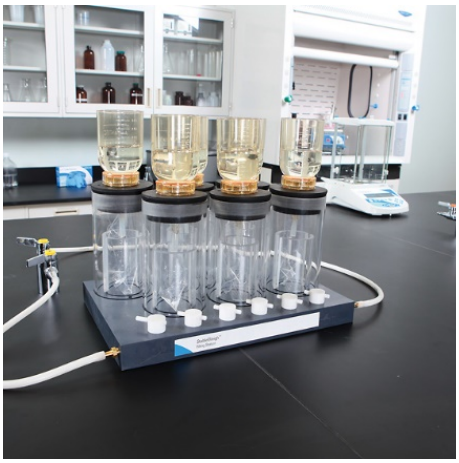
An Alternative to Total Dissolved Solids and Total Solids Analysis

by Joe Boyd



An alternative to preparing, weighing, cooling and cleaning dishes and crucibles for total dissolved solids (TDS) and total solids (TS) analysis uses disposable prepared vessels, eliminating hours of manual labor and increasing efficiencies.

The basics of TDS testing

TS are the materials left in a vessel after a sample is evaporated at a defined temperature. TDS are the portion of the total solids that pass through a 2.0-µm (or smaller) nominal-pore-size filter. For TS, the liquid sample is evaporated at a temperature of 104 °C; for TDS, the filtrate is first evaporated and the evaporating dish is then transferred to a 180 °C oven for at least one hour. In both analyses, the evaporating dish is cooled in a desiccator to balance temperature and is then weighed. These heating, cooling and weighing steps are repeated until a constant weight of ±0.5 mg is achieved. The difference between the post- and preweight is the amount of TS or TDS in milligrams for the sample.

The key to successful TS and TDS analysis is the container from which the filtrate is evaporated. Approved analytical methods such as Standard Methods 2540B and 2540C have specific instructions regarding preparation of the container to achieve the most accurate results possible; the evaporation dishes must hold at least 100 mL and be constructed of porcelain, platinum or high-silica glass. The dish must be washed with soapy water to remove residue, rinsed with deionized water and then dried for one hour at 104 °C for TS or 180 °C for TDS. It should then be stored in a desiccator until ready for use (the dish should be weighed immediately prior to use).[1,2]

Vessels for TDS

StableWeigh™ vessels from Environmental Express are an alternative to traditional dishes or crucibles. They are constructed of a proprietary blend of high-temperature plastics and arrive at the laboratory as prepared vessels, ready to use for TS or TDS analysis. Each vessel meets the preparation requirements of Standard Methods and is preweighed, with the weight and ID printed on the vessel. This saves several hours that would be spent manually cleaning and weighing dishes. The vessels are also disposable.

StableWeigh vessel advantages

Traditional dishes used for TS and TDS analysis weigh around 80 g, and the sample residue range per Standard Methods is 10 to 200 mg. This creates sensitivity issues in the analysis that can lead to erroneous results and difficulties establishing weight stability. StableWeigh vessels weigh between 3 and 4 g, giving much better resolution on lower TS/TDS ranges and helping to achieve weight stability faster.

One of the most widely used evaporating dishes is the porcelain crucible. These are shipped to the laboratory with a glaze that helps decrease moisture absorption from the atmosphere, which is important when establishing dish preweights and weight stability at the end of analysis. Over time, the glaze wears off from washing the crucibles to remove residue from previous analyses. Porcelain is a porous material that draws moisture from the atmosphere, affecting weights. This leads to data uncertainty and adversely affects results. StableWeigh vessels are constructed of a proprietary blend of high-temperature plastics that will not absorb moisture from the atmosphere. Because the vessels are disposable, there is also no risk of altering their composition by washing.

Unique properties of vessel material and design greatly reduce cooling times. While dishes or crucibles constructed of porcelain or glass typically require about one hour in a desiccator to cool down after a process conducted in a 104 °C or 180 °C oven, StableWeigh vessels require only 10 to 15 minutes.

Method acceptance

StableWeigh vessels are listed in the 23rd Edition of *Standard Methods* SM 2540B-2015 for Total Solids (TS) and SM 2540C-2015 for Total Dissolved Solids (TDS). The StableWeigh vessels are also compliant with ASTM D5907-2013.

References

1. Rice, E.W.; Baird R.B. et al., Eds. *Standard Methods for the Examination of Water and Wastewater;* vol. 22, 2012; APHA, AWWA, WEF: Washington, D.C.
2. Baird, R.B.; Eaton A.D. et al. *Standard Methods for the Examination of Water and Wastewater*; online edition, 2016; APHA, AWWA, WEF.
3. https://www.epa.gov/sites/production/files/2015-08/documents/cwa-method-flexibility_memo_11-20-2007.pdf

Table 1 – Method blank data for StableWeigh shows results within method acceptance criteria*

Table A1: LRB StableWeigh Blank, Oven								
Sample #	**Volume (ml)**	**Initial weight (g)**	**Final weight 1 (g)**	**Final weight 2 (g)**	**Final weight 3 (g)**	**Two Consecutive Weights Difference (mg)**	**Final weight used (mg)**	**Percent Change**
1	25	3.9073	3.9075	3.9079		0.4	3.9079	0.01536%
2	25	3.8838	3.8848	3.8851		0.3	3.8851	0.03347%
3	25	3.9673	3.9673	3.9675		0.2	3.9675	0.00504%
4	25	3.6667	3.6667	3.6668		0.1	3.6668	0.00273%
5	25	3.6966	3.6969	3.6972		0.3	3.6972	0.01623%
6	25	3.6898	3.6897	3.6902		0.5	3.6902	0.01084%
7	25	3.7101	3.7100	3.7105		0.5	3.7105	0.01078%
8	25	3.6792	3.6790	3.6792		0.2	3.6792	0.00000%
9	25	3.7136	3.7134	3.7134		0.0	3.7134	-0.00539%
10	25	3.6771	3.6775	3.6779		0.4	3.6779	0.02176%
							Average	0.01108%
							Standard Deviation	0.01136%

*Laboratory Reagent Blank (LRB)

Table 2 –LFB, inorganic material for StableWeigh shows results within ±4% of the true value and obtaining weight stability in 10 out of 10 samples on first try*

Table A2: LFB Low Inorganic Standard TS StableWeigh Oven										
Sample #	**Bag #**	**Volume (ml)**	**Initial weight (g)**	**Final weight 1 (g)**	**Final weight 2 (g)**	**Final weight 3 (g)**	**Two Consecutive Weights Difference (mg)**	**Final weight used (mg)**	**Final Solids Recovered Weight (mg)**	**Percent Recovery**
1	**1**	25	3.9096	3.9676	3.9676		0.0	3.9676	58.0	100.00%
2	**2**	25	3.6663	3.7238	3.7237		-0.1	3.7237	57.4	98.97%
3	**3**	25	3.8910	3.9483	3.9482		-0.1	3.9482	57.2	98.62%
4	**4**	25	3.8949	3.9521	3.9521		0.0	3.9521	57.2	98.62%
5	**5**	25	3.6003	3.6570	3.6570		0.0	3.6570	56.7	97.76%
6	**6**	25	3.8687	3.9254	3.9251		-0.3	3.9251	56.4	97.24%
7	**7**	25	3.5858	3.6423	3.6420		-0.3	3.6420	56.2	96.90%
8	**8**	25	3.9043	3.9612	3.9608		-0.4	3.9608	56.5	97.41%
9	**9**	25	3.9007	3.9568	3.9565		-0.3	3.9565	55.8	96.21%
10	**10**	25	3.8964	3.9536	3.9534		-0.2	3.9534	57.0	98.28%
								Average	56.8	98.00%
								Standard Deviation	0.6	1.12%

*LFB, laboratory fortified blank.

Table 3 –LFB, inorganic material for porcelain evaporating dishes shows results within ±6% of the true value and obtaining weight stability in 6 out of 10 samples on first try

Table A3: LFB Low Inorganic Standard TS Evaporation Dish										
Sample #	**Dish #**	**Volume (ml)**	**Initial weight (g)**	**Final weight 1 (g)**	**Final weight 2 (g)**	**Final weight 3 (g)**	**Two Consecutive Weights Difference (mg)**	**Final weight used (mg)**	**Final Solids Recovered Weight (mg)**	**Percent Recovery**
1	**3**	25	80.7460	80.8000	80.8022	80.8017	-0.5	80.8017	55.7	96.03%
2	**23**	25	92.0546	92.1084	92.1108	92.1106	-0.2	92.1106	56.0	96.55%
3	**16**	25	70.3770	70.4318	70.4319		0.1	70.4319	54.9	94.66%
4	**5**	25	80.1832	80.2397	80.2401		0.4	80.2401	56.9	98.10%
5	**7**	25	77.3485	77.4038	77.4048	77.4045	-0.3	77.4045	56.0	96.55%
6	**A**	25	83.3934	83.4492	83.4490		-0.2	83.4490	55.6	95.86%
7	**13**	25	71.7404	71.7981	71.7975	71.7972	-0.3	71.7972	56.8	97.93%
8	**18**	25	69.7256	69.7826	69.7826		0.0	69.7826	57.0	98.28%
9	**20**	25	91.8968	91.9542	91.9547		0.5	91.9547	57.9	99.83%
10	**1**	25	80.0774	80.1351	80.1351		0.0	80.1351	57.7	99.48%
								Average	56.5	97.33%
								Standard Deviation	1.0	1.66%

Table 4 – Biosolids (high organic content) sample results using StableWeigh shows weight stability in 10 out of 10 samples on first try

Table A4: Biosolids, Drying Oven, StableWeigh									
Sample #	**Bag #**	**Volume (ml)**	**Initial weight (g)**	**Final weight 1 (g)**	**Final weight 2 (g)**	**Final weight 3 (g)**	**Two Consecutive Weights Difference (mg)**	**Final weight used (mg)**	**Final Solids Recovered Weight (mg)**
1	**1**	25	3.9184	4.6407	4.6406		-0.1	4.6406	722.2
2	**2**	25	3.9125	4.6331	4.6328		-0.3	4.6328	720.3
3	**3**	25	3.9114	4.6252	4.6252		0.0	4.6252	713.8
4	**4**	25	3.8827	4.5990	4.5987		-0.3	4.5987	716.0
5	**5**	25	3.8992	4.6250	4.6248		-0.2	4.6248	725.6
6	**6**	25	3.9333	4.6584	4.6582		-0.2	4.6582	724.9
7	**7**	25	3.8864	4.6068	4.6068		0.0	4.6068	720.4
8	**8**	25	3.9001	4.6197	4.6195		-0.2	4.6195	719.4
9	**9**	25	3.8999	4.6155	4.6159		0.4	4.6159	716.0
10	**10**	25	3.9105	4.6276	4.6273		-0.3	4.6273	716.8
								Average	719.5
								Standard Deviation	3.9

Table 5 – Biosolids (high organic content) sample results using porcelain evaporating dishes shows weight stability in 0 out of 10 samples and weight stability never being achieved in 6 out of 10 samples after two tries

Table A5: Biosolids, Drying Oven, Evaporation Dish									
Sample #	**Dish #**	**Volume (ml)**	**Initial weight (g)**	**Final weight 1 (g)**	**Final weight 2 (g)**	**Final weight 3 (g)**	**Two Consecutive Weights Difference (mg)**	**Final weight used (mg)**	**Final Solids Recovered Weight (mg)**
1	**20**	25	91.8975	92.6090	92.6163	92.6167	0.4	92.6167	719.2
2	**16**	25	70.3774	71.0945	71.1032	71.1034	0.2	71.1034	726.0
3	**A**	25	83.3937	84.1089	84.1164	84.1169	0.5	84.1169	723.2
4	**3**	25	80.7467	81.4655	81.4724	81.4721	-0.3	81.4721	725.4
5	**5**	25	80.1838	80.9014	80.8984	*	-3.0	*	*
6	**7**	25	77.3493	78.0623	78.0624		0.1	78.0624	713.1
7	**18**	25	69.7260	70.4513	70.4464	*	-4.9	*	*
8	**23**	25	92.0549	92.7767	92.7743	*	-2.4	*	*
9	**13**	25	71.7408	72.4644	72.4641		-0.3	72.4641	723.3
10	**1**	25	80.0785	80.7966	80.7966		0.0	80.7966	718.1
								Average	721.2
								Standard Deviation	4.6
*** Crucible Weight Varies Due to Crusting on Surface – weight stability could not be achieved**									