Gravimetric Determination of Density and Total Dissolved Solids on Water Samples

1. Introduction

Density and Total Dissolved Solids (TDS) at 180° C are two measurements that can be used to evaluate water samples. For TDS measurements, this method is intended for samples that have concentrations of total dissolved solids that are greater than about 200 mg/L since the required sample size needed to evaporate lower concentrations of TDS would be greater than 100 ml of sample. For samples that have a specific conductance greater than 10,000 uS/cm, density will also be used to correct for the gravimetric dilution of the samples from mg/kg of solution to mg/L of solution. This method was modified from the procedures that were presented in the USGS publication edited by Fishman and Friedman (1989).

2. Interfaces with Other Methods

EGL Method 25, Method for Sample Login, Control, and Disposition
EGL Method 29, Calibration of Laboratory Scales and Analytical Balances
EGL Method 31, Determination of Cation and Anion Concentrations in Water Samples by Ion Chromatography

3. Materials and Equipment

- 100 ml glass beakers or aluminum weighing dishes
- 15 ml test tube to weigh water samples
- Deionized water
- Disposable plastic beakers
- Analytical balance capable of weighing up to 200 grams to the nearest 0.1 milligram.
- Drying Oven, 180° C to evaporate samples for TDS measurement.
- Thermometer
- Digital pipettes and pipette tips
- Desiccator

4. Procedure

Density, gravimetric

The density determination is based on the weight of a carefully measured volume of sample at a given temperature, usually 20°C. Prior to measurement, samples should be allowed to equilibrate with ambient room temperature which should be documented to the nearest 1°C. Pour about 12 ml of sample into a disposable beaker. Using a pipette, transfer 10 ml of the sample from the beaker into a tared test tube being careful not to draw any air into the pipette. Cap the test tube to prevent water loss by evaporation and weigh the solution to the nearest 1 mg. After measurement, pour the sample from the test tube back into the sample beaker. Repeat the sample measurement two more times so that each sample has three measured densities. The reported density is then calculated from the average of the three measurements and corrected for the departure of the ambient sample temperature from 20°C using the following correction factor:

$$\frac{\text{Relative density (20°C)}}{\text{Relative density (test temperaure in °C)}}$$

See Attachment 1 for relative density values of water at various temperatures.

Total Dissolved Solids at 180°C

TDS is determined by evaporating a carefully measured volume of sample to dryness at 105°C then heating the sample to 180°C for two hours and weighing the residue. Pipette a volume of filtered sample containing 20 to 200 mg dissolved solids (100 mL max) into a tared glass beaker or aluminum weighing dish and record the volume of sample used. An estimate of the expected amount of dissolved solids in a sample can be calculated by multiplying the specific conductance by a factor of 0.65. For example, a sample with a specific conductance of 10,000 uS/cm would have an anticipated TDS of about 6,500 mg/L or about 6.5 mg/ml of sample. Evaporate the sample to dryness at 105°C then dry in an oven at 180°C for 2.0 hours. Cool in a desiccator and immediately weigh. Record the weight to the nearest 0.1 mg.

5. Calibration and Quality Control Samples

The electronic balance is calibrated using EGL Method 29 and the digital pipettes are calibrated using EGL Method 31. To check for the proper operation of the pipette used to measure the volume of samples, first measure the density of deionized water and compare the measured density with the values in Attachment 1. A standard for TDS can be prepared by dissolving a measured weight of sodium chloride into deionized water. This standard will then be used as a quality control sample for the TDS measurements.

6. Limits, Precautions, and Interferences

The weight of the residue for the TDS measurement is limited to 200 mg to ensure that all of the residue is fully dried at 180°C. Large sample residues can create a crust during evaporation and entrap water that will not be completely vaporized during the drying process. Large volumes of residues may also release the water of crystallization more slowly than do thin films of residue.

When drawing the sample into the pipette, avoid drawing air into the pipette as the entrapped air will displace the sample and affect the sample volume. If air is drawn into the pipette, dispel the sample back into the sample beaker and re-draw the sample into the pipette.

7. Acceptance of Data

The satisfactory performance of this procedure will be judged by the analysis of the sodium chloride quality control sample for TDS measurements and replicate measurements of the sample density. For TDS, the measured TDS value for the

quality control sample should be within ±10% of the prepared concentration. For sample density, the three measured sample weights should span a range of no more than 50 mg. If the results are found to be outside these acceptance limits, the samples will be reanalyzed.

Precision of the results are expected to be better than ±5% of the reported values.

8. Data Handling and Transfer

Data from this procedure will be sample weights from the balance. The weights may either be recorded onto a sample form and then transferred into a computer spreadsheet or directly input into a computer spreadsheet. The ambient air temperature is only used to correct the relative densities from the measurement temperature to the reporting relative density at 20ºC. Temperature corrections for the density measurements will be performed within the spreadsheet.

The spreadsheet will be used to transfer the data into the LIMS. The results will then be validated by the Analyst and approved by the Inorganic Lead.

9. References

5–A1.Methods for determination of inorganic substances in water and fluvial sediments, by M.J. Fishman and L. C. Friedman, editors: USGS—TWRI Book 5, Chapter A1. 1989. 545 pages.

10. Attachments

Attachment 1: Relative Density Values of Water at Various Temperatures

11. History of Changes

Revision 0: initial issue.

Relative Density Values of Water at Various Temperatures

Temperature, ºC	Density, g/cc
10	0.999699
11	0.999605
12	0.999494
13	0.999377
14	0.999244
15	0.999099
16	0.998942
17	0.998774
18	0.998595
19	0.998404
20	0.998203
21	0.997991
22	0.997769
23	0.997537
24	0.997295
25	0.997043
26	0.996782
27	0.996511
28	0.996232
29	0.995943
30	0.995645