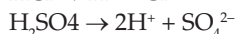
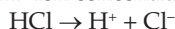


## Acids and Bases

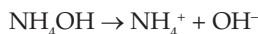
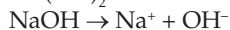
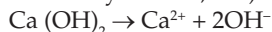
By Peter S. Cartwright, PE, CWS-VI

The basic chemistry fundamentals presented every month is not intended to be a comprehensive chemistry course, but rather basic instruction on chemistry as it relates to water and water treatment. It is hoped that your interest will be piqued and induce you to want to learn more. The desired outcome is that it will help you become a more effective and valuable water treatment professional. Please get back to us with any questions or concerns; we welcome your input!

**A**cids are compounds that release hydrogen ions ( $H^+$ ) in solution (e.g: hydrochloric acid, sulfuric acid, etc.). It is the  $H^+$  ion that gives acids their properties; the greater the  $H^+$  ion concentration, the stronger the acid.



Bases are compounds that release hydroxide ( $OH^-$ ) ions in solution (e.g: calcium hydroxide [slaked lime], sodium hydroxide, ammonium hydroxide, etc.). They produce a form of alkalinity.

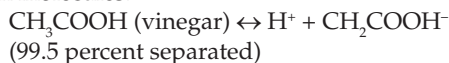


### Acids

Strong acids completely separate into their ions and stay separated. This is indicated by a single arrow pointing in one direction.



Weak acids and bases are in a continuous process of ionization, but free ions are also continuously recombining to form molecules.



At any one time, only a portion of the acid or base is present as ions. This equilibrium process is indicated by arrows pointing in both directions.

### Strong/weak acids

Strong acids ionize 100 percent and include the following examples:

- HCl (Hydrochloric)
- HBr (Bromic)
- HI (Hydriodic)
- $HNO_3$  (Nitric)
- $HClO_4$  (Perchloric)
- $H_2SO_4$  (Sulfuric)

Weak acids do not ionize completely and include the following examples:

- $HC_2H_3O_2$  (Acetic)
- HCN (Hydrocyanic)
- $H_2B_4O_7$  (Boric)
- $HNH_2SO_3$  (Sulfamic)

- $C_6H_8O_7$  (Citric)
- $H_3PO_4$  (Phosphoric)
- HOCl (Hypochlorous)
- $H_2CO_3$  (Carbonic)

### Strong/weak bases

Strong bases are alkaline compounds that ionize 100 percent. The term most familiar in water chemistry for bases dissolved in water is alkalinity.

The most common strong bases in water chemistry include the following:

- NaOH (Sodium hydroxide)
- KOH (Potassium hydroxide)
- $Ca(OH)_2$  (Calcium hydroxide)

Weak bases are alkaline compounds that do not ionize completely. There are a number of weak bases, not normally encountered in water treatment.

**The pH helps in predicting corrosion and scaling tendencies, but is not the only measure for these. At low pH (acidic) levels, the solution tends to be corrosive.**

### pH

While on the subject of acids and bases, it is important to introduce the subject of pH.

- pH stands for potential of hydrogen.
- pH is defined as "the negative log of hydrogen ion concentration" and indicates relative intensity on a scale of 1 to 14. Pure water has pH 7.

Concentration of hydrogen ions compared to distilled water		Examples of solutions at this pH
10,000,000	<b>pH = 0</b>	battery acid, strong hydrofluoric acid
1,000,000	<b>pH = 1</b>	hydrochloric acid secreted by stomach lining
100,000	<b>pH = 2</b>	lemon juice, gastric acid, vinegar
10,000	<b>pH = 3</b>	grapefruit, orange juice, soda
1,000	<b>pH = 4</b>	tomato juice, acid rain
100	<b>pH = 5</b>	soft drinking water, black coffee
10	<b>pH = 6</b>	urine, saliva
1	<b>pH = 7</b>	"pure" water
1/10	<b>pH = 8</b>	sea water
1/100	<b>pH = 9</b>	baking soda
1/1,000	<b>pH = 10</b>	Great Salt Lake, milk of magnesia
1/10,000	<b>pH = 11</b>	ammonia solution
1/100,000	<b>pH = 12</b>	soapy water
1/1,000,000	<b>pH = 13</b>	bleaches, oven cleaner
1/10,000,000	<b>pH = 14</b>	liquid drain cleaner

- The higher the hydrogen ion concentration, the greater the acidity.
- The lower the hydrogen ion concentration, the greater the alkalinity.
- pH 7 indicates neutral state.
- On the pH scale, each number is 10 times more or less acidic than the next adjacent number. Water with pH of 6 is 10 times more acidic than water with pH 7, with 100 times more alkaline than pH 4.

pH may determine whether certain compounds will precipitate out of solution or not. Many compounds become more insoluble at higher pH levels.

pH helps in predicting corrosion and scaling tendencies, but is not the only measure for these. At low pH (acidic) levels, the solution tends to be corrosive.

### **About the author**

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