MSIC-204

Date
21/05/2022

Relationship between various units of hardness

1 ppm = 0.1°Fr = 0.07°Cl = 1mg/lit

Degree clarke (°Cl)

Degree French (°f)

1°Fr = 1 Part CaCO3 equivalent hardness per 10^5 Parts of water.

* Degree of hardness:

mg of CaCO3 equivalent hardness per L of water = 1 ppm

mg of CaCO3 equivalent hardness per million parts of water = 1 ppm

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Advantages and disadvantages of hard water are summarized in Table 2 below :

Table 2

S. No.	Hard Water	
	Advantages	*Disadvantages*
1.	The taste of hard water is usually better than soft water. The label on the bottle of mineral water shows that it contains Mg^{2+} and Ca^{2+} ions and it tastes good.	Hard water produces scum with soap. Thus, the washed clothes look dull. Efficiency of soap decreases in hard water so economy decreases.
2.	The dissolved calcium in hard water can help to produce strong teeth and healthy bones in children.	Boiler feed water should be free from hardness otherwise even explosion can occur.
3.	In old houses, lead piping was used for distribution of water. Hard water coats these with a layer of insoluble $CaCO_3$. This prevents any of the poisonous lead dissolving in the drinking water.	

Degree of Hardness

Although hardness of water is never present in the form of calcium carbonate because it is insoluble in water, hardness of water is conveniently expressed in terms of equivalent amount *(equivalents) of* $CaCO_3$.

The **reason for choosing $CaCO_3$ as the standard for reporting hardness of water** is the ease in calculations as its *molecular weight is exactly 100*. Moreover, it is the most insoluble salt that can be precipitated in water treatment.

$$\text{Equivalents of } CaCO_3 = \frac{\left[\begin{array}{c}\text{Strength of hardness}\\ \text{producing substance}\\ \text{(in mg/L)}\end{array}\right] \times \left[\begin{array}{c}\text{Chemical equivalent}\\ \text{of } CaCO_3\\ (=50)\end{array}\right] \times 2}{[\text{ Chemical equivalent of hardness Producing substance }] \times 2}$$

$$= \left[\begin{array}{c} \text{Strength of hardness} \\ \text{producing substance} \\ \text{in mg/L} \end{array} \right] \times \left[\frac{100}{2 \times \text{Chemical equivalents of hardness producing substance}} \right]$$

$$= \left[\begin{array}{c} \text{Strength of hardness} \\ \text{producing substance} \\ \text{in mg/L} \end{array} \right] \times (\text{Multiplication factor}) \text{ in } \frac{\text{mg}}{\text{L}} \text{ or ppm}$$

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↓ →	ppm	mg/l	°Fr	°Cl
ppm	1	1	0.1	0.07
mg/l	1	1	0.1	0.07
°Fr	10	10	1	0.7
°Cl	0.07	0.07	0.7	1