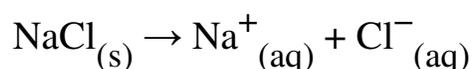


# Electrolyte

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An **electrolyte** is a compound that ionizes when dissolved in suitable ionizing solvents such as water. This includes most soluble salts, acids, and bases. Some gases, such as hydrogen chloride, under conditions of high temperature or low pressure can also function as electrolytes. Electrolyte solutions can also result from the dissolution of some biological (e.g., DNA, polypeptides) and synthetic polymers (e.g., polystyrene sulfonate), termed polyelectrolytes, which contain charged functional groups.

Electrolyte solutions are normally formed when a salt is placed into a solvent such as water and the individual components dissociate due to the thermodynamic interactions between solvent and solute molecules, in a process called solvation. For example, when table salt (sodium chloride), NaCl, is placed in water, the salt (a solid) dissolves into its component ions, according to the dissociation reaction



It is also possible for substances to react with water, producing ions. For example, carbon dioxide gas dissolves in water to produce a solution that contains hydronium, carbonate, and hydrogen carbonate ions.

Note that molten salts can be electrolytes, as well. For instance, when sodium chloride is molten, the liquid conducts electricity.

An electrolyte in a solution may be described as concentrated if it has a high concentration of ions, or dilute if it has a low concentration. If a high proportion of the solute dissociates to form free ions, the electrolyte is strong; if most of the solute does not dissociate, the electrolyte is weak. The properties of electrolytes may be exploited using electrolysis to extract constituent elements and compounds contained within the solution.

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## Physiological importance

In physiology, the primary ions of electrolytes are sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), chloride ( $\text{Cl}^-$ ), hydrogen phosphate ( $\text{HPO}_4^{2-}$ ), and hydrogen carbonate ( $\text{HCO}_3^-$ ). The electric charge symbols of plus (+) and minus (−) indicate that the substance is ionic in nature and has an imbalanced distribution of electrons, the result of chemical dissociation. Sodium is the main electrolyte found in extracellular fluid and is involved in fluid balance and blood pressure control.

All known higher lifeforms require a subtle and complex electrolyte balance between the intracellular and extracellular environment. In particular, the maintenance of precise osmotic gradients of electrolytes is important. Such gradients affect and regulate the hydration of the body as well as blood pH, and are critical for nerve and muscle function. Various mechanisms exist in living species that keep the concentrations of different electrolytes under tight control.

Both muscle tissue and neurons are considered electric tissues of the body. Muscles and neurons are activated by electrolyte activity between the extracellular fluid or interstitial fluid, and intracellular fluid. Electrolytes may enter or leave the cell membrane through specialized protein structures embedded in the plasma membrane called ion channels. For example, muscle contraction is dependent upon the presence of calcium ( $\text{Ca}^{2+}$ ), sodium ( $\text{Na}^+$ ), and potassium ( $\text{K}^+$ ). Without sufficient levels of these key electrolytes, muscle weakness or severe muscle contractions may occur.

Electrolyte balance is maintained by oral, or in emergencies, intravenous (IV) intake of electrolyte-containing substances, and is regulated by hormones, in general with the kidneys flushing out excess levels. In humans, electrolyte homeostasis is regulated by hormones such as antidiuretic hormone, aldosterone and parathyroid hormone. Serious electrolyte disturbances, such as dehydration and overhydration, may lead to cardiac and neurological complications and, unless they are rapidly resolved, will result in a medical emergency.

## Measurement

Measurement of electrolytes is a commonly performed diagnostic procedure, performed via blood testing with ion-selective electrodes or urinalysis by medical technologists. The interpretation of these values is somewhat meaningless without analysis of the clinical history and is often impossible without parallel measurement of renal function. Electrolytes measured most often are sodium and potassium. Chloride levels are rarely measured except for arterial blood gas interpretation, since they are inherently linked to sodium levels. One important test conducted on urine is the specific gravity test to determine the occurrence of electrolyte imbalance.

## Rehydration

In oral rehydration therapy, electrolyte drinks containing sodium and potassium salts replenish the body's water and electrolyte levels after dehydration caused by exercise, excessive alcohol consumption, diaphoresis, diarrhea, vomiting, intoxication or starvation. Athletes exercising in extreme conditions (for three or more hours continuously, e.g. marathon or triathlon) that do not consume electrolytes risk dehydration (or hyponatremia).<sup>[1]</sup>

An electrolyte drink can be home-made by using the correct proportions of water, sugar, salt, salt substitute for potassium, and baking soda.<sup>[2]</sup>

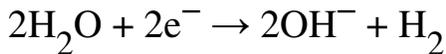
Electrolytes are commonly found in fruit juices, coconut water, sports drinks, milk, and many fruits and vegetables (whole or in juice form) (e.g., potatoes, avocados).

## Electrochemistry

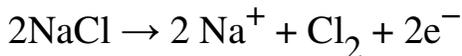
*Main article: electrolysis*

When electrodes are placed in an electrolyte and a voltage is applied, the electrolyte will conduct electricity. Lone electrons normally cannot pass through the electrolyte; instead, a chemical reaction occurs at the cathode, consuming electrons from the anode. Another reaction occurs at the anode, producing electrons that are eventually transferred to the cathode. As a result, a negative charge cloud develops in the electrolyte around the cathode, and a positive charge develops around the anode. The ions in the electrolyte neutralize these charges, enabling the electrons to keep flowing and the reactions to continue.

For example, in a solution of ordinary table salt (sodium chloride, NaCl) in water, the cathode reaction will be



and hydrogen gas will bubble up; the anode reaction is



and chlorine gas will be liberated. The positively charged sodium ions  $\text{Na}^+$  will react toward the cathode, neutralizing the negative charge of  $\text{OH}^-$  there, and the negatively charged hydroxide ions  $\text{OH}^-$  will react toward the anode, neutralizing the positive charge of  $\text{Na}^+$  there. Without the ions from the electrolyte, the charges around the electrode would slow down continued electron flow; diffusion of  $\text{H}^+$  and  $\text{OH}^-$  through water to the other electrode takes longer than movement of the much more prevalent salt ions.

Also: Electrolytes dissociate in water because water molecules are dipoles and the dipoles orient in an energetically favorable manner to solvate the ions.

In other systems, the electrode reactions can involve the metals of the electrodes as well as the ions of the electrolyte.

Electrolytic conductors are used in electronic devices where the chemical reaction at a metal/electrolyte interface yields useful effects.

- In batteries, two materials with different electron affinities are used as electrodes; electrons flow from one electrode to the other outside of the battery, while inside the battery the circuit is closed by the electrolyte's ions. Here, the electrode reactions convert chemical energy to electrical energy.<sup>[3]</sup>
- In some fuel cells, a solid electrolyte or proton conductor connects the plates electrically while keeping the hydrogen and oxygen fuel gases separated.
- In electroplating tanks, the electrolyte simultaneously deposits metal onto the object to be plated, and electrically connects that object in the circuit.
- In operation-hours gauges, two thin columns of mercury are separated by a small electrolyte-filled gap, and, as charge is passed through the device, the metal dissolves on one side and plates out on the other, causing the visible gap to slowly move along.
- In electrolytic capacitors the chemical effect is used to produce an extremely thin 'dielectric' or insulating coating, while the electrolyte layer behaves as one capacitor plate.
- In some hygrometers the humidity of air is sensed by measuring the conductivity of a nearly dry electrolyte.
- Hot, softened glass is an electrolytic conductor, and some glass manufacturers keep

the glass molten by passing a large current through it.

## Solid electrolytes

Solid electrolytes can be mostly divided into three groups:

- Gel electrolytes - they closely resemble liquid electrolytes. In essence, they are liquids in a flexible lattice framework. Various additives are often applied to increase the conductivity of such systems.<sup>[3][4]</sup>
- Dry polymer electrolytes - they differ from liquid and gel electrolytes in the sense that salt is dissolved directly into the solid medium. Usually it is a relatively high dielectric constant polymer (PEO, PMMA, PAN, polyphosphazenes, siloxanes, etc.) and a salt with low lattice energy. In order to increase the mechanical strength and conductivity of such electrolytes, very often composites are used, and inert ceramic phase is introduced. There are two major classes of such electrolytes: polymer-in-ceramic, and ceramic-in-polymer.<sup>[5][6][7]</sup>
- Solid ceramic electrolytes - ions migrate through the ceramic phase by means of vacancies and/or interstitials within the lattice. There are also glassy-ceramic electrolytes.

## See also

- Strong electrolyte
- ITIES (Interface between Two Immiscible Electrolyte Solutions)

## References

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## External links

- electrolyte mixtures (<http://scitation.aip.org/content/aip/journal/jcp/32/4/10.1063/1.1730863>)

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