Gravimetric Preparation of Standard Solutions

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APPLICATION Note 8

Dilutions prepared gravimetrically will need no correction for temperature. The working standard solution concentration will be in µg/g units and is easily calculated provided the density of the standard solution is known (Figure 1). There are too many possible pipetting errors to risk a volumetric transfer without checking the accuracy by weighing the aliquot. If the density of the standard stock solution is not reflected on the certificate of analysis, then it can be determined using the Anton Parr density apparatus located in the main laboratory.

An example is given here of the procedure to prepare working standards by gravimetric means:

A stock solution of calcium at 1000ug/ml and density of 1.016g/ml from Heyns Lab Supplies was used. Since we know the density, the parts-per-million (µg/g) can be calculated:

$$\frac{1000\mu g/ml}{1.016g/ml} = 984.25ppm\ or\ 984.25\mu g/g$$

From this concentration it is then just a simple matter of serial diluting to the desired concentration by weighing the stock and intermediate standards into a known mass of ultrapure water. The equipment used included: an analytical balance accurate to 0.1mg, Pasteur pipettes and several clean 100ml polyethylene plastic bottles. To avoid all of the dilutions required as shown in Table 1, a 100ppm or 10ppm certified calcium standard can be used as the stock solution with a serial dilution to the required concentration.

To calculate actual concentration of the working standards the equation to use is:

$$\frac{mass\ (g) of\ 10ppb\ standard\ x\ concentration\ of\ 10ppb\ standard}{mass\ of\ final\ dilution\ volume\ (g)}$$

An example:

$$\frac{6.0153(g) of\ 9.8425\ ng/g}{100.000g} = 0.5921ppb$$

Table 1. Preparation scheme for calcium calibration standards by serial dilution on a mass to mass basis.

Standard	**Desired Concentration**	**Mass Standard**	**Water Addition**
A	98.425 ug/g	10.00g of Stock	90.00g
B	9.8425 ug/g	10.00g of Std.1 into	90.00g
C	0.98425 ug/g	10.00g of Std. 2 into	90.00g
D	0.098425 ug/g	10.00g of Std.3 into	90.00g
E	9.8425 ppb	10.00g of Std.4 into	90.00g
F	0.98425 ppb	10.00g of Std 5 into	90.00g
	Working Standards		
5	0.78740ppb	8.000g of Std E into	90.00+2.00g
4	0.59055ppb	6.000g of Std. E into	90.00+4.00g
3	0.39370ppb	4.000g of Std. E into	90.00+6.00g
2	0.19685ppb	2.000g of Std. E into	90.00+8.00g
1	*Blank	0.000g	100g
	Note: ug/g=ppm		

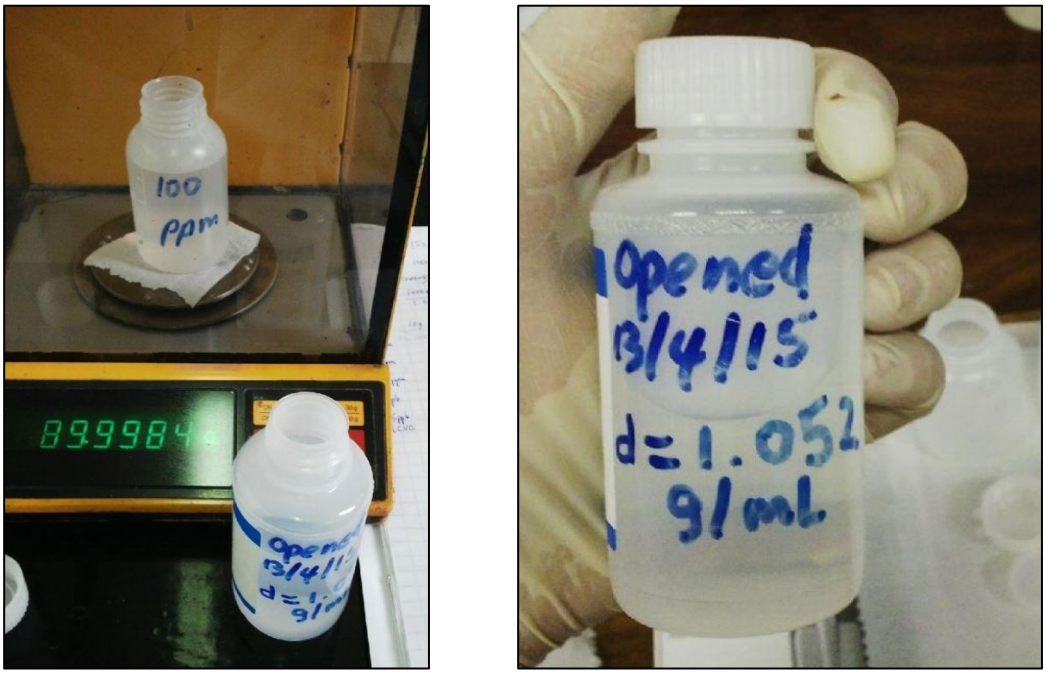

Figure 1. Gravimetric serial dilution of 1000µ/ml calcium standard solution with density of 1.052g/ml (Agilent Technologies).

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Notes on ppm and ppb

The difference between ppm and µg/ml is often confused. A common mistake is to refer to the concentration units in ppm as a short cut (parts per million) when we really mean µg/ml. One ppm is in reality equal to 1µg/g. In similar fashion ppb (parts per billion) is often equated with ng/ml. One ppb is in reality equal to 1ng/g. To convert between ppm or ppb to µg/ml or ng/ml the density of the solution must be known. The equation for conversion between mass/mass and mass/volume units is:

$$(\mu g/g) \cdot (density\ in\ g/ml) = \mu g/ml$$

and/or

$$(ng/g) \cdot (density\ in\ g/ml) = ng/ml$$

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