

The tools of water purification

The Hydration Code · Chapter 2

BOOK

The Hydration Code

CHAPTER

2 of 10

AUDIO IN GERMAN

15 minutes

“Water must be ‘pure’, not rich in nutrients. Its quality is defined not by what it contains, but by everything that is ‘not’ to be found in it.”

The history of water purification is closely bound up with the progress of humanity. As the foundation of pharmacy and the heart of historical alchemy, it is indispensable today. Neither pharmaceutical manufacturers nor medical laboratories could carry out their work without the use of highly pure water.

In pharmacy, Aqua ad injectabilia, or water for injection, is the most strictly controlled element. To serve as a carrier for remedies, it must be completely free of any foreign substances. This highest standard springs from the insight that only an absolutely pure medium possesses the power to transport active substances unadulterated and to initiate healing processes. No laboratory in the world, no pharmaceutical manufacturer and no medical institution could exist without this highly pure water.

“Rain, high up in the clouds, is distilled water.”

Let us begin our comparison directly with nature itself. Since the beginning of time it has applied precisely the principle of water purification that we regard technologically as the supreme discipline, namely the phase change. When the solar energy of the sun warms our rivers, lakes and seas, water rises in gaseous form as pure vapour into the atmosphere. Gently it leaves behind all salts, sediments and the material burden of the earth. This mo-

ment of release represents the ultimate separation. The water rises ever higher, forms clouds and finally rain. Only very few know that rain, high up in the clouds, is at first nothing other than pure distilled water.

Since this water, just like any technically obtained highly pure water, is extremely receptive as a universal solvent and positively “hungry”, the pure raindrop inevitably takes up gases, dust particles and industrial pollutants from the air on its plunge to earth. When this already contaminated rain finally reaches the ground and seeps through the various layers of earth, it becomes further saturated with organic and inorganic burdens. Thus it ultimately returns to our cycle of life as water highly saturated with substances.

Our waterworks achieve a great deal. Their plants are designed to provide gigantic quantities of water for millions of households, from industrial use to the ordinary flushing of a toilet. They strive to clarify burdened water as well as possible, filter out coarse substances mechanically, regulate the pH value chemically and neutralise microbiological dangers.

Yet molecular purification to the level of ultrapure water that would be necessary for optimal hydration is, under these conditions, simply impossible economically and technically. Added to this is the problem of the so-called last mile. For even when the water leaves the works in a controlled state, it must often flow for kilometres through an ageing infrastructure. On this path through rusty pipe systems and partly dilapidated mains, it once again takes up residues that appear in no official test report and in the end land directly in your glass.

Since you are probably already aware of all these connections, you are likely already purifying your water today. It is precisely for this reason that I believe this book can be of particular value to you. You will learn from it, on the one hand, what water purification really means in its depth and, on the other, what profound changes the enjoyment of highly pure water can open up for our organism.

A uniform unit of measurement

More and more people now purify their drinking water themselves. This trend is reflected in a growing market for water treatment systems that is continually supplemented by innovations. The offer ranges from simple activated carbon filters from the supermarket to technologically sophisticated and expensive reverse osmosis systems.

Whoever begins treating their own water should first become familiar with the essential fundamentals. In this connection the important question arises, “By what methods can the degree of purity of water be reliably determined at all?”

To determine the purity of water, science uses two methods, “TDS and TOC”. The more widespread of the two is water analysis by TDS, which stands for Total Dissolved Solids. Its value is recorded in parts per million and usually abbreviated as “ppm”. A marked limitation of this method is that it can detect only electrically conductive substances in the water. All other substances that lack this conductivity remain “completely silent” to this analysis.

To make these silent passengers visible as well, a second method was developed, TOC. The abbreviation stands for Total Organic Carbon and gives detailed information about the burden from substances such as pesticides, residues of medicines or solvents. With this method even the finest nuances of the various substances can be measured to within a microgram. This analysis represents the most thorough form of water testing. Only the sum of both methods together gives a complete and honest picture of the actual degree of purity of drinking water.

At this point, however, an important matter must be mentioned. Analytical systems for measuring precision by TOC often cost as much as an entire detached house and moreover require highly qualified specialists and an elaborate infrastructure. For private users this means in practice that a quick, uncomplicated and at the same time affordable test of their own drinking water for substances such as glyphosate or hormones is in fact not possible.

To illustrate the specific fields of application of the measuring methods, the following list shows the substances that can be detected by TDS and TOC measurements together. A direct distinction is made between substances that are harmless and those that are of concern to health.

TDS AND TOC SUBSTANCES IN DRINKING WATER

TDS OF CONCERN	TDS HARMLESS	TOC OF CONCERN	TOC HARMLESS
Arsenic (As)	Bicarbonates	Medicines	Humic substances
Lead	Calcium	Bacteria	Sugar compounds
Cadmium	Chlorides	Benzene (VOC)	
Lime	Gold	Glyphosate	
Sodium fluoride	Potassium	Hormones	
Nitrates	Magnesium	Microplastics	
Mercury	Sodium	Pesticides	
	Silver	PFOS (PFAS)	
	Sulphates	Viruses	

SOURCES

- BLV, Verordnung des EDI über Trinkwasser TBDV (SR 817.022.11), Swiss drinking water ordinance
- BAFU, Nationale Grundwasserbeobachtung NAQUA, Swiss National Groundwater Monitoring
- UBA, Trinkwasserverordnung 2023, German Drinking Water Ordinance
- BMASGPK, Trinkwasserverordnung, Austrian Drinking Water Ordinance
- WHO, Guidelines for Drinking-water Quality, 4th edition incorporating addenda, Geneva 2022

The next list sets the average burden values of tap water in different countries and cities side by side.

REGIONAL TDS AND TOC BURDEN

REGION	TOC PPM	TDS PPM	TOTAL PPM
Austria	0,19	280	280
Switzerland	0,22	320	320
Germany	0,24	410	410
EU average	0,30	520	520
Los Angeles	0,45	640	640
Beijing	0,73	710	710
New Delhi	0,97	980	980

SOURCES

- BAFU, Nationale Grundwasserbeobachtung NAQUA, Swiss National Groundwater Monitoring
- UBA, Trinkwasserverordnung 2023, German Drinking Water Ordinance
- BMASGPK, Trinkwasserverordnung, Austrian Drinking Water Ordinance
- WHO, Guidelines for Drinking-water Quality, 4th edition incorporating addenda, Geneva 2022

What stands out in this list is that the TOC value represents only a “tiny fraction” compared with the TDS value. Here it is essential to know a quite fundamental biological insight. It reads, “The quantity of a substance says nothing about its effect.”

This principle becomes even clearer when one compares substances in our body with one another. Our organism can cope quite well with larger quantities of inorganic lime or magnesium, for example. On the other hand, our entire bodily system reacts incomparably more strongly to some substances. One need only think of the enormous effect a single molecule of LSD can have on our entire body, mind and soul.

One should know that we humans can react to substances present only in the tiniest quantities of nanograms. Hormones, medicines, artificial molecules and pesticides can act even in these tiniest, barely measurable, yet powerful quantities.

In the water treatment industry this connection is often not sufficiently known. The mistaken assumption therefore frequently prevails there that a low TDS value of dissolved particles alone automatically guarantees a high or the highest purity of water. Unfortunately this is not so. The most powerful substances in our drinking water cannot be measured at all by 99.9 % of all people who purify their water.

Five techniques and three principles of water purification and their highest stage of refinement

The principles by which water is to be purified, Light - Filter - Phase change - Refinement

The choice of a method of purifying water depends on the kind of burden the water carries and on its intended degree of purity and purpose. The methods can be divided into physical, chemical and biological approaches to purification.

While physical methods hold back particles mechanically, chemical methods aim at binding dissolved substances through adsorption, as for instance with the use of activated carbon. Biological approaches, on the other hand, concentrate on neutralising microorganisms such as bacteria and viruses by

means of a very special light. The most effective and powerful of all methods, however, uses the molecular phase change of water. It is the most natural and efficient form of water purification, distillation.

To grasp water in all its depth and might, there are kinds of purification that go far beyond purely material cleansing. Great masters such as Paracelsus spoke of “Aqua Mercurii”, that precious elixir which became the basis of his remedies. To this day they have secured him a place among the greatest physicians in history.

An alchemical purification of water strives to lead the entire nature of water back to its purest form, to its most original vitality and power of movement. Paracelsus spoke of purifying the body, the spirit and the soul of water, in order to separate everything impure from the water fundamentally on every level. The great masters of alchemy, among them Paracelsus, said, “In the highest purity of water, its power to receive and its life force are mightiest.”

Yet before we immerse ourselves more deeply in the matter of water, let us compare the five techniques for purifying water with one another.

1. UV-C sterilisation

Looking into the field of disinfection, we come upon UV-C technology. This highly effective method uses light radiation at 254 nm to sterilise the DNA of all microorganisms and thus renders them “harmless”. It is the most perfect kind of sterilisation. Yet it is precisely here that the limit of this technology lies. Since it removes no matter whatsoever from the water, all chemical and material contaminations remain one hundred percent in the water. The result is a microbiologically “dead” water, but by no means a materially “pure” medium. The inorganic pollutants that burden our organism flow unhindered through the light into our glass.

2. Ion exchangers

It is similar with ion exchangers, which are often wrongly understood as purification systems. In truth this is merely a material redistribution. The system exchanges hardness minerals such as calcium and magnesium for

sodium ions. For your coffee machine this protection against limescale may be a blessing, but for your body the total material burden remains identical. The water is merely relabelled, but by no means freed of its burden.

3. Activated carbon filters

A widespread standard is activated carbon. Through adsorption it acts like a magnetic sponge and is excellently suited to binding chlorine, pesticides and organic gases. The secret of its effect lies in its gigantic inner surface. A single teaspoon of high-quality activated carbon has the area of an entire football pitch. Yet inorganic burdens such as lime, nitrates or heavy metals pass this barrier almost unhindered. Activated carbon is a specialist for the surface, but it capitulates before the depth of chemical saturation.

An often underestimated risk with this method is the so-called danger of breakthrough. When the capacity of the carbon is exhausted, it can suddenly release the previously bound pollutants back into the water.

Moreover, during longer periods of standing, the porous structure offers an ideal breeding ground for bacteria. Without an additional barrier, the activated carbon filter therefore remains merely one building block in a comprehensive purification strategy, but never a complete solution for true purity.

4. Reverse osmosis

The technically most sophisticated form of filtration is reverse osmosis, in which water is pressed at high pressure through a semi-permeable membrane. Its performance is impressive, for the pores of these membranes are so fine that in theory they allow only water molecules to pass. Despite its high efficiency, however, it remains a child of pressure filtration with all its inherent limits.

Besides the latent risk of microbial growth directly on the membrane, the dreaded biofilm, there is always the danger of the so-called concentration polarisation effect. Pollutants accumulate in front of the membrane in such high density that the smallest molecular compounds can finally overcome the mechanical resistance after all. Gaseous impurities in particular, or low-molecular substances such as certain pesticide residues, often slip unhin-

dered through this net. Reverse osmosis is without doubt a master of filtration, but it is not absolutely safe from the finest intruders of the chemical world.

5. Distillation

At the summit of all purification methods stands a principle that breaks radically with the concept of sieving and filtering, namely distillation. It is the only method that compels a true separation through a “molecular phase change”. As the water is brought to the boil by heat and transferred into the gaseous state, an insurmountable physical boundary arises for everything material. Only the pure water molecules rise as vapour, and the entire burdensome material past remains behind in the boiler as a concentrate.

This method imitates exactly the eternal cycle of nature. As in the formation of clouds, the water is freed of its earthly burden. While mechanical filters merely try to hold back foreign substances, distillation lets the water itself leave them behind. Heavy metals, residues of medicines, nitrates and even viruses have a far higher boiling point than water and therefore physically have no chance of passing into the vapour state. The result is a highly pure condensate that in its material freedom resembles the original rain in the atmosphere.

“A filter system, whether activated carbon or reverse osmosis, is always a ‘passive’ medium.”

Distillation, by contrast, is an “active” process. With its mighty heat it is the only kind of water purification that intervenes directly in the molecular realm of water. In the decisive moment of the mighty phase change, all water molecules rise free of their material burden and leave their entire material past behind them.

Filtration, no matter how fine the sieve of the membrane, inevitably means that the system becomes a little more soiled with every litre of water filtered. A filter is logically most effective on its first day, yet from that moment on it continually loses performance and gradually becomes ever more of a “collecting basin” for precisely the burdens it was meant to eliminate. With insufficient maintenance this can even lead to dangerous recontami-

nation of the water. When a filter reaches its saturation limit and is not replaced, the system may suddenly release the pollutants collected over weeks back into the water.

Distillation, by contrast, remains as efficient with every pass as on its first day. Nothing ever has to be replaced, since the laws of thermodynamics are subject to no wear. The separating power between pure vapour and burdened concentrate always remains identical. Moreover, the heat of the process acts like a natural autoclaving of the entire system.

The ultimate comparison

The following tabular comparison sets the methods explained directly against one another. The analysis makes clear the special role of distillation, which, because of its consistent purifying effect, forms the decisive reference point and at the same time the technological benchmark of the entire comparison.

SUBSTANCE	● OF CONCERN ● HARMLESS	ACTIVATED CARBON	ION EXCHANGER	UV-C	REVERSE OSMOSIS	DISTILLATION
Acaricides	●	~ 60 %	0	0	~ 90.0 %	~ 99.9 %
Algal toxins	●	~ 60 %	0	0	~ 85.0 %	~ 99.9 %
Aluminium	●	0	~ 70 %	0	~ 93.0 %	~ 99.9 %
Antimony	●	0	~ 60 %	0	~ 85.0 %	~ 99.9 %
Arsenic	●	0	~ 50 %	0	~ 85.0 %	~ 99.9 %
Residues of medicines	●	~ 70 %	0	0	~ 90.0 %	~ 99.9 %
Asbestos fibres	●	~ 50 %	0	0	> 94.0 %	~ 99.9 %
Bacteria	●	0	0	~ 99.9 %	~ 93.0 %	~ 99.9 %
Barium	●	0	~ 80 %	0	~ 90.0 %	~ 99.9 %
Lead	●	~ 20 %	~ 90 %	0	~ 93.0 %	~ 99.9 %
Cadmium	●	0	~ 80 %	0	~ 93.0 %	~ 99.9 %
Chlorine	●	~ 90 %	0	0	~ 85.0 %	~ 99.9 %
Chromium	●	0	~ 70 %	0	~ 85.0 %	~ 99.9 %
Dioxins	●	~ 80 %	0	0	~ 90.0 %	~ 99.9 %
Fluoride	●	0	~ 40 %	0	~ 85.0 %	~ 99.9 %

SUBSTANCE	● OF CONCERN ● HARMLESS	ACTIVATED CARBON	ION EXCHANGER	UV-C	REVERSE OSMOSIS	DISTILLATION
Fungicides	●	~ 70 %	o	o	~ 90.0 %	~ 99.9 %
Glyphosate	●	~ 70 %	o	o	~ 93.0 %	~ 99.9 %
Hormones	●	~ 70 %	o	o	~ 90.0 %	~ 99.9 %
Insecticides	●	~ 70 %	o	o	~ 90.0 %	~ 99.9 %
Copper	●	~ 20 %	~ 90 %	o	~ 93.0 %	~ 99.9 %
Manganese	●	o	~ 80 %	o	~ 90.0 %	~ 99.9 %
Microplastics	●	~ 30 %	o	o	> 94.0 %	~ 99.9 %
Nitrate	●	o	~ 50 %	o	~ 80.0 %	~ 99.9 %
Nickel	●	~ 20 %	~ 80 %	o	~ 93.0 %	~ 99.9 %
PFAS	●	~ 40 %	o	o	~ 85.0 %	~ 99.9 %
Pesticides	●	~ 70 %	o	o	~ 90.0 %	~ 99.9 %
Mercury	●	~ 40 %	~ 60 %	o	~ 90.0 %	~ 99.9 %
VOCs	●	~ 70 %	o	o	~ 40.0 %	~ 90 %
Viruses	●	o	o	~ 99.9 %	~ 90.0 %	~ 99.9 %
Uranium	●	o	~ 70 %	o	~ 90.0 %	~ 99.9 %
Wear		very high	very high	medium	high	none
Recontamination		high	high	low	high	none
Cleaning effort		high	high	medium	high	low
Noise		inaudible	inaudible	inaudible	inaudible	barely audible
Purchase costs		low	low	low	high	high
Use		simple	simple	hazardous	simple	simple

SOURCES

- BLV, Anerkannte Aufbereitungsverfahren für Trinkwasser, recognised treatment methods for drinking water
- UBA, Liste zulässiger Aufbereitungsstoffe und Desinfektionsverfahren gemäss § 20 Trinkwasserverordnung, list of permitted treatment substances and disinfection methods
- AGES, Ionentauscher und Filtermedien zur nicht ortsfesten Wasseraufbereitung, Schwerpunktaktion A-034-24, Vienna 2025
- WHO, Guidelines for Drinking-water Quality, 4th edition incorporating addenda, Geneva 2022
- WHO, Good manufacturing practices, water for pharmaceutical use, Technical Report Series 1033, Annex 3, Geneva 2021

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