Instructions:

This procedure consists of the following steps;
1. Making a test solution. 2. Testing a water sample. 3. Determining the total alkalinity in terms of calcium carbonate ($CaCO_3$). 4. Calculating the amount of CRS required to treat the brewing water. 5. Treating the water.
6. Checking the alkalinity of the treated water. 7. Correcting the alkalinity if required.

1. Making a Test Solution (a 1/40 CRS solution).

Purchase 1L of distilled or di-ionised water (available from supermarkets near the ironing products).

Stand a 1L PET bottle on some digital scales and pour the water into the bottle ensuring it is exactly 1L (1000g=1L), Measuring jugs and analogue scales should be considered inaccurate for this test.

Carefully mark the 1L level with tape or a fine marker pen then return around 50mls of the water back to the original bottle (to make room for the CRS).

Take care with the following procedure, CRS is an acid and therefore very corrosive. The wearing of eye protection is advisable.

Using the syringe supplied, draw up 25mls of CRS, ensuring all air bubbles are removed and add it to the PET bottle.

To remove air bubbles from the syringe, carefully draw up a little more of the liquid than required, hold the syringe with the tip pointing up and draw back the plunger a little further. Gently cover the tip with a folded paper towel and tap it until the air is at the top. With the tip still covered, squeeze the syringe until the air is removed and it contains the desired amount of CRS with the excess absorbed by the towel. Try practicing with water first.

Top the PET bottle back to the 1L mark with the di-ionised water, re-cap and shake well. Label the bottle CRS 1/40 solution, DO NOT DRINK. Rinse and dry the syringe.

2. Testing the Water.

Place a clean well rinsed clear glass vessel or jug on some digital scales and accurately fill with 250mls of tap water (250g). The quantity must be exactly 250mls. Measuring jugs should be considered inaccurate.

Add 7-12 drops of indicator to the tap water using a clean pipette and mix. If the sample turns clear at any point during the test, more drops of indicator can be added to restore the colour.

Using a clean, dry syringe, draw up a measured amount of test solution (e.g. 20mls) using the method described above to remove any air bubbles.

Using a teaspoon or pipette in the dominant hand, stir the sample water while slowly adding the 1/40 CRS test solution ½ a ml at a time watching for a slight colour variation across the entire sample. This variation is known as the end point.

Once this slight red hue appears, note the amount of solution that has been added. If you are uncertain, a further ½ml will cause a definite change to confirm that the end point has been achieved. (More than one syringe load may be required so keep count).

3. Calculating Total Alkalinity expressed as calcium carbonate ($CaCO_3$).

Every 1ml of test solution added represents 18mg/l of $CaCO_3$, therefore;

Total Alkalinity as $CaCO_3$ = Amount of Test Solution Required to Reach End Point x 18

E.g. a sample requires 11.5ml to reach end point therefore total alkalinity is;

11.5 x 18 = 207mg/l $CaCO_3$

4. Calculating the Amount of CRS required. (Use one of the following methods).

Method 1. Per 10L to leave a residual alkalinity of 27mg/l suited to pale ales and bitters.

CRS required in ml per 10L = Amount of Test Solution Required to Reach End Point – 1.5

e.g. if 11.5ml was required, the CRS required to treat 10L of brewing water is;
11.5 – 1.5 = 10ml i.e. 10ml of CRS should be added to every 10L f brewing water, if 32L is being treated;

CRS required = 32/10L x 10ml i.e. 32ml of CRS is required to treat 32L of brewing water.

How It Works; A residual alkalinity of 27mg/l $CaCO_3$ is suited to pales ales and bitters and as 1.5ml of test solution represents 27mg/l of $CaCO_3$ (1ml = 18mg/l) and 1 ml of CRS will neutralise 180mg of calcium carbonate, subtracting 1.5 from the amount of test solution required to reach end point will determine the amount of CRS required to treat 10L of water leaving a residual alkalinity of 27mg/l $CaCO_3$.

Method 2. For a specific residual alkalinity in a specific volume of water.

$$\text{CRS required} = \frac{(\text{Total Alkalinity} - \text{Residual Alkalinity})}{180} \times \text{Volume of Water to be Treated}$$

e.g. if the total alkalinity is 207mg/l, the required residual alkalinity is 20 and the volume to be treated is 32L, the amount of calcium carbonate which must be neutralised is 187mg/l, therefore the amount of CRS required is;

$\frac{207 - 20 \times 32}{180}$ = 33 i.e. 33ml of CRS in 32L of water will reduce the alkalinity to 20mg/l

5. Treating Your Brewing Water

Measure and add the determined amount of CRS to the brewing water, stir vigorously to remove the CO_2 produced then allow to sit for 10 mins. That's it although it is now advisable to check the residual alkalinity after treatment.

6. Checking the Residual Alkalinity (this step is optional but advisable).

Take 250ml of your now treated water and repeat steps 2 and 3. The total alkalinity should now be equal to the desired residual alkalinity. If the alkalinity is more than a few points off you can follow appropriate step in section 7 on page 3 to correct it.

7. Alkalinity Correction (choose the appropriate method below).

The Total Alkalinity is Still Too High (insufficient CRS added);

Use the CRS calculation in section 4 to determine the amount of CRS to add.

The Total Alkalinity is Too Low (too much CRS has been added);

To raise the alkalinity, replace an amount of treated water with untreated water, calculate as follows,

U = Untreated Water To Replace Treated Water	V = Total Volume of Treated Water
T = Target Alkalinity	C= Current Alkalinity (should be less than T)
A = Alkalinity of Untreated Water	

To calculate the amount of treated water that needs to be replaced with untreated water (U) where the total volume (V) = 32L, the target alkalinity (T) = 27 mg/l, the current alkalinity (C) = 17mg/l and the original alkalinity (A) = 207 mg/l, use the following equation;

U = (VT - VU)/AC

U= (32 x 27 – 32 x 17)/(207 – 17) U = 1.68L

Therefore to correct the alkalinity, draw off 1.68L of treated water and replace it with 1.68L of untreated water.

For the mathematicians, here's the explanation;

VT is the desired alkalinity, VU is actual alkalinity.

The difference is the amount required.

A – C is the difference between how much alkalinity we have in the treated and untreated water, i.e. how much extra alkalinity you would get by replacing a litre.

The division simply tells you how many litres to replace.

The formula can be factorised;

V(T – U)/(A – C)

(Thanks to Gurgeh for the above formula and explanation)

If the residual alkalinity is consistently incorrect, the markings on the HLT or the vessel where the water treatment takes place may be incorrect.

Notes:

1. All brewing water should be treated prior to use. It's preferable to treat an amount of water slightly in excess of requirements, all in one go but if there is insufficient space in the HLT, the mash and sparge water can be treated separately by calculating the CRS for the individual volumes.

2. The water will still require treating for chlorine and chloramines., before CRS treatment if using a water filter or after if using campden tablets.

3. This test relies on the use of accurate digital scales and syringes, the syringe supplied has been found to be sufficiently accurate for the test but none the less can be checked if required along with the accuracy of the scales being used by following the procedure headed Scale Calibration at the bottom of this page.

4. When selecting a PET bottle for the 1/40 CRS solution, try and find one with a narrow neck (such as the type used for supermarket tonic water) as the narrow neck reduces errors when topping the bottle back to the 1L mark.

5. 1ml of CRS reduces 180mg of calcium carbonate, this has been found from a figure determined by testing. Murphys give a figure of 184mg.

6. This method can be adapted for use with a PH meter. Just follow the same method and leave out the indicator solution. The end point is at PH 4.5.

7. Making a new test solution for every new bottle of CRS reduces errors caused by any variations between batches of CRS.

Scales Calibration

To check your scales, reset/zero them and use various combinations of (good condition) coins to check whether they are reading within +/-2g. If they are reading under or over, note the amount and add or subtract the amount from the values you get when weighing your water.

Euro Coins		English Coins	
2 Euro	8.5g	£2	12g
1 Euro	7.5g	£1	9.5g
50c	7.8g	50p	8g
20c	5.4g	20p	5g
10c	4.1g	10p	6.5g
5c	3.92g	5p	3.25g
1c	2.3g	2p	7.12g
		1p	3.56g

Syringe Calibration

Once you've checked out your scales, with your syringe and DI water, squirt 5 lots into a tarred vessel (a vessel sat on the scales with the display reset). If it weighs 99-101g, that can be considered very good.

Many thanks to Delboy for supplying the vials for the indicator, Gurgeh for devising the correction formula and our not so unknown forum member for designing the test, supplying the indicator and passing it on to use at www.jimsbeerkit.co.uk , without whom this would not have been made possible.