

# Difference Between Alkalinity and Hardness

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## Key Difference - Alkalinity vs Hardness

Although water covers 71.1% of the earth's crust, water everywhere is not the same. However, water is the only [inorganic substance](#) that can exist in all three physical states naturally as liquid water, ice or water vapor. This is due to the variations in temperature. According to the constituents that are dissolved in it, water can be different in color, taste or chemical composition from one place to another. For example, sea water is quite different from water sample from a well. Therefore, water testing parameters have been introduced in order to test the water quality. Alkalinity and hardness are such parameters which are very important factors that should be tested before consuming water. The key difference between alkalinity and hardness is that **alkalinity measures the total amount of bases present in water** whereas **hardness measures the total amount (concentration) of divalent salts**.

## What is Alkalinity?

Alkalinity is the ability of water to keep its pH stable. In other words, alkalinity is the capability of water to neutralize [acids](#). The degree of alkalinity is mostly dependent on the soil or rocks it passes through. Alkalinity mainly occurs due to the presence of [carbonate](#) species present in water. It is related to the [basicity](#) of water. Alkalinity comes mainly from [hydroxides](#) or bases. Carbonate species contribute to the alkalinity than other basic species does because considerable amounts of carbonate species are found in water naturally.

Alkalinity is an important parameter because it can directly affect [aquatic](#) life. The best pH range for aquatic life to function properly is 6.0-9.0 pH. Alkalinity helps to maintain this pH of water bodies. It is measured with the use of [acid-base titration](#). In this titration, the amount of an acid that can be neutralized by a water sample is measured. The carbonate species will neutralize the acid and the end point is obtained when all the carbonate species are consumed.



Figure 1: Alkali water from Mono Lake

## What is Hardness?

Water hardness is the measurement of the concentration of total divalent ions present in water. Examples of some divalent ions present in water are calcium ion, magnesium ions, and  $\text{Fe}^{2+}$  ion. However, calcium and magnesium are the most common sources of water hardness. The unit for hardness is ppm per  $\text{CaCO}_3$  equivalents. There are two types of water hardness:

### Temporary Hardness

Temporary hardness occurs due to the presence of calcium hydrogencarbonate ( $\text{Ca}(\text{HCO}_3)_2$ ) and magnesium hydrogencarbonate ( $\text{Mg}(\text{HCO}_3)_2$ ). Both species decompose when heated and  $\text{CaCO}_3$  or  $\text{MgCO}_3$  precipitation occurs. Therefore, temporary hardness can be removed by boiling water.

### Permanent Hardness

Permanent water hardness occurs due to the presence of calcium sulfate. It cannot be removed by boiling water.

Sodium carbonate can be used for both temporary and permanent hardness to soften hard waste. [Sodium carbonate](#) is dissolved in water and provides enough carbonate ions to react with calcium ions in the water. This helps to soften the hard water.

The hardness of water can easily be estimated by an EDTA titration. EDTA will bind with both calcium and magnesium ions; hence, it can determine the amount of those ions present.

## What are the Similarities between Alkalinity and Hardness?

The terms alkalinity and hardness often get confused due to several similarities that they share. One such similarity is that the unit of measurement is the same for both parameters, which is ppm (parts per million) in CaCO<sub>3</sub> equivalents.

Another similarity is that hardness and alkalinity of water mainly come from limestone or dolomite sources in nature. This happens when the water passes through rocks and uptake minerals which cause alkalinity and hardness., When [limestone and dolomite](#) dissolve in water, calcium ions, magnesium ions, and carbonate species are mixed with water. Calcium and magnesium ions cause water hardness and the alkalinity occurs due to the presence of carbonate species.

## What is the difference between Alkalinity and Hardness?

Alkalinity vs Hardness	
Alkalinity is the capability of water to resist pH changes that occur due to acids.	Hardness is the measurement of total amount of divalent ions present in water.
Causative Species	
Alkalinity is mainly caused by the presence of carbonate species.	Hardness is caused by divalent ions such as calcium, magnesium or iron ions.
Determination	
Alkalinity can be determined by acid-base titrations.	Hardness can be determined by EDTA titrations.
Reactions in Titrations	
Carbonate species which cause alkalinity can react with strong acids in the presence of phenolphthalein and methyl orange indicators to give color changes when all carbonate ions are consumed.	Calcium and magnesium ions which cause hardness can bind with EDTA and by finding the amount of EDTA, one can find the hardness of water sample.

### Summary - Alkalinity vs Hardness

Alkalinity and hardness are found in natural water in different degrees. Those are parameters used to determine the water quality. The main difference between alkalinity and hardness is that alkalinity measures the total amount of bases present

in water whereas hardness measures the total amount (concentration) of divalent salts.

References:

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### **How to Cite this Article?**

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