90th birthday series

# What is "hydrogen water"?

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Issue 1
May 30, 2026

**Summary**

We often read that drinking "hydrogen water" confers various health and wellness benefits. But what exactly is "hydrogen water"? It seems that in this context the term is usually used to refer to water in which is dissolved molecular hydrogen ($H_2$). This article discusses this substance, and some methods used to produce it.

The article does not discuss the purported health or wellness benefits of "hydrogen water" nor the physiological mechanisms that might be involved.

## 1 INTRODUCTION

### 1.1 Hydrogen water

*Hydrogen water* most often seems to refer to water in which molecular hydrogen ($H_2$) is dissolved. It is sometimes called "hydrogen rich water" or "hydrogenated water"[1]. For conciseness, I will call it here just "hydrogen water".

As with many gases, hydrogen is to some extent soluble in water. The amount of hydrogen that can remain dissolved in water depends on the temperature and the *partial pressure* of hydrogen in the space above the liquid.

### 1.2 About "partial pressure"

If we have a mixture of gases at a certain pressure, we can think of the *partial pressure* of one of the gases as being its contribution to the overall pressure.

Here is the usual formal definition: imagine that we have a closed container with a certain volume, containing a mixture of gases, at a certain temperature.

[1] This term was probably adopted to be parallel to the "carbonation" of beverages (in which carbon dioxide is dissolved), but this use is inconsistent with the normal meaning of "hydrogenated" in chemistry.

The partial pressure of any one of the gases is the pressure that would exist (at that same temperature) if the quantity of that gas in the mixture occupied that entire volume by itself.

### 1.3 Saturation solution level

Under given conditions of temperature and partial pressure, only a certain amount of a certain gas (*e.g.*, hydrogen) can remain dissolved in a certain solvent (*e.g.*, water). This is referred to as the *saturation* solution level.

As the temperature increases, the amount of hydrogen that can remain dissolved in the water (the saturation level) decreases. As the partial pressure of the hydrogen in the atmosphere above the liquid solution increases, the amount of hydrogen that can remain dissolved in the water increases.

At “room temperature”, with the solution exposed to air at normal atmospheric pressure, the maximum amount of hydrogen that can remain dissolved in water is approximately 1.6 milligrams of hydrogen per liter of water[2] (“1.6 parts per million”, ppm). This is sometimes stated in “parts per billion”, ppb, for which the level above would be 1600 ppb.

## 2 DIFFERING OPINIONS

There is a difference of opinion over whether or not drinking hydrogen water actually confers various health and wellness benefits. I do not here weigh in on this, limiting my discussion to the substance itself.

## 3 MAKING HYDROGEN WATER

### 3.1 Metallic magnesium

If pure metallic magnesium (a light, soft metal) is in contact with water this chemical reaction takes place

$$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2 \qquad (1)$$

That is, the magnesium reacts with the water to produce magnesium hydroxide and molecular hydrogen, both ending up dissolved in the water.

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[2] That metric is stated in terms of “mass per volume”, But because the mass of one liter of water is almost exactly 1000 grams, a concentration of 1.6 mg/liter is often considered to be $1.6 \times 10^{-6}$ “by mass” (often said as “by weight”).

### 3.2 Hydrogen generating tablets

Tablets are sold commercially that use a variation of this principle to create hydrogen water in a consumer context. The magnesium here is finely-divided and combined with an edible acid, such as malic or tartaric acid. The reaction is more vigorous in the presence of the acid than it would be with only the magnesium in contact with the water.

The generic formula for such reactions is:

$$Mg + 2H^{+} \rightarrow Mg^{2+} + H_2 \qquad (2)$$

where $H^{+}$ is the hydrogen ion from the acid involved and $Mg^{2+}$ is the magnesium ion of the resulting magnesium salt.

One result is that the magnesium salt (a base) essentially neutralizes the residual acid in the final product, leaving that essentially neutral.

### 3.3 Proton exchange membrane electrolysis

#### 3.3.1 *Introduction*

Small, modest-cost devices are available for home use that are said to produce water with molecular hydrogen dissolved in it. These are often said to use “SPE/PEM” (Solid Polymer Electrolysis/Proton Exchange Membrane) technology.

#### 3.3.2 *Principle of operation*

These presumably operate by means of “proton exchange membrane electrolysis”.

While familiar electrolysis processes employ a liquid electrolyte, this process uses a solid polymer electrolyte. The result of the entire process (which is complex) is that water molecules are electrically decomposed into molecular hydrogen and molecular oxygen. The hydrogen is generated at one electrode and becomes dissolved in the water. The oxygen is generated at the other electrode and is exhausted into the surrounding atmosphere.

#### 3.3.3 *The resulting level of dissolved hydrogen*

I have no authoritative information on the level of hydrogen dissolved in the water by these devices.

## 4 COMMERCIAL DISTRIBUTION OF HYDROGEN WATER

What is described as hydrogen water is available in various packages (aluminum pouches, cans, etc.) for consumer use. The container material is of necessity one that is essentially impermeable to

molecular hydrogen. I assume that the pressure in the “head space” of these containers is above atmospheric pressure.

I note that several brands sold in aluminum pouches claim that the hydrogen concentration in the product is about 15 ppm.

## 5 ABOUT “90TH BIRTHDAY SERIES”

This article is one of several publications made around the time of the 90th birthday of the author, May 8, 2026.

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