Deter. Of Water Total Hardness & Calculation of (gpg),(dGH),(°Clark) and (°fH) using FAAS

Introduction:

- What is Water Hardness?
- What are the types of WH?
- What does cause WH?
- Softening of HW:
- What are the WH main effects?
- What are (gpg),(dGH),(°Clark) and (°fH)?
- How to calculate (gpg),(dGH) and (°fH)?

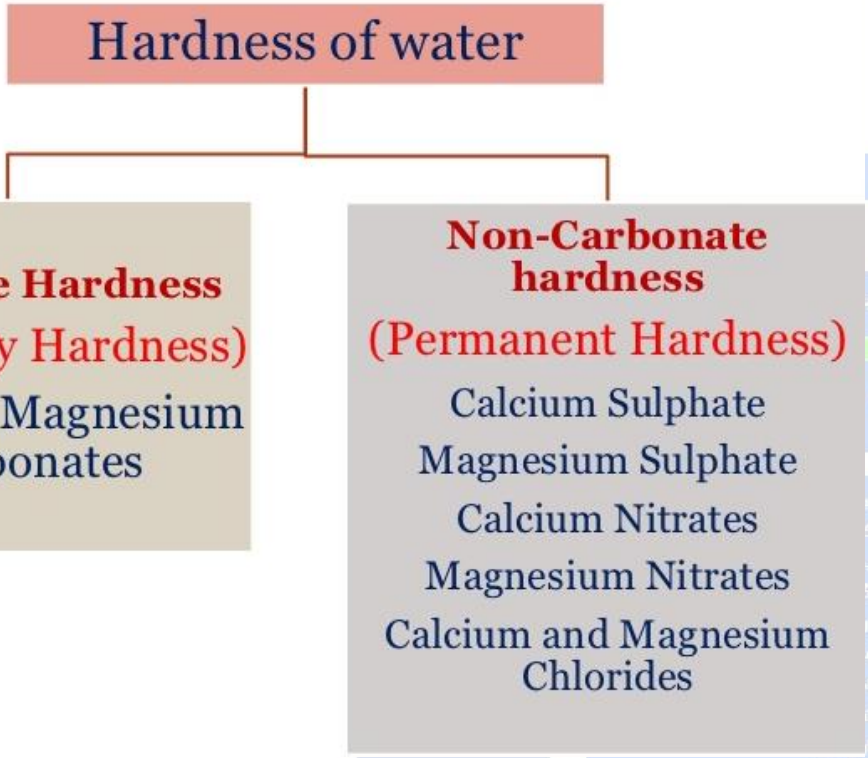
Water Hardness:

The property of water to form an insoluble curd with soap instead of lather.

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

What are the types of WH:

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



What does cause 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.

Mainly due to Four Dissolved Compounds :

1. Calcium Bicarbonate
2. Magnesium Bicarbonate
3. Calcium Sulphate
4. Magnesium Sulphate

Less Common:

1. Calcium Chlorides and Nitrates
2. Magnesium Chloride and Nitrates
3. Iron and Manganese salts
4. Aluminium Compounds

What are the WH main effects:

- Hard water might cause scale deposition in water distribution and irrigation systems.
- It reduces the efficiency of heat exchangers.
- Water hardness might cause corrosion.
- Might cause scaling in membrane filtration systems.

❑ **Consumes More soap and detergent - Financial loss.**

❑ **When water boiled , Carbonates precipitates , deposited in boiler , require more energy for heating: Industrial loss and boiler inefficiency , may explode**

❑ **Shorten the life of cloth fabrics**

❑ **Not suited for various industrial processes**

❑ **Shorten life span of pipes (deposition and scaling of salts)**

WH Removal:

Temporary Hardness

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

Permanent Hardness

1. Addition of Sodium carbonate
2. Base exchange process

What are (gpg),(dGH), (°Clark) and (°fH):

-gpg:

-dGH:

- °Clark:

- °fH:

Calculation of (gpg),(dGH) 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 100ml Of [100ppm] of (Ca^{2+}) & 100ml Of [100ppm] of (Mg^{2+}) from given raw materials using dis.water.

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

No	1	2	3	4	1	2	3	4	7	8
Flask	 Ca^{2+}	 Ca^{2+}	 Ca^{2+}	 Ca^{2+}	 Mg^{2+}	 Mg^{2+}	 Mg^{2+}	 Mg^{2+}	 Blank	 Given Sample
(ppm)	20	40	60	80	5	10	15	20	Dis. Water	NIL

3-Add (0.5ml) of [2M] of H_2SO_4 to flasks (1-4 & 1-4).

4-Fill all above flasks (1-4 & 1-4) with distilled water.

5-Blank: Put (0.5ml) of [2M] of H_2SO_4 in (50ml) v.flask and fill with Dis.water.

6-The unknown sample is ready to be detected.

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	1.71
2	Ca^{2+}	40	3.53
3	Ca^{2+}	60	5.20
4	Ca^{2+}	80	6.36
1	Mg^{2+}	5	0.73
2	Mg^{2+}	10	1.52
3	Mg^{2+}	15	2.27
4	Mg^{2+}	20	2.95
Given Sample	Ca^{2+}	?	5.93
Given Sample	Mg^{2+}	?	1.95

Calibration Graphs: