Understanding Total Dissolved Solids (TDS)

Introduction – Water has the ability to dissolve a large variety of materials.

Approved Methods – There are three different approved methods; all of which follow a similar analysis procedure. The notable differences are slight variations in requirements for the supplies used.

• SM2540 C – 1997
• ASTM D5907-03
• USGS I-1750-85

Method Summary – A measured volume of aqueous sample is filtered through a glass fiber filter disk. The filtrate is collected in a preweighed evaporating dish. The liquid is evaporated to dryness at 104°C and then placed in an oven at 180°C. The dish and residue are weighed with the mass of the residue being determined by difference.

What You Should Know – The analysis procedure in Standard Methods seems to be the most detailed in terms of the specified equipment and data quality requirements. Additionally, it is probably the most commonly used method. Most of this section will use the steps as presented in Standard Methods as the basis for the discussion.

Standard Methods has the same requirement for TDS as they do for all gravimetric analyses. The residue must go through the drying and weighing portion of the procedure at least twice and as many times as necessary to obtain successive weights within 0.5 mg or a change of less than 4% from the previous weight, whichever is smaller. The requirement for the dish is that it be made out of platinum, porcelain, or high-silica glass. Platinum is typically the lightest weight dish although very expensive. Porcelain on the other hand is cheaper but much heavier. A standard size evaporating dish will hold approximately 100 mL and has a mass of around 80 g. Porcelain’s porous nature and affinity for humidity can make it difficult to get replicate weights to agree within 0.5 mg on a mass this large. The best way to achieve consistent results is to allow the same cooling/desiccating time each time the sample is weighed. A one hour wait time is generally enough to allow cooling to balance temperature. The best check for equal drying time is the weight of the dish for the blank analysis.

Because different temperatures can have varying effects on dissolved substances the cycle of drying and weighing is particularly important with TDS. The drying temperature of 180°C is necessary to drive off all mechanically occluded water. Most of the water of crystallization will also be removed at this temperature. Some will remain, especially if high amounts of sulfates are present. This temperature is also sufficient to drive off carbon dioxide and convert all forms of bicarbonate to carbonate. Too high of a temperature will cause further conversion to oxides. Samples that have high amounts of these species may require longer drying times to ensure complete conversion. Some organic matter is lost to volatilization at this temperature, but this loss is kept to a minimum. Some inorganic salts such as chlorides and nitrates may also volatilize at this temperature. Despite the potential for loss of solids, 180°C is a good compromise between complete removal of water and minimization of volatile loss.
The choice of filter also plays a big role in TDS determination. Because total suspended solids (TSS) are defined as the particles retained by a 1.5 μm glass fiber filter, TDS must necessarily be defined as everything that passes through said filter. Use of a common pore size is critical to method adherence and in comparison of results between analyses.

Prior to use the filters and dishes need to be prepared. The filters are prepared by washing them under vacuum with three portions of 20 mL volumes of reagent water. The washings are discarded after use. This serves to remove any particles that may have come loose from the filter as well as remove any soluble material that could pass through and bias the results high. Similarly, the evaporating dishes should be washed to remove any residue from a previous analysis. The dish should then be placed in a drying oven at 180 C for at least one hour. Once the dishes are dry they should be kept in a desiccator until ready for use. The initial dish weight should be obtained immediately prior to use.

Sample size selection is also important to obtaining an accurate result. Standard Methods instructs to “Choose sample volume to yield between 2.5 and 200 mg dried residue.” Both upper and lower limits are important to observe. The lower limit of 2.5 mg is 5 times the allowed variance between replicate sample weights. This gives a sufficient signal to noise ratio to allow for good measurements. The upper limit of 200 mg serves to allow for complete and timely removal of water from the crystals. Amounts greater than 200 mg have a tendency to form multiple layers of crystals while drying. This could cause water to be trapped between two layers of crystals and result in a high bias. If the dish you have available is not of sufficient size to accommodate the volume of sample needed, it is allowable to add successive portions of sample to the dish after evaporation. Unlike TSS, Standard Methods does not give an upper limit as to the amount of sample that can be filtered for this test.
Method Procedure

Note – This is not intended to be a standalone method and does not address all safety or quality control aspects that may be required. Please consult your local regulations to comply with all requirements.

1. Collect your sample in the appropriate size glass or plastic container.
2. Preweigh a porcelain, platinum or high silica glass evaporating dish.
3. Connect your Vacuum pump to the side arm of your vacuum flask.
4. Seat your filter holder in the top of your vacuum flask or use a manifold for increased numbers of simultaneous samples and higher efficiency.
5. Place a washed and dried filter in your filter holder. Wet it with a small amount of DI water to seat it and secure the funnel to the base. Using a washed and dried filter saves you the filter preparation steps outlined in Standard Methods. If you prefer to do those steps yourself you may use an unwashed filter and prepare the filter accordingly.
6. Mix your sample thoroughly and measure out a portion expected to contain between 2.5 and 200 mg residue.
7. Pull your sample through the filter. Wash the filter and collected solids with three successive 10 mL portions of reagent water. This will remove dissolved solids trapped in and on the filter. Continue suction for about three minutes after filtration is complete.
8. Transfer the total filtrate, including the washings, to your evaporating dish and record the sample volume.
9. Evaporate the sample to dryness on a steam bath or in a drying oven.
10. Dry the dishes for at least one hour at 180 ± 2 C.
11. Remove dishes from the oven and place in a desiccator until at room temperature.
12. Weigh each dish on a balance to the nearest 0.0001 g and record the weight.
13. Repeat steps 10-12 at least one more time and as many as are necessary to obtain a reading ± 0.0005 g from the previous weight.
14. Calculate your result with the following equation

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\frac{\text{Weight}_{\text{final}} (g) - \text{Weight}_{\text{initial}} (g) \times 1,000,000}{\text{Sample Volume (mL)}} = \text{mgTDS/L}
\]

The final weight is the weight of the dish plus the dried residue and the initial weight is the weight of the dish.

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