

# Distilled water

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**Distilled water** is water that has had many of its impurities removed through distillation. Distillation involves boiling the water and then condensing the steam into a clean container.

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Bottle for distilled water in the Real Farmacia in Madrid.

## History

Drinking water has been distilled from sea water since at least about AD 200, when the process was clearly described by Alexander of Aphrodisias.<sup>[1]</sup> Its history predates this, as a passage in Aristotle's *Meteorologica* (II.3, 358b16) refers to the distillation of water.<sup>[2]</sup> Captain Israel Williams of the *Friendship* (1797) improvised a way to distill water, which he described in his journal.<sup>[3]</sup>

## Applications

In chemical and biological laboratories, as well as in industry, cheaper alternatives such as deionized water are preferred to distilled water. But if these alternatives are not pure enough, distilled water is used. If exceptionally high purity water is required, double distilled water is used.

Distilled water is also commonly used to top off lead acid batteries used in cars and trucks. The presence of other ions commonly found in tap water will drastically reduce an automobile battery's lifespan.

Distilled water is preferable to tap water for use in automotive cooling systems. The minerals and ions typically found in tap water can be corrosive to internal engine components, and can cause a faster depletion of the anti-corrosion additives found in most antifreeze formulations.<sup>[4]</sup>

Distilled water is also preferable to tap water for use in model steam engine boilers and model engines of other types. Mineral build-up resulting from the use of tap water in model boilers can severely reduce the efficiency of the boilers if run for long periods. This build-up is known as boiler scale.

Some people use distilled water for household aquariums because it lacks the chemicals found in tap water. It is important to supplement distilled water when using it for fishkeeping; it is too pure to sustain the chemical

reactions needed to support an aquarium ecosystem.<sup>[5]</sup>

Distilled water is also essential for use in cigar humidors. Mineral build-up resulting from the use of tap water (including bottled water) will reduce the effectiveness of the humidor.

In contrast, some home brewers who want to brew a traditional European Pilsner will dilute their hard water with distilled water so as to mimic the soft waters of Pilsen.<sup>[6]</sup>

Another application was to increase the density of the air to assist early airplane jet engines during takeoff in "hot and high" atmospheric conditions, as was used on the early Boeing 707.<sup>[7]</sup>

Distilled water is also used in Constant Positive Airway Pressure (CPAP) machines. These machines help people with sleep apnea breathe throughout their sleep cycles. The water is used to humidify the air entering the user's nasal cavity, mouth, and throat. Distilled water will not leave any contaminants behind when the humidifier in the CPAP machine evaporates the water.<sup>[8][9]</sup>

## Use in steam irons

Although possibly once the recommended procedure, using distilled water in steam irons for pressing clothes (once thought to help reduce mineral build-up and increase iron life),<sup>[10]</sup> is no longer necessary. Now most manufacturers say that distilled water is unnecessary in their irons, and can also cause malfunction, including spitting and leaking during use. This may be due to the lack of impurities in distilled water, which can heat *beyond* the normal boiling point, rather than nucleating around dissolved impurities *at* the normal boiling point and producing the necessary steam when it hits the soleplate. It has been suggested that this superheated (distilled) water in an iron will flash boil when disturbed (as with moving an iron), and cause the iron to spit, leak, and possibly scald the user.

## Equipment to distill water

Until World War II, distilling sea water to produce fresh water was time-consuming and expensive in fuel. The saying was: "It takes one gallon of fuel to make one gallon of fresh water." Shortly before the war, Dr. R.V. Kleinschmidt developed a compression still, which became known as the Kleinschmidt Still, for extracting fresh water from sea water or contaminated water. By compressing the steam produced by boiling water, 175 gallons of fresh water could be extracted from sea water for every gallon of fuel used. During World War II this equipment became standard on Allied ships and on trailer mounts for armies. This method was in widespread use in ships and portable water distilling units<sup>[11]</sup> during the latter half of the century. Modern vessels now use flash-type evaporators to boil sea water, heating the water to between 70-80 °C and evaporating the water in a vacuum; this is then collected as condensation before being stored.

Solar stills can be relatively simple to design and build, with very cheap materials.<sup>[12]</sup>



A boiling water distiller. Boiling tank on top and holding tank on the bottom.



Typical laboratory distillation unit

## Drinking distilled water

Bottled distilled water can usually be found in supermarkets or pharmacies, and home water distillers are available as well. Water purification, such as distillation, is especially important in regions where water resources or tap water is not suitable for ingesting without boiling or chemical treatment.

Municipal water supplies almost always contain trace components at levels which are regulated to be safe for consumption.<sup>[13][14]</sup> Some other components such as trace levels of aluminium may result from the treatment process (see water purification). Fluoride and other ions are not removed through conventional water filter treatments. However, distillation eliminates most impurities.<sup>[15]</sup>

Distilled water is also used for drinking water in arid seaside areas lacking sufficient freshwater, via desalination of seawater.<sup>[16]</sup>

## Health effects

Distillation removes all minerals from water, and the membrane methods of reverse osmosis and nanofiltration remove most, or virtually all, minerals. This results in demineralized water, which has not been proven to be healthier than drinking water. The World Health Organization investigated the health effects of demineralized water in 1980, and its experiments in humans found that demineralized water increased diuresis and the elimination of electrolytes, with decreased serum potassium concentration. Magnesium, calcium, and other nutrients in water can help to protect against nutritional deficiency. Recommendations for magnesium have been put at a minimum of 10 mg/L with 20–30 mg/L optimum; for calcium a 20 mg/L minimum and a 40–80 mg/L optimum, and a total water hardness (adding magnesium and calcium) of 2–4 mmol/L. At water hardness above 5 mmol/L, higher incidence of gallstones, kidney stones, urinary stones, arthrosis, and arthropathies have been observed. For fluoride the concentration recommended for dental health is 0.5–1.0 mg/L, with a maximum guideline value of 1.5 mg/L to avoid dental fluorosis.<sup>[17]</sup>

Water filtration devices are becoming increasingly common in households. Most of these devices do not distill water, though there continues to be an increase in consumer-oriented water distillers and reverse osmosis machines being sold and used. Municipal water supplies often have minerals added or have trace impurities at levels which are regulated to be safe for consumption. Much of these additional impurities, such as volatile organic compounds, fluoride, and an estimated 75,000+ other chemical compounds<sup>[18][19][20]</sup> are not removed through conventional filtration; however, distillation and reverse osmosis eliminate nearly all of these impurities.

The drinking of purified water as a replacement for drinking water has been both advocated and discouraged for health reasons. Purified water lacks minerals and ions such as calcium that play key roles in biological functions such as in nervous system homeostasis, and are normally found in potable water. The lack of naturally occurring minerals in distilled water has raised some concerns. The *Journal of General Internal Medicine*<sup>[21]</sup> published a study on the mineral contents of different waters available in the US. The study found that "drinking water sources available to North Americans may contain high levels of calcium, magnesium, and sodium and may provide clinically important portions of the recommended dietary intake of these minerals". It encouraged people to "check the mineral content of their drinking water, whether tap or bottled, and choose water most appropriate for their needs". Since distilled water is devoid of minerals, mineral intake through diet is needed to maintain good health.

The consumption of "hard" water (water with minerals) is associated with beneficial cardiovascular effects. As

noted in the *American Journal of Epidemiology*, consumption of hard drinking water is negatively correlated with atherosclerotic heart disease.<sup>[22]</sup>

## See also

- Atmospheric water generators are used to make distilled water from air.
- Deionized water
- Desalination
- Heavy water
- Purified water
- Distillation

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