Reverse Osmosis: Blissful or Unhealthy?

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INTRODUCTION

Reverse osmosis (RO) is thought to be an effective process for water desalination and an appropriate technique to treat solutions having salt concentrations from 100 to over 50,000 mg/ liter. Solutions with salinity from surface water to sea water, and brines, can be treated by RO membrane. It is used especially when salt and/or dissolved solids need to be removed from a solution.[1] In other words, RO systems are capable of separating dissolved ions from a feed stream. In RO systems, feed water is split into two streams: one has no or low salinity and the other has high salinity. The low salinity stream is known as 'permeate or product water' while the high salinity stream is known as 'concentrate, brine, or reject'.[1]

Water molecules fit into the membrane matrix by forming hydrogen bonds in the RO membrane so the water molecules that enter the membrane can be pushed under pressure. Most of the organic substances having a molecular weight 100 or more i.e., oils, pyrogens and particulates including bacteria and viruses are sieved out.[2] On the other hand, salt ions are rejected according to the valence of the ion. Ions are repelled by dielectric interactions; ions with higher charges are repelled to a greater distance from the membrane surface. Divalent sulfate ions are rejected more efficiently in comparison to the monovalent ions such as chloride ions. The nominal rejection ratio of common ionic salts is 85 - 98%.[2]

The RO technique is used in various applications due to its relative energy efficiency because comparatively low temperature is required for operation of RO, for e.g. desalination, treatment of waste water, reclamation of minerals, purification of water, concentration of whey and other food products.[3,4] The RO has been used in making processed water for dialysis in hospitals and for certain cosmetics and drugs by pharmaceutical companies.[5,6] The RO is capable of producing water of sufficient purity to be used as water forinjection and for the preparation of parenteral solutions.[7-10]

What is Double RO?

The double RO systems, permeate from one unit becomes feed to another unit.

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In situations, where ultra-pure water is required, double pass RO systems are used to meet stringent standards required in hemodialysis, pharmaceuticals, lab, boiler feed and industrial applications. The standard units are available with variable desalination efficiency ranging from 100 LPH to 25000 LPH.[11]

Companies manufacturing RO water machines

- Ree & Company Engineering Works:
  a) Water softener: used to produce soft water by highly acidic cation exchanger, which removes calcium and magnesium ions.
  b) Water demineralizer: It is designed on latest cost-effective ion exchange technique of counter current regeneration.
  c) Reverse osmosis system: emerged as an alternative to chemical treatment. It is used in restaurants, carwashes, bottled water and beverage plant, hotel/ motel drinking water installations, greenhouses, ice manufacturing plants, medical and scientific labs, electronics and pharmaceuticals industries and boiler and cooling water application.
  d) Mineral water system / Bottled water plant "Membrane Technology" incorporating ozone technology-based disinfection offers the opportunity to provide a high quality, hygienically pure and abundant supply of fresh and clear water.
- Sky Aqua Design Manufacture for RO Plants
- Leo Ro Aqua Solutions
- Apas Water Solutions Pvt Ltd
- Water Care Equipmentsand Services
- Aqua Ion Exchange Systems
- Envirospec
- Britomatics Engineers Pvt Ltd
- ERA- Hydro Biotech Energy Pvt Ltd
- Placon Filters Pvt Ltd and many more RO companies are working in this field.

Is the RO water good for health?

After numerous scientific studies concerning demineralized or RO water, the World Health Organization stated that demineralized water has adverse effects on the human and other living organisms. It reported that long term consumption of demineralized (RO) water, results in deficiency of essential nutrients like calcium and magnesium, since during effective cleaning of water through RO machines calcium and magnesium are removed, which are the elements responsible for producing energy to the body tissues.[12]

Short-term exposure from water that is low in magnesium and/or calcium in the Czech and Slovak populations who began using RO treated drinking water at their home taps in 2000-2002 resulted in various health complaints. Acute magnesium (and possibly calcium) deficiency were reported. The complaints related to cardiovascular disorders, tiredness, weakness or muscular cramps and decreased heart rate.[13]

What are the health problems with RO water?

When mineral deficient RO water is consumed, the minerals from the body also tend to leach out to balance the concentration. This means, the minerals that are being consumed in food and vitamins are filtered away from the body. Fewer minerals consumed plus more minerals being excreted give rise to adverse effects and health problems. Homeostasis mechanism of body is negatively affected due to consumption of low mineral content water, thus compromising the mineral and water metabolism in the body. Consumption of RO water leads to the dilution of the electrolytes dissolved in the body water. Inadequate body water redistribution between compartments may compromise the function of vital organs.[14]

In a study on rats it was found that due to consumption of distilled water there was decreased secretion of tri-iodothyronine and aldosterone, increased secretion of cortisol, morphological changes in the kidneys including a more pronounced atrophy of glomeruli, swollen vascular endothelium limiting the blood flow and reduced skeletal ossification in fetuses.[15]

If RO water is not good for health, why is it permitted in the country?

It was primarily for other purposes and not for human consumption. Chemically-produced demineralized waters were distilled and later deionized or RO-treated. It was used mainly for industrial, technical and lab purposes. However, later these became extensively applied in drinking water treatment in coastal and inland arid areas. Higher living standards, industrial development, and mass tourism led to wide spread use. Drinking water supply was also of concern to ocean-going ships and spaceships.

Many natural waters are low in many minerals or soft (low in divalent ions), and hard waters are often artificially softened. Community drinking water sources in industrialized countries where drinking water regulations were developed. These circumstances lead to RO industries flaring up globally.

What should be done?

The RO desalinated /demineralized water used must be enriched with minerals before it is packaged in bottles, to make the water fully appropriate for consumption.

The composition of water varies in different local ecological conditions. Water of natural origin contains small amounts of gases, minerals and organic material. These undesirable contents are the main consideration for establishing guidelines and regulations for drinking water.

Awareness to significance of minerals and other useful contents in drinking water has existed for thousands of years, being mentioned in the Vedas of ancient India. In Rig Veda, the properties of ideal consumable water have been described as Sheetham (cold to touch), Sushihi (clean), Sivam (should have nutritive value, requisite minerals and trace elements), Istham (transparent), Vimalamlahu Shadgunam (its acid base balance should be within normal limits).[16] However such water quality has received less attention. Demineralization of water was primarily needed where the only plentiful water source available was highly mineralized brackish water or sea water.

Facts revealed that some substances present in water could have both beneficial as well as adverse effects on human health. For example, artificially fluoridated water decreased the incidence of tooth caries, and some epidemiological studies in the 1960's reported lower morbidity and mortality rate from some cardiovascular diseases in areas consuming hard water.

Researchers focused on two issues: the possible adverse health effects of demineralized water, and what are the minimum and the desirable or optimum contents of the relevant minerals like calcium and magnesium in drinking water needed to meet both technical and health considerations.

Calcium and magnesium both are essential elements. Calcium is a basic component of bones and teeth. It also plays an important role in neuromuscular excitability such as conduction in myocardial system of heart and muscle contractility. Calcium is also responsible for intracellular information transmission and the coagulation of blood. Magnesium has role as a cofactor and activator of more than 300 enzymatic reactions including glycolysis, ATP metabolism, transport of elements such as sodium, potassium, and calcium across the cell membranes, synthesis of proteins and nucleic acids, neuromuscular excitability and muscle contraction.[16] Although drinking water, is not a major source of essential elements for humans, except the areas where the soil is poor in certain minerals, food or water requires addition of the elements that are deficient, then a supplement must be imparted. The diet of many people may not contain sufficient minerals and microelements so in the case of borderline deficiency of a certain element, even the relatively low intake of the element with drinking water may play a significant protective role. This is because the elements are usually present in water are in the form of free ions and therefore more readily adsorbed from water as compared to food where they are mostly bound to other substances.[17]

Recent studies have changed the perspective about the optimal levels of minerals that should be present in demineralized water. Two cohort epidemiological studies were conducted in four South Siberian cities, the subject was the effect of drinking water of different hardness on the health status of 460 and 511 women aged from 20 to 49 years.[19,20] The water in city A had the lowest levels of calcium and magnesium (3.0 mg/l calcium and 2.4 mg/l magnesium). The water in city B had slightly higher levels (18.0 mg/l calcium and 5.0 mg/l magnesium). The highest levels were in city C (22.0 mg/l calcium and 11.3 mg/l magnesium) and city D (45.0 mg/l calcium and 26.2 mg/l magnesium). As a result, cardiovascular changes (as measured by ECG), higher blood pressure, somatoform autonomic dysfunctions, headache, dizziness, and osteoporosis (as measured by X-ray absoptiometry) were more frequently noticed in women living in cities A and B compared to those of cities C and D. The results suggest that the minimum magnesium content of drinking water should be 10 mg/l and the minimum calcium content should be 20 mg/l rather than 30 mg/l, as recommended in 1980.[17]

Based on the currently available data, various researchers have recommended that the following levels of calcium, magnesium, and water hardness should be present in drinking water:[18-25]

For magnesium, a minimum of 10 mg/l and an optimum of about 20-30 mg/l

For calcium, a minimum of 20 mg/l [19] and an optimum of about 50 (40-80) mg/l

For total water hardness, the sum of calcium and magnesium should be 2 to 4 mmol/l

Minimal or no adverse effects were observed at the above mentioned concentrations. The magnesium levels were recommended on basis of cardiovascular system effects, whereas calcium metabolism and ossification changes were used as a basis for the recommended calcium levels. The upper limit of the hardness optimal range was derived from data that showed a higher risk of gall stones, kidney stones, urinary stones, arthrosis and arthropathies in populations supplied with water of hardness higher than 5 mmol/l.[24,25]

To overcome all the ill effects of RO, the best alternative is the Graphene based water filters. These are exceptionally eco-friendly and have the potential to resolve the global drinking water crisis. Recently, grapheme nano composites have shown effective use in all types of water purification. Chemically treated graphene, namely graphene oxide and reduced graphene oxide, have shown numerous potential applications in water purification.[26] Graphene oxide contains many oxygen functional groups such as carboxyl, ketone, epoxy, and hydroxyl groups at their basal as well as edge planes. It is hydrophilic in nature with large negative charge surface that helps effectively remove cationic impurities (heavy metal cations and cationic dyes) by electrostatic interaction.[27,28] Graphene oxides are capable to act as adsorbent for various heavy metals.[29]

We started with the opening remark that RO was thought to be an effective process for water desalination. Considering the research we are forced to change our opinion that RO is certainly not blissful but rather unhealthy. Let us not get carried away by the marketing blitz of the companies who are selling this obsolete technology in our country.

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