FAAS Deter. Of Total Water Hardness in some Riyadh's water samples & Calculation of (gpg),(dGH),(°Clark) and (°fH)

Introduction:

The simple definition of water hardness is the amount of dissolved calcium and magnesium in the water. Hard water is high in dissolved minerals, largely calcium and magnesium. Depending on the hardness of your water, after using soap to wash you may have felt like there was a film of residue left on your hands. In hard water, soap reacts with the calcium (which is relatively high in hard water) to form "soap scum". When using hard water, more soap or detergent is needed to get things clean, be it your hands, hair, or your laundry.

Have you done a load of dishes in the dishwasher, taken out the glasses, and noticed spots or film on them? This is more hard -water residue- not dangerous, but unsightly. When hard water is heated, such as in a home water heater, solid deposits of calcium carbonate can form. This scale can reduce the life of equipment, raise the costs of heating the water, lower the efficiency of electric water heaters, and clog pipes. And, yes, mineral buildup will occur in your home coffee maker too, which is why some people occasionally run vinegar (an acid) through the pot.

But hard water can have some benefits, too. Humans need minerals to stay healthy, and the World Health Organization (WHO) states that drinking-water may be a contributor of calcium and magnesium in the diet and could be important for those who are marginal for calcium and magnesium intake.

What is/are:

Water Hardness?

Types of WH?

Causes of WH?

Softening of HW:

WH main effects?

(gpg),(dGH),(°Clark) and (°fH)?

Calculations of (gpg),(dGH) and (°fH)?

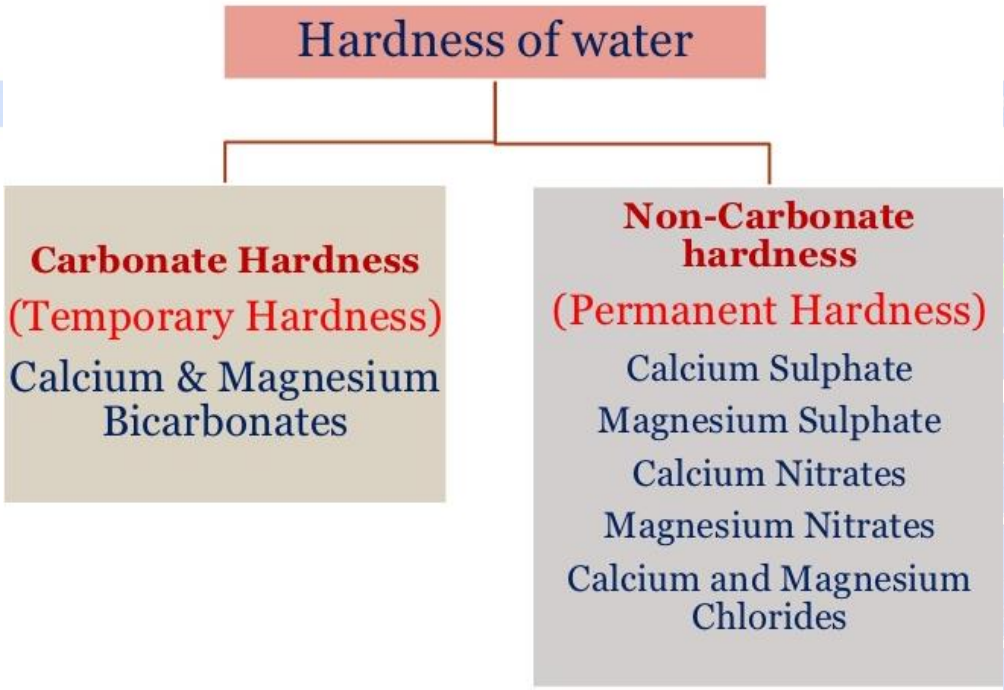
Water Hardness:

In scientific terms, water hardness is generally the amount of dissolved calcium and magnesium in water. But in layman's terms, you may notice water hardness when your hands still feel slimy after washing with soap and water, or when your drinking glasses at home become less than crystal clear.

WATER HARDNESS SCALE					
ppm as $CaCO_3$	Grains/Gallon	German degrees	Clark degrees	French degrees	Classification
<60	<3.5	<3.4	<4.2	<6.0	Soft
61 - 120	3.51 – 6.96	3.41 – 6.72	4.21 – 8.40	6.1 – 12.0	Moderately Hard
121 - 180	6.97 – 10.44	6.73 -10.08	8.40 – 12.60	12.1 – 18.0	Hard
>180	>10.44	>10.08	>12.60	>18.0	Very Hard

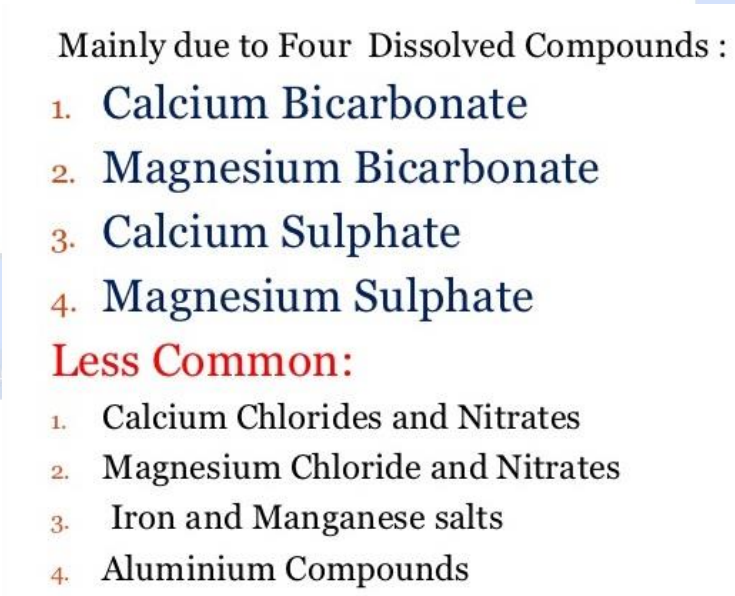
Types of WH:

- Temporary hardness: Bicarbonate.
- Permanent hardness: Non-Bicarbonate.
- Pseudo hardness: Sodium.



Causes of WH:

The main contributors to the hardness of the water are calcium and magnesium ions. Additional contributors to the hardness of the water include iron (Fe^{2+}), strontium (Sr^{2+}), zinc (Zn^{2+}), manganese (Mn^{2+}) and other ions. However, their concentrations are usually significantly lower than the concentration of calcium and magnesium.



WH Main Effects:

Undesirable effects	Exemples (non-comprehensive list)
LIMESCALE DEPOSITS, MARKS	• **White marks** on the walls of shower cabinets, taps, windows • **Limescale** deposits that trap dirt in toilet pans, washbasins and sinks • **Discoloured and indelible rings** appearing on laundry when ironing due to mineral particles deposited by the steam • Etc.
MALFUNCTIONING EQUIPMENT DUE TO LIMESCALE DEPOSITS	• **Flow from taps reduced** to a mere trickle due to limescale deposits • **Flooding and breakdown** of washing machines with components covered by limescale (heating elements...)
REDUCED PERFORMANCE AND OPERATIONAL LIFE OF APPLIANCES AND EQUIPMENT	• **Unwanted shutdown** of electrical household appliances with limescale deposits • **Reduced performance** of appliances due to limescale
EXCESSIVE ENERGY CONSUMPTION	• Limescale deposits act as **thermal insulation** As a result, the **energy output** from heating elements with limescale deposits **reduces considerably** with very hard water (see the Battelle Institute study)
INCREASED CONSUMPTION OF DETERGENTS AND THE NEED TO ADD ANTI-SCALING PRODUCTS OOR MOISTURISING CREAMS	• Une eau calcaire **empêche le savon, les détergents et produits de nettoyage de mousser** et contraint à **augmenter les dosages** (voir préconisations des marques de lessive : dosages eau douce/eau dure). • Need to add **anti-scaling** products, which are generally expensive • **Increased use of moisturising** creams to counteract dry skin due to the high lime content
INCREASE IN POLLUTING WASTE	• Due to **over-consumption** of detergents and additives in cases of hard water, users **generate more chemical waste**
DISCOMFORT AND UNPLEASANT SENSATIONS	• **Dry skin**, that can lead to skin disorders • **Dull, brittle hair** • Rough, stiff and **uncomfortable laundry** • **Altered taste of coffee** or tea • Water giving rise to **eye disorders** • Etc.

WH Removal:

1. Boiling
2. Addition of lime
3. Addition of sodium carbonates
4. Base exchange process

Temporary Hardness

1. Addition of Sodium carbonate
2. Base exchange process

Permanent Hardness

(gpg), (dGH), (°Clark) and (°fH):

- *Parts per million (ppm)* is usually defined as 1 mg/L $CaCO_3$ (the definition used below). It is equivalent to **mg/L** without chemical compound specified, and to **American degree**.
- *Grains per Gallon (gpg)* is defined as 1 grain (64.8 mg) of calcium carbonate per U.S. gallon (3.79 litres), or 17.118 ppm.
- a *mmol/L* is equivalent to 100.09 mg/L $CaCO_3$ or 40.08 mg/L Ca^{2+}.
- A *degree of General Hardness (dGH* or 'German degree (°dH, *deutsche Härte*))' is defined as 10 mg/L CaO or 17.848 ppm.
- A *Clark degree (°Clark)* or *English degrees (°e or e)* is defined as one grain (64.8 mg) of $CaCO_3$ per Imperial gallon (4.55 litres) of water, equivalent to 14.254 ppm.
- A *French degree (°fH or °f)* is defined as 10 mg/L $CaCO_3$, equivalent to 10 ppm.

$$TWH_{(ppm)} = [\ (\frac{M.wt\ of\ Calcium\ Carbonate}{A.wt\ of\ Calcium})[Ca]ppm + (\frac{M.wt\ of\ Calcium\ Carbonate}{A.wt\ of\ Magnesium})[Mg]ppm\ ]$$

$$= [\ (\frac{100}{40})[Ca]_{ppm} + (\frac{100}{24})[Mg]_{ppm}\ ]$$

$$TWH_{(ppm)} = (\ 2.5[Ca]_{ppm} + 4.1[Mg]_{ppm}\ )$$

Experimental:

1- Prepare **50ml** Of [250ppm] of (Ca^{2+}) & **50ml** Of [250ppm] of (Mg^{2+}) from the given substances using distilled water.

2- Prepare next (all are **50ml** Volumetric flasks):

No	1	2	3	4	1	2	3	4	9	10	11
	Ca^{2+}				Mg^{2+}				Blank	$Sample_{Ca}$	$Sample_{Mg}$
Flask											
(ppm)	20	40	60	80	2.5	5	7.5	10	NIL	NIL	NIL

3- Add (0.5ml) of [2M] of H_2SO_4 to each flasks (Except $Sample_{Mg}$).

4- Fill all of the above flasks with distilled water (Except $Sample_{Mg}$).

5- The unknown sample are ready to be determined **directly** for [Ca^{2+}].

6- For determination of [Mg^{2+}], Dilute the unknown sample to one fifth (1/5), then Add (0.5ml) of [2M] of H_2SO_4, And Fill with distilled water

7- Move to the next Laboratory and follow given instructions to find the Total Water Hardness.

Results:

No	Element	$C_{(ppm)}$	Absorbance
Blank	---	NIL	0
1	Ca^{2+}	20	A_1
2	Ca^{2+}	40	A_2
3	Ca^{2+}	60	A_3
4	Ca^{2+}	80	A_4
Sample	Ca^{2+}	?	A_{Ca}
1	Mg^{2+}	2.5	A_1
2	Mg^{2+}	5	A_2
3	Mg^{2+}	7.5	A_3
4	Mg^{2+}	10	A_4
Sample	Mg^{2+}	? (1/5 OF THE SAMPLE)	A_{Mg}

Calibration Graphs: