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Reverse Osmosis, Ion Exchange and Other Processes for Point-of-Use (Post)Treatment of Drinking Water – an Opinion from the Czech Republic

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ABSTRACT

Utilization of apparatuses for point-of-use (e.g. chemical sorption, ion exchange and reverse osmosis) is discussed. Simple rules for (potential) consumers to use in selecting and maintaining the apparatuses are outlined. Such devices should be utilized very carefully, since although they can improve drinking water quality, they may deteriorate water quality for some other parameters. Moreover, drinking water quality from public drinking water networks is good and usually does not need to be improved. Therefore, utilization of an apparatus for drinking water quality improvement is suggested for individual water sources when specific contaminants of concern exist and should be removed.

Keywords: drinking water; point-of-use (post)treatment

The attitude of people working in drinking water field to apparatuses used for improvement of its quality is rather reserved, which was expressed already in 1991 by the CS Association of Water Supply Experts (independent non-profit organization) [1]. The main points can be summarized as follows:

1. The point-of-use post treatment of drinking water can be one of the possibilities for improving drinking water quality.
2. Such water is not suitable for consumption by infants.
3. Post-treatment devices that significantly decrease the content of minerals in the water render the output water as not being suitable for human consumption due to the lack of mineral nutrients.
4. The most common types of contamination of Czech drinking waters are organic compounds and nitrates. Occurrence of heavy metals in drinking and raw waters in the CR is rare and bound to certain localities.
5. Filters with activated carbon can improve the taste of water and remove odor in addition to removing some organic contaminants. For the removal of nitrates from drinking water there is no suitable device in the CR market which can effectively remove nitrates from the water and simultaneously improves water quality for other parameters (author's note: the last sentence is not fully true nowadays).

People interested in purchasing such filters were encouraged:

1. To seek independent information and to know their water quality when they have their own individual water source (well, etc.).
2. To make sure that the filter is certified by a hygienic authority.
3. To require unambiguous information, as for flow rate, efficiency, service life, etc. The information must be in manual in Czech language.
4. To purchase only such device whose parameters correspond the requirements.
5. To adhere very carefully parameters in the manual.

Since 1991 several meetings devoted to the topic of post treatment of drinking water in households, either as a specialized workshops or sessions in

conferences. Probably the largest workshop took place in National Health Institute on November 15, 2005. The workshop materials are accessible on internet [2]. The workshop summarized pros and cons of the point of use devices. The cons are overwhelmingly prevailing and are listed subsequently:

1. The removal efficacy may not be constant during the whole life time and the end of life service is not commonly indicated.
2. The consumer typically is unable to check water quality during filter operation.
3. When using ion exchange for removal of hardness or nitrates, typically the contaminant is exchanged for another undesirable ion (Na^+ for Ca^{2+} and Mg^{2+} or NO_3^- for Cl^-).
4. Sometimes conditions inside the apparatus are suitable for microorganisms growth, especially during extended periods of inactivity, e.g. overnight.
5. The possibility of leaching of undesirable compounds to the treated water (bacteriostatic metals, plasticizers, etc.).
6. Lack of professionalism among vendors (i.e., they are not mostly technicians).
7. Vendors may offer filters for non-selective bulk improvement of drinking water quality, which is a misguided and frivolous approach.
8. Uncertain or overestimated information about life time of the filtration medium or device.
9. Incomplete or inaccurate operation manuals.

We should also keep in our mind that the filters are operated by the general population. Therefore, the manuals must be visually acceptable and possibly well translated which is not often met, which may have counterproductive consequences. Vendor often do not count on "operator failure" by a household. However, this "failure" is quite common. The health of children is especially vulnerable to such "failures".

The devices for (post) treatment are utilized either for treatment of "raw" water, usually from a ground water source, or for improving of drinking water quality in households served by a public source. When people install "universal" filter without knowledge of ground water quality and the specific target contamination, can be almost dangerous. It is known, that in the CR about 70% of ground water samples from individual domestic wells do not meet criteria for drinking water quality (predominantly from microbiological point of view, but higher concentrations of nitrates, iron and manganese, ammonia, etc. can be found). In some cases the point-of-use device for water treatment may not manage the removal of pollutants to required degree, without even simple calculation (any calculation is not a strong point of companies selling this type of goods). In EU countries (including Czech Republic), drinking water quality from public networks is high and meets international, EU and national standards [3-5]. It is a matter of discussion, what specific water quality parameters should be improved, when the cases of violation are very rare and type (if any) of pollution is unknown or unpredictable. It should be pointed out that installation of a wrong type of the device can drinking water quality deteriorate, rather than improve.

Vendors of water filters very often speak about carcinogens in drinking water. Common chemical carcinogens from water (hydrophobic pesticides, polycyclic aromatics, etc.) are best removed by activated carbon adsorption (especially when designed for the proper flow rate). The presences of carcinogens in drinking waters of bigger cities was discussed in the annual report of Czech National Health Institute [6]. The conclusion for 2007 is: *"the evaluation revealed that drinking water intake might theoretically result in an annual excess cancer risk of about 2 x 10^{-7}, i.e. 2 excess cancer cases per 10 million population"* (which is approximate number of Czech Republic inhabitants – author's remark). If all households (2 – 3 millions) in the Czech Republic purchased filters (supposing quite cheap in a price range from 100 to 200 EUR, they would spend 200 – 600 millions EUR. If the filters are 100 % efficient, we save annually 2 human lives. Cancer is the second cause of death (the first are cardiovascular diseases) and cancer mortality only in the Czech Republic reaches annually several tens thousands of persons. Contribution of drinking water quality to cancer mortality is less than negligible. Potentially financial resources used to combating cancer could be better spent elsewhere (e.g., combating smoking, feed and life habits, lack of motion, etc).

Devices used to remove (almost) all minerals from water should be discussed separately. In author's opinion drinking water should contain certain concentration of minerals, especially calcium and magnesium. Water for human consumption is an easily accessible source of these elements since they are present in water as

simple hydrated cations. It is also reflected in Czech standard for drinking water quality, where minimal and optimal thresholds are set [5]. There are known different diseases, when human organism suffers from a lack of calcium and magnesium (e.g. osteoporosis, pregnant complications, higher risk of cardiovascular diseases mortality, etc.). Critical review on health significance of drinking water calcium and magnesium was published in National Health Institute by Kozisek [7]. On the other hand, harder water is not suitable for household water heaters, due to a formation of scales. However, the analogy between scales formation in heaters and boilers and clogging of blood vessels is misguided, even though often used by demineralization devices vendors.

In recent years there has been significant progress in the area of ion exchange. Currently, it is possible to remove contaminants such as nitrates using household apparatuses relative safely, without enrichment of the product excessively by chlorides (exchanged in chloride-bicarbonate form). So called "selective" resins are used. These resins prefer nitrates over sulfates, which is normal affinity order for standard anion exchangers. Relatively reliable has been solved removal of iron and manganese from ground water using cation exchanger in Ca-cycle (exhausted resin is regenerated usually by solution of calcium chloride) has been improved. Iron and manganese in water are replaced by calcium and concentration of other cations remain the same like in raw water.

CONCLUSIONS

Devices for water treatment in households from individual water sources can be means for improvement of water quality in specific cases. The author is convinced that the devices do not have a significant applicability for post treatment of drinking water from public drinking water network. The drinking water has sufficient quality and utilization of the device can lead to worsening of drinking water quality, sometimes in quite unexpected parameters. If application of the apparatus is necessary (e.g. for individual resources), several rules should be followed [1,2,8]:

1. Determine the water quality and if treatment really needed? Determine if the contamination is random or long-term.
2. Obtain independent information on the vendor related to reliability and quality.
3. Consider economical issues and other possible alternatives (bottled water for infrequent usage – e.g. weekend houses).
4. Purchase only devices, whose parameters correspond to your requirements (flow rate, target contaminants, treatment goals, etc.).
5. Require clear information about the particular device from the vendor.
6. When water is for technical reasons softened, a pipeline for untreated water (containing calcium and magnesium) should be used in kitchen.
7. Devices that produce demineralized water (reverse osmosis, distillation, ion exchange in some cases) are acceptable only for very hard waters. By-pass of raw water must be used, in order the resulting hardness of the mixture will be in the acceptable level. However, extremely hard waters are not in Czech Republic usual.
8. After application of the device, it is desirable to verify produced water quality by chemical and microbiological analysis.
9. When the device is out of operation for an extended period, it is important to flush and/or to disinfect the device.
10. Water treated using the devices placed on a tap should not be used for consumption by infants.
11. In EU countries the device must have a certain approval – e.g. [9] in Czech Republic.
12. The water device should not be used for non-specific "improvement of water quality" without knowledge what I really want to remove from the treated water. The device application should be restricted on cases, when unacceptable pollution was revealed by chemical or microbiological analysis.

Such recommendations may seem to be trivial for professionals. However, the devices placed on a tap are purchased most often by the general public, who in fact do not understand physico-chemical principles of the devices and, in many cases, the protocols from chemical and microbiological analysis. Without education the general public becomes easy victim of vendors, who want very often simply to sell their goods without respect on final effect and resulting water quality.

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REFERENCES

1) CS Association of Water Supply Experts: Point of View to Devices to Point-of-Use Treatment of Drinking Water, Prague, September 10, 1991.

2) http://filtry.ic.cz/ (accessed 2009-08-04)

3) WHO: Guidelines for Drinking-water Quality, third edition, Volume 1 Recommendations, Geneva 2004.

4) Council directive on the quality of water intended for human consumption, 98/83/EC, November 3, 1998.

5) CR register of acts, Law 252/2004 Sb. defining hygienic requirements on drinking and heated water and frequency and extent of its examination.

6)http://www.szu.cz/uploads/documents/chzp/voda/pdf/monit/voda_07.pdf (accessed 2009-08-04)

7)http://www.szu.cz/uploads/documents/chzp/voda/pdf/hardness.pdf (accessed 2009-08-04)

8) http://www.csave.cz/nazory-a-stanoviska/
(accessed 2009-08-04)

9) CR register of acts, Law 409/2005 Sb. on hygienic requirements on products coming into direct contact with water and used for water treatment.