Reverse Osmosis Drinking Water: The Myths and the Facts

By Gary Battenberg and Peter Cartwright, PE

Note to WC&P readers: *The purpose of this article is to counter a recent blog from India that is critical of POU RO drinking-water treatment. It contains out-dated and unsubstantiated claims surrounding this widely used treatment process. You can read the blog at https://www.downtoearth.org.in/news/water/ban-ro-systems-if-dissolved-solids-are-less-than-500-mg-l-ngt-64795). The authors refute these myths in detail and go beyond this to address other myths relating to POU RO technology.*

When asked what kind of water is ideal to consume, the above-mentioned blog author stated: "Ideal water is rich in minerals, which adds nutrition to one's health like inorganic substances (such as rocks and similar matter) found in the earth strata, like calcium, magnesium and potassium. So, these minerals make up for the nutritional value of water, which we call ideal water."

Fact: A *WQA Technical Fact Sheet* regarding consumption of low TDS water[1] concludes the human body's own natural control of mineral concentration mechanism (homeostasis) regulates the mineral content of the body fluids and the discharge of different types of ions from the body of normal-health individuals drinking water with low or high mineral content. Arthur L. Guyton, MD in his *Textbook of Medical Physiology, 11th Edition* states: "Homeostasis is the maintenance of static or constant conditions in the internal body environment. This natural process controls the mineral (ion) and the water concentrations in the body fluids within narrow limits inside and outside all the cells in all the organs and tissues of the body. The kidneys are most important in maintaining constant ion concentrations (including sodium, potassium, calcium, etc.) through elimination and reabsorption. In homeostasis, three body fluids are involved: plasma (approximately 3/5 of the blood volume); interstitial fluid (the fluid between cells); and the intracellular (fluid inside the cells)."

According to experts, a healthy adult male should ingest about 13 cups (three liters) of water (or water-based liquid) per day and healthy adult women nine cups (2.2 liters). We are all too aware of global water-quality issues: 90 percent of diseases are water-related and cause 80 percent of the deaths in developing countries—about six million people every year. Most of these result from microorganism contamination (acute illnesses) and tend to overshadow the long-term toxic effects of chemicals in drinking water. Arsenic, fluoride, lead, nitrite, nitrate, manganese are just some of the naturally occurring ionic substances of concern. The organic chemicals mainly resulting from manufacturing, agricultural, mining and other human activities are often overlooked as sources of long-term illnesses and premature deaths. All this is exacerbated by water-shortage issues: as the global population grows, a larger percentage of our fixed quantity of fresh water is being contaminated and many people are forced to drink this water.

The solution to these issues is water treatment. In the developed countries, virtually all public water supplies are treated, at least to control pathogenic organisms. In these countries, many consumers have chosen to go beyond this level of treatment for their personal supply of drinking water. Over the last 60 years, RO technology has developed, improved and is recognized for its ability to reduce the concentrations of all classes of contaminants in water supplies: suspended solids, salts, organics and micro-organisms. The introduction of POU RO systems has given the consumer an inexpensive tool to ensure that their drinking water is largely free from health-related contaminants.

When asked for comment on the fact that many households use RO for water purification, the blog author responded with: "Most people are under the impression the RO systems excel at removing water impurities, but few are aware that they remove the beneficial minerals. In fact, the reverse-osmosis process removes 92 to 99 percent of beneficial calcium and magnesium. What is alarming, is that consuming RO water for even just a few months can create serious side effects. But it gets even worse. Because RO water doesn't have enough minerals. When it is consumed, it also leaches minerals from the body. This means that the minerals being consumed in food and vitamins are being urinated away. Hence, whatever the claims could be from the RO suppliers, drinking water treated using RO technology is definitely hazardous to health."

Fact: Guyton explains further: "The kidneys control the overall concentration of the constituents of body fluids. It filters about 180 liters (165 quarts) of water per day, but over 99% is reabsorbed and only 1.0-1.5 liters are eliminated as urine. If the osmolality of the fluid to be filtered by the kidney is lower than normal (lower solute concentration, such as low TDS water) nervous and hormonal feedback mechanisms cause the kidney to excrete more water than normal and thus maintain the ion concentration of fluid to normal values. The opposite is true if the ion concentration of the fluid to be filtered is higher than normal. The three basic hormonal and nervous control systems triggered by abnormal ion concentration in the body fluids to be filtered by the kidney are antidiuretic hormone (ADH) from the pituitary gland, aldosterone from the adrenal glands, and thirst (as osmolality rise of about 1% causes thirst)."

Minerals in drinking water are required

A claim is made that minerals in water are absorbed into the bloodstream more quickly that from food. As far back as 1991, one of the authors wrote an article addressing this issue.[3] The article concluded the following: "Regardless of whether a

mineral (calcium, for example) is in food or water, it still exists in the same form and, when ingested, is either metabolized in the body or excreted. If a person follows a normal pattern of food intake, he/she ingests more minerals than needed and the excess are eliminated."

Another claim is that humans need the beneficial minerals (e.g., calcium, magnesium) found in drinking to maintain good health. No two drinking-water sources are the same with regard to mineral concentration (or any other parameter, for that matter), and even supplies with very high hardness levels would only provide about 6.5 percent of the RDA (Recommended Dietary Allowance) of that mineral. The rest would have to come from food.

Myth: RO water will attack the body

Yet another claim is that RO purified water is so pure that it will attack the mucous membranes in the body and cause harm. This water is all described as low TDS water. TDS stands for total dissolved solids and is roughly the total salts concentration of a given water supply, expressed as mg/L.

There are numerous scientific studies as far back as 1993[3] addressing the health effects of drinking low TDS water. This study was updated in a *Technical Fact Sheet* published by WQA in 2013.[4] The studies address homeostasis, the natural processes of maintaining concentrations of minerals and fluids in the human body, and their relationship with drinking water.

There is also significant anecdotal evidence of humans consuming low TDS water for extended periods of time without any known health effects. An example of this is the city of Vancouver, BC, Canada. Their municipal drinking-water report lists the conductivity of the water over a range of 21 to 53 μmhos/cm. This converts to a TDS range of approximately eight to 20 mg/L. If a POU RO unit is treating a water supply with a TDS of 300 mg/L, it would be possible to expect the quality of the treated water (permeate) to be about 17 mg/L. This is certainly within the TDS range of the water consumed by much of Vancouver's population and we would certainly know if there were health effects in that city.

Finally, the 2017 WHO document, *Guidelines for Drinking-water Quality*[5] states: "The palatability of water with a total dissolved solids (TDS) level of less than about 600 mg/L is generally considered to be good…" "No health-based guideline value for TDS has been proposed." They also state that no guideline value has been established for TDS because it is: "Not of health concern at levels found in drinking-water."

Myth: other technologies are just as effective

If not RO, the blog author said: "I can surely state that RO is not essential where the source of water to be treated is surface water and specifically if the TDS of the water is below 1,000 ppm. There are alternative technologies such as natural zeolites, CDI, etc., which can effectively treat water at the same time retain natural mineral present in water." *Note to readers:* Zeolites and CDI do not, in fact, effectively treat water for potable purposes. This is a broader subject for another article addressing their limitations.

Fact: It is critically important to remember that it is the water, not the soluble or suspended minerals and other constituents that serve as a solvent and medium for the transport of nutrients and wastes to and from cells throughout the body. Water bathes the cells, cushions the brain, lubricates the joints and tissues and regulates body temperature, as well as the body's biochemical reactions.

In point-of-fact, it must be noted that the US Navy has used distilled water with less than 3-ppm TDS aboard navy vessels for more than 50 years. Submarine crews typically drink nothing but low-TDS purified water for months at a time, all with no reported ill effects. The US Army uses expeditionary (portable) RO systems to provide low TDS safe water for its field personnel. They do not consider low-TDS water to be a problem and have no minimum standards. The US EPA conducted a project in San Ysidro, NM in which the drinking-water TDS was reduced from 800 mg/L to a range of 40 to 70 mg/L. No ill-health effects were observed during a one-year test. Many hundreds of thousands of RO drinking-water appliances have been sold residentially over the past 40 years without any reported ill health effects from consumption of this type of water.[1]

Myth: RO wastes water

A primary criticism of RO technology has been that it wastes too much water and that membranes must be replaced frequently. It is important to realize that any technology designed to remove a contaminant from a water stream has to separate and collect the contaminant. Ion exchange resins and activated carbon, respectively, exchange and adsorb the contaminants, but they still have to eventually be removed, by generating a waste stream or by discarding the resin. In the case of RO, the wastewater (reject or concentrate) stream is continuous. In this technology, the term recovery refers to the percentage of feedwater flow that passes through the membrane and becomes permeate (purified water). Obviously, 100 minus recovery is the percentage of the feedwater stream that is wastewater. This wastewater is not highly concentrated. For example, for a typical POU RO unit (operating at 25-percent recovery), the concentration of salts in the wastewater is only 33-percent higher than in the feedwater. In many cases, this wastewater can easily be collected and used for other purposes (such as watering plants, washing dishes, etc., because it is not under pressure). A trend in the industry is to manufacture RO units that run at higher recovery, approaching 50 percent, which will significantly reduce the quantity of the wastewater stream. In addition, experience has shown that most membranes last at least 10 years in operation.

Myth: Bottled water is better than RO water

Many consumers rely on bottled water for their only source of drinking water. This is based on the apparent lack of confidence in the quality of water provided by the municipal water provider (or from the private well). An argument can be made that this may have some scientific validity for two reasons:

1) All municipal water supplies must meet the requirements of the US EPA *Safe Drinking Water Act*; however, the distribution system, full of biofilms and arguably subject to deterioration and possible leakage, may have compromised the quality of the water by the time it reaches the residence.

2) Virtually all water supplies, regardless of source, contain PPCPs (pharmaceutical and personal care products). These are tiny concentrations of (mainly) organic compounds which go down the drain from all activities. These contaminants ultimately end up in drinking-water supplies, including surface water as well as aquifers. The concentrations are measured in parts per trillion (equivalent to one second in 32,000 years), but it is estimated that there are as many as 85,000 different chemicals in our drinking water.[6,7]

There is no doubt that RO drinking water will improve the quality of water supplies from both of the above issues. The problem is that not all bottled water is made from RO permeate; some is advertised as spring water and may even come from a municipal supply. The water has probably been ozonated when the bottle is filled, so it should be free of pathogenic microorganisms, but that may be the only treatment it has received. Unless the bottle label states the source (and treatment)

of its contents, it is difficult to determine exactly the quality of this product. There has been concern about various components of the plastic material that may be leached into the supply and contaminate from within.

Another factor is the cost of bottled water. Significant advertising dollars are spent extolling the virtues of a particular brand and making wild claims to appeal to the absurd (there is even one labeled *Liquid Death*, purported to be only water) and the resulting pricing appears to be as high as $9/gallon. Compare this to the current price of gasoline. And yet, Americans spend almost $12 billion/year for this product.

And, of course, consider the plastic pollution resulting from all these bottles. It is estimated that Americans discard 60-million water bottles per day. Because we recycle only nine percent of our trash, the vast majority end up in a landfill, where it will take 450 years for them to break down. Thanks to the benign characteristics of plastic, they only break into tiny particles, most of which end up in the ocean. It is predicted that by 2050, the weight of plastics in the ocean will exceed the weight of all fish.

Conclusion

Water quality around the globe continues to deteriorate due to increased stresses placed on the natural water sources. Contaminants that have just recently been identified add to the problems we already face and fortunately, water purification devices, especially reverse-osmosis drinking-water appliances are relied upon to provide safe, high-quality life support water. Although public utilities enjoy a splendid reputation for dependable water service, they are sometimes left with no choice but to decentralize when a contaminant exceeds the US EPA acceptable maximum contaminant level (MCL). When this happens, consumers are notified that supplemental treatment is required to ensure safe drinking water.

This is where time-tested and proven RO systems create that final barrier to remove/reduce those contaminants, giving the consumer piece of mind for their well-being and improving their quality of life. In defense of the US water-treatment industry, our collective efforts in water conditioning and purification technologies have reduced waterborne illness and disease drastically since before the turn of the 20th century. We must refute the misinformation so prevalent in the media with facts and figures, not with generalities, myths and opinions.

References

1. "Consumption of Low TDS Water," Report by the Water Quality Association Science Advisory Committee, 1992-1993, with Review by Dr. Lee T. Rozelle and Dr. Ronald L. Wathen, M.D., March 1993. Adopted: March 1994

2. Guyton, Arthur L., M.D. "Textbook of Medical Physiology 11th Edition," *W.B. Saunders Company*, Philadelphia (2006).

3. Cartwright, P.S. "Minerals and the Body," *WC&P International*, November 1991.

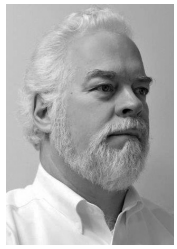
4. "WQA Technical Fact Sheet: Consumption of Low TDS Water," 2013

5. World Health Organization. "Guidelines For Drinking-water Quality, Fourth Edition," 2017

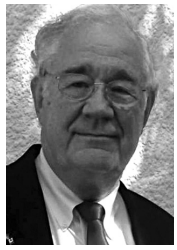
6. Cartwright, P.S. "The Next Drinking Water Contamination Issue, Part 1?" *WC&P International*, October 20177.

7. Cartwright, P.S. "The Next Drinking Water Contamination Issue, Part 2?" *WC&P International*, November 2017

About the authors



♦ *Gary Battenberg is a Technical Support and Systems Design Specialist with the Fluid System Connectors Division of Parker Hannifin Corporation in Otsego, MI. He has 37 years of experience in the fields of domestic, commercial, industrial, high-purity and sterile water treatment processes. Battenberg has worked in the areas of sales, service, design and manufacturing of water treatment systems and processes utilizing filtration, ion exchange, UV sterilization, reverse osmosis and ozone technologies. He may be reached by phone at (269) 692-6632 or by email, gary.battenberg@parker.com*



♦ *Peter Cartwright entered the water purification and wastewater treatment industry in 1974 and has had his own consulting engineering firm since 1980. He has a degree in chemical engineering from the University of Minnesota and is a registered Professional Engineer in that state. Cartwright has provided consulting services to more than 250 clients globally. He has authored over 300 articles, written several book chapters, presented over 300 lectures in conferences around the world and is the recipient of several patents. Cartwright also provides extensive expert witness testimony and technology training courses. He is on numerous editorial advisory boards and technical review committees of several trade publications and a frequent lecturer in numerous technical conferences globally. Cartwright is a recipient of both the Award of Merit and Lifetime Member Award from the Water Quality Association and is the Technical Consultant for the Canadian Water Quality Association. He was the 2016 McEllhiney Distinguished lecturer for the National Ground Water Research and Educational Foundation and gave over 35 lectures throughout the world on groundwater contaminant mitigation. Cartwright can be reached via email, peterscartwright@gmail.com or visit his website, www.cartwright-consulting.com*