Light Weight Evaporation Vessel for the Determination of Dissolved Solids

David Smith, Technical Specialist, Environmental Express, Inc.

Method Summary

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

Current Difficulties with the Method

The methods call for repeated weighings of the dried residue and dish to establish that all water has been removed from the dried residue. The requirement for replicate weights of the same sample must be within ±0.5 mg. The total mass of sample that is allowed to be used is limited to no more than 200 mg. A typical evaporating dish used by labs has a weight of approximately 80 g. This results in a difference of five orders of magnitude between the mass of the dish and the resolution needed for the required precision. Further, because of the material typically in use for the evaporating dishes, analysts must often wait for at least one hour after removal from the oven to ensure the dishes are cool enough to handle and will not cause instability on the scale due to thermal drafts.

Objectives

The purpose of this development is to produce a product that light enough for the mass of the residue to be more significant and provide shorter cooling times. The vessels must fit within currently accepted method guidelines to avoid method modification approval times. Additional desired specifications include the ability to prepare the bags for use prior to purchase by the customer. This includes obtaining an initial dry weight and printing that information on the bag to eliminate preparation steps by the end user.

Method Descriptions of Suitable Vessels

Standard Methods is more rigid in their material description, while *ASTM* discusses the theory of the dish and leaves more options available.

Standard Methods 2540B – Dishes of 100 mL capacity made of one of the following materials:

1) Porcelain, 90 mm diameter

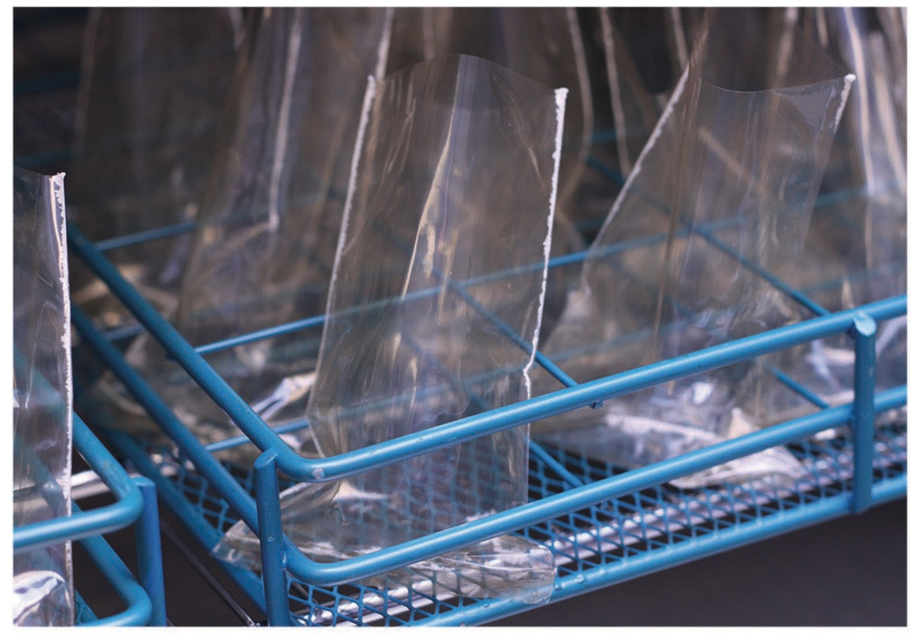
2) Platinum – Generally satisfactory for all purposes.

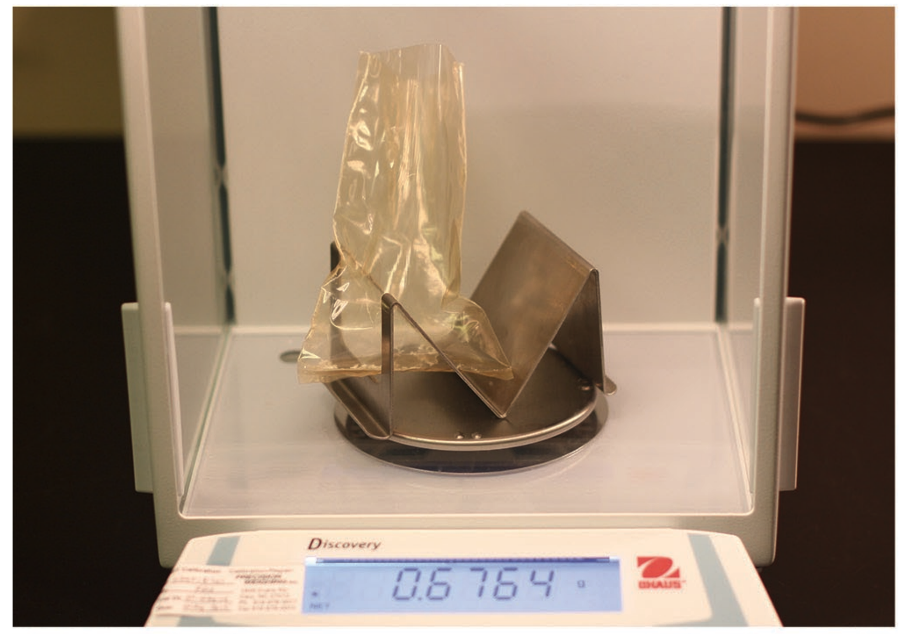
3) High-silica glass

ASTM D5907-10 – 6.3 – Evaporating Dishes, 70 mL to 250 mL capacity, not to exceed 200 g in weight.

11.2.1 NOTE 5 – The dish should be as small as practical to contain the volume of the sample plus the rinses. The relative mass of the dish needs to be kept at a minimum in order to be able to measure small mass differences with any accuracy. This is because of the inherent difficulties of trying to control temperature and moisture on a large mass within the requirements of the test. For larger volumes, it may be more practical to evaporate smaller increments, refilling the dish when dry until all the sample is transferred.

11.2.1 NOTE 6 – The dish should be made of a material that is inert to the sample. Materials such as aluminum will oxidize when heated with many liquids, increasing the mass of the pan. Glass or light weight ceramic is generally preferred.





Challenges

Several immediate challenges were foreseen in the development of the vessels while others sprang up during development.

<u>Expected Challenges</u> – The biggest challenge was to find a material light weight enough to bring the desired advantages and still offer mass stability at the required temperature. Additional requirements for the material include general inertness to expected constituents and minimal capacity to absorb moisture from the atmosphere. Print media used on the material also needs to withstand 180°C.

<u>Unexpected Challenges</u> – Plastic was the obvious choice for the material of use in the fabrication of the vessels. After locating a plastic with the desired specifications outlined above two additional difficulties arose.

— The first was identifying the correct shape and manufacture of the vessels. The stability of the bag as well as a 'memory effect' in the plastic led to further design changes.

— The second obstacle arose during the winter months. Cold dry weather brought a problem with static electricity. The current bag holder led to solutions for both of those problems.

Low Weight Trials 10 mg Dissolved Solids

Sample (mg)	Volume (mL)	Bag #	Initial weight	Final Weight 1	Final Weight 2	Final Weight 3	TDS (g)	Percent Recovery
Blank Water	50	43	0.62850	0.6222	0.6219	NA	-0.0066	-0.66%
Standard	50	301	0.60837	0.6193	0.6191	NA	0.0107	106.98%
Standard	50	305	0.60660	0.6163	0.6159	NA	0.0093	92.72%
Standard	50	306	0.60002	0.6067	0.6104	0.6101	0.0101	100.50%
Standard	50	307	0.60193	0.6117	0.6117	NA	0.0098	97.41%
Standard	50	308	0.61248	0.6220	0.6222	NA	0.0097	96.91%
Standard	50	309	0.61932	0.6293	0.6282	0.6282	0.0089	88.53%
Standard	50	310	0.60518	0.6137	0.6141	NA	0.0089	88.93%
Standard	50	311	0.61292	0.6258	0.6236	0.6233	0.0104	103.49%

Medium Weight Trials 100 mg Dissolved Solids

Sample (mg)	Volume (mL)	Bag #	Initial weight	Final Weight 1	Final Weight 2	Final Weight 3	TDS (g)	Percent Recovery
Blank Water	50	121	0.64732	0.6476	0.6461	0.6466	-0.0007	-0.07%
Standard	50	122	0.64692	0.7492	0.7477	0.7473	0.1004	100.17%
Standard	50	123	0.64621	0.7462	0.7457	NA	0.0995	99.29%
Standard	50	124	0.63899	0.7388	0.7384	NA	0.0994	99.21%
Standard	50	125	0.63319	0.7319	0.7323	NA	0.0991	98.91%
Standard	50	126	0.64529	0.7509	0.7438	0.7434	0.0981	97.91%
Standard	50	127	0.65533	0.7575	0.7544	0.7540	0.0987	98.47%
Standard	50	128	0.65111	0.7533	0.7479	0.7474	0.0963	96.09%
Standard	50	129	0.64583	0.7459	0.7428	0.7425	0.0967	96.47%
Standard	50	130	0.64998	0.7483	0.7465	0.7460	0.0960	95.82%
Standard	50	131	0.65568	0.7534	0.7532	NA	0.0975	97.32%
Standard	50	132	0.64883	0.7458	0.7468	0.7466	0.0978	97.57%
Standard	50	133	0.65163	0.7506	0.7475	0.7480	0.0964	96.17%
Standard	50	134	0.65401	0.7592	0.7505	0.7502	0.0962	95.99%
Standard	50	135	0.64929	0.7554	0.7460	0.7456	0.0963	96.11%
Standard	50	136	0.65030	0.7492	0.7471	0.7469	0.0966	96.40%
Standard	50	137	0.65167	0.7496	0.7486	0.7487	0.0970	96.83%
Standard	50	138	0.63879	0.7365	0.7354	0.7349	0.0961	95.91%
Standard	50	139	0.63492	0.7317	0.7321	NA	0.0972	96.98%
Standard	50	140	0.65061	0.7503	0.7466	0.7463	0.0957	95.49%
Standard	50	141	0.65720	0.7573	0.7522	0.7522	0.0950	94.81%
Standard	50	142	0.64917	0.7478	0.7460	0.7455	0.0963	96.13%
Standard	50	143	0.64966	0.7464	0.7459	NA	0.0962	96.04%
Standard	50	144	0.65333	0.7504	0.7499	NA	0.0966	96.37%

High Weight Trials 200 mg TDS

Sample	Volume (mL)	Bag #	Initial weight	Final Weight 1	Final Weight 2	Final Weight 3	TDS (mg)	Percent Recovery
Blank Water	100	30	0.64529	0.6434	0.6426	0.6422	-0.0031	-0.31%
Standard	100	25	0.64732	0.8795	0.8791	NA	0.2318	113.51%
Standard	100	26	0.64692	0.8528	0.8526	NA	0.2057	100.72%
Standard	100	27	0.64621	0.7227	0.8513	0.8511	0.2049	100.34%
Standard	100	28	0.63899	0.8365	0.8357	0.8360	0.1970	96.48%
Standard	100	29	0.64934	0.8517	0.8517	NA	0.2027	100.68%
Standard	100	32	0.65111	0.8349	0.8351	NA	0.1840	91.88%
Standard	50	33	0.64583	0.8405	0.8403	NA	0.1945	97.13%
Standard	50	36	0.65163	0.8465	0.8464	NA	0.1948	97.28%