperature is ≤2°C below the salinometer bath temperature.

7.2 The salinometer is calibrated with IAPSO standard seawater. At least two standards are run prior to running the samples. The samples are run only if two standards give identical readings. At the end of the run, two new standards are run to check for instrument drift. The drifts are generally found to be zero. Using this procedure, the instrument can give a salinity precision of ± 0.001-0.002.

8.0 Calculation and expression of results

The calculation of salinity is based on the 1978 definition of practical salinity (UNESCO, 1978). The following gives the necessary computation to calculate a salinity (S) given a conductivity ratio determined by the salinometer:

$$S = a_0 + a_1 R_T^{\frac{1}{2}} + a_2 R_T + a_3 R_T^{\frac{3}{2}} + a_4 R_T^2 + a_5 R_T^{\frac{5}{2}}$$

$$+ \frac{T-15}{1+kT-15}\left\{ b_0 + b_1 R_T^{\frac{1}{2}} + b_2 R_T + b_3 R_T^{\frac{3}{2}} + b_4 R_T^2 + b_5 R_T^{\frac{5}{2}} \right\}$$

Where:

a_0 = 0.0080 b_0 = 0.0005

a_1 = -0.1692 b_1 = -0.0056

a_2 =25.3851 b_2 = -0.0066

a_3 =14.0941 b_3 = -0.0375

a_4 = -7.0261 b_4 = 0.0636

a_5 = 2.7081 b_5 = -0.0144

k = 0.0162

R_T = conductivity ratio of sample (=0.5 salinometer reading)

T = bath temperature of salinometer (°C)

$$\sum_{i=0}^{5} a_i = 35.0000$$

$$\sum_{i=0}^{5} b_i = 0.0000$$

for:

-2°C ≤ T ≤ 35°C

2 ≤ S ≤ 42

9.0 Quality assurance

9.1 *Quality control*: The bottle salinities are compared with the downcast CTD profiles to search for possible outliers. The bottle salinities are plotted against potential temperature and overlaid with the CTD data. Historical envelopes from the time-series station are further overlaid to check for calibration problems or anomalous behavior.

9.2 *Quality assessment*: Replicate deep water (>3000m) samples are found to agree in salinity, ±0.001.

9.3 Regular intercalibration exercises are performed with other laboratories.

10.0 References

Guildline Instruments. (1981). Technical Manual for 'Autosal' Laboratory Salinometer Model 8400.

UNESCO. (1978). *Technical Papers in Marine Science*, **28**, 35pp.