NFIS

National Fluoridation Information Service

Household water treatment systems for fluoride removal

National Fluoridation Information Service Advisory

Regional Public Health
Better Health For The Wellington Region

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MASSEY UNIVERSITY
WELLINGTON

ESR

NZ National Poisons Centre

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DISCLAIMER

NATIONAL FLUORIDATION INFORMATION SERVICE

The National Fluoridation Information Service (NFIS) is a consortium funded by the Ministry of Health, led by Regional Public Health working in partnership with:

- Hutt Valley DHB Community Dental Services,
- Environmental Science and Research,
- Centre for Public Health Research at Massey University and
- National Poisons Centre.

Our work includes:

- Following public debate and choices on water fluoridation
- Monitoring international research on the usefulness of water fluoridation
- Critically reviewing emerging research
- Working with District Health Boards and Councils to provide accurate and up-to-date information to their communities
- Providing clinical advice to the Ministry of Health
- Monitoring water fluoridation policy
- Providing access to New Zealand oral health data and research
- Sharing information via quarterly e-newsletters and e-briefings and the NFIS website

INTRODUCTION

Some households in New Zealand receive fluoridated drinking water as they are in areas with community water fluoridation programmes. Others may obtain their water from sources with naturally occurring fluoride concentrations that are similar to, or greater than, the concentrations found in intentionally fluoridated drinking-water supplies. People may wish to remove fluoride from their water, or reduce its concentration, for reasons that include their belief that it is harmful, or the need to reduce excessive naturally-occurring fluoride concentrations to levels closer to those in a fluoridated supply.

Whether fluoride is naturally-occurring or intentionally added to drinking water, household treatment units are available that can reduce its concentration. Treatment units are only able to remove a percentage of the fluoride (estimates are given later). They are unable to remove all of it. However, following treatment by a unit that is operating properly, the fluoride concentration in the water should be less than that in a non-fluoridated water supply.

This fact sheet describes these household units. It provides information about how different treatment units work, the extent to which they remove the fluoride from the drinking water, and other information to consider when buying a unit. Specific brands of treatment unit are not discussed, nor are recommendations made about which treatment system to use.

TREATMENT TECHNOLOGIES FOR FLUORIDE REMOVAL

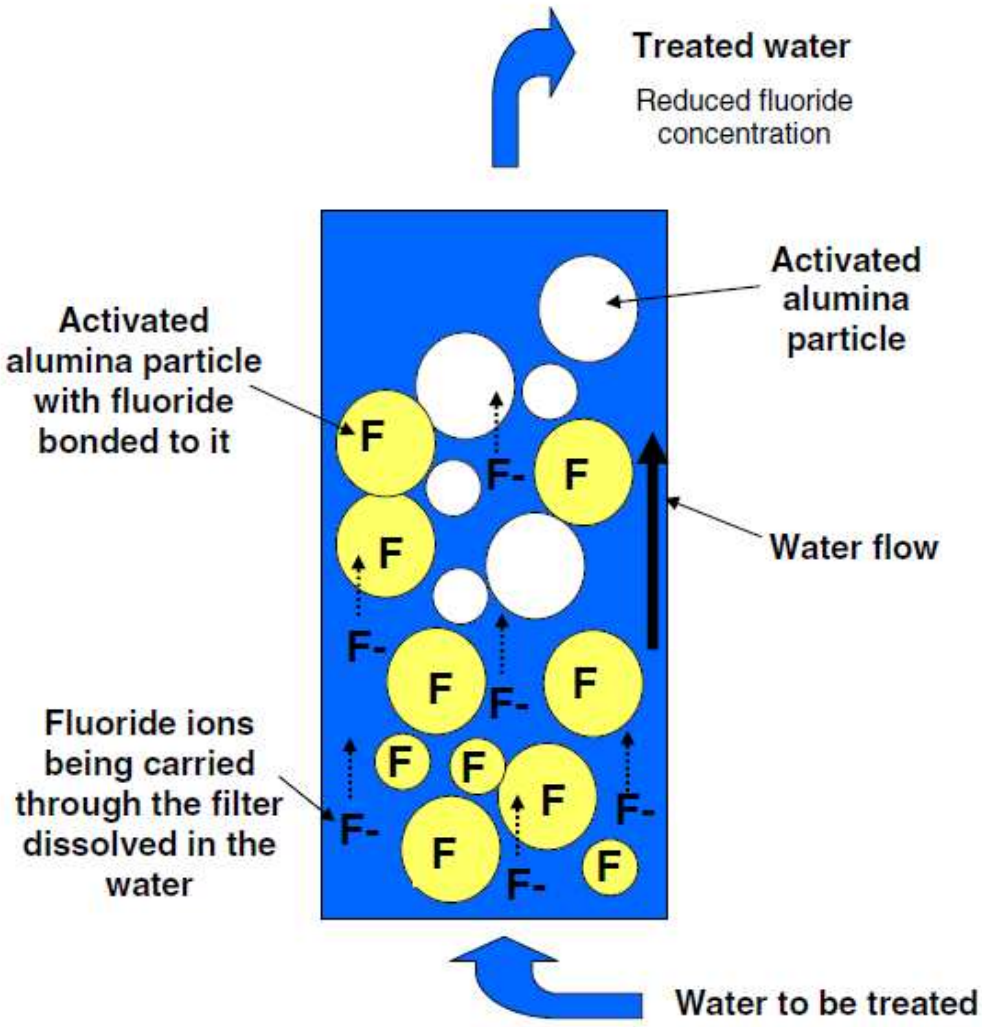
Several different technologies are used to reduce fluoride concentrations in water. Many of these technologies use some form of adsorbent material[1] to which the fluoride adsorbs. The effectiveness of the different adsorption technologies is usually determined by the way in which the adsorbent material is prepared and the conditions (e.g. the pH of the water – how acidic or alkaline it is) that they operate under.

In addition to adsorption-based technologies, other technologies can reduce fluoride levels in water. These technologies include using membranes (such as reverse

[1] Adsorbent materials adsorb dissolved substances from water by holding onto them when they collide with the surface of the adsorbent material. There is a difference between “adsorption” and “absorption”. Adsorption is the process of something becoming attached to the surface of a medium, and absorption is the process of something being taken into a medium, as a sponge absorbs water for example.

osmosis- see description of the process below) or boiling off the water as steam, cooling the steam and collecting it as water (water distillation).
Some of the technologies available in domestic treatment units are discussed in more detail next.

ACTIVATED ALUMINA



How it works

Alumina is aluminium oxide manufactured to produce a highly porous and adsorbent material. As water containing fluoride passes through it, the fluoride adsorbs onto the alumina. Sometimes an activated carbon filter is used after the activated alumina treatment unit to remove tastes from the water caused by the alumina treatment.

How much fluoride is removed?

Fluoride removal is most effective at a somewhat acidic pH of 5.0. At this pH level, 85–95% of the fluoride originally in the water may be removed (Ayoob et al, 2008).

However, given that household treatment units cannot adjust the pH of the water, this level of fluoride removal may not be reached.

Other things to consider

The activated alumina in these treatment units does not have an endless capacity to adsorb fluoride. Once the filter cannot adsorb any more fluoride, it has to be replaced. The volume of water that can be treated before this happens decreases as the concentrations of fluoride and other ions[2], such as sulphate, that will also adsorb to the alumina increase.

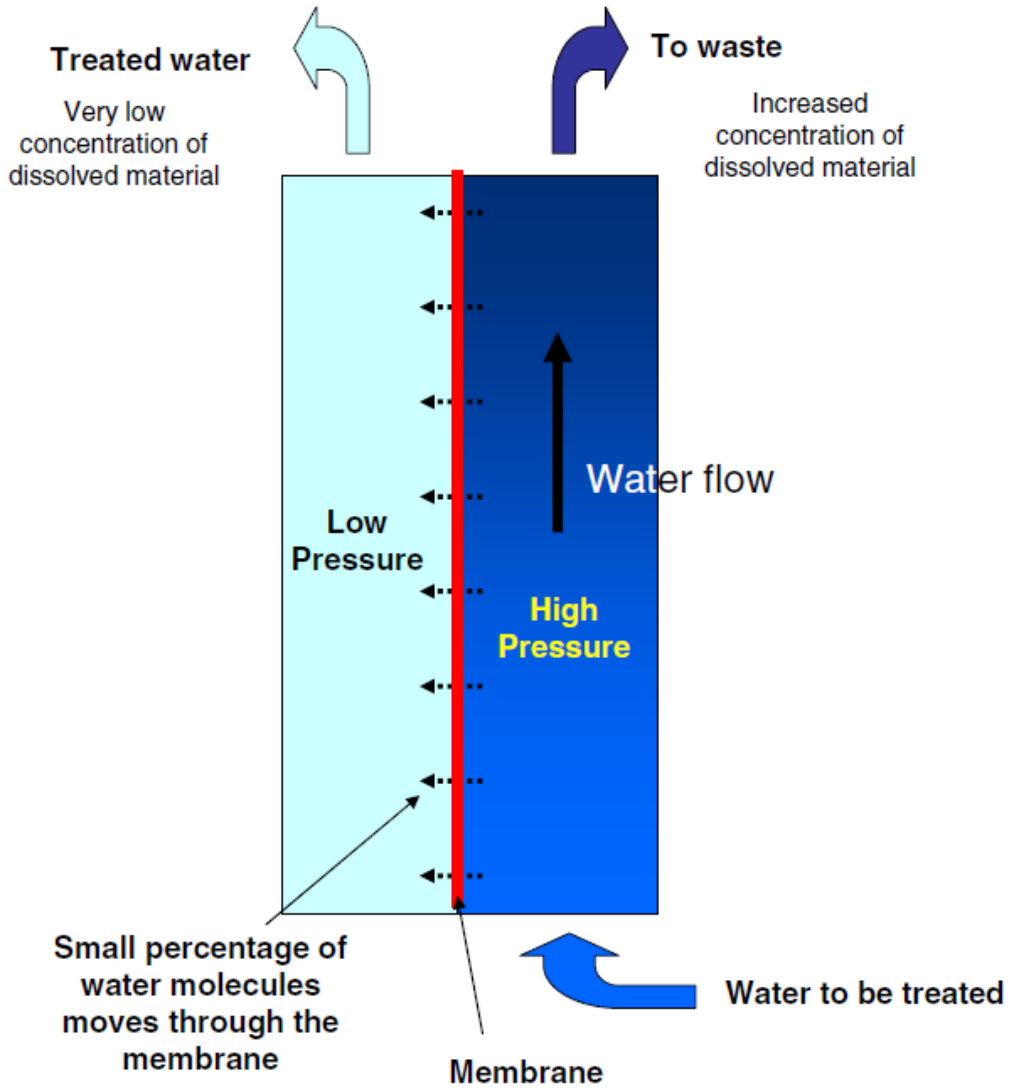
When enquiring about buying a filter, ask how long the filter will last and how to tell when it is no longer doing its job. You may need to provide a chemical analysis of your water for this question to be answered. If you are on a public water supply, the city or district council should be able to provide you with information about the chemical composition of your water. If you are on a private water supply, you will need to have your water tested. Look up "Laboratories" in the yellow pages and select one that offers water testing.

Small amounts of alumina dissolve into the water passing through the filter with the result that the aluminium concentration in the water may increase. This is more likely to happen with slightly acidic waters. Ask the salesperson what the concentration of aluminium in the water is likely to be – they may ask you for the pH of the water being treated. The *Drinking-water Standards for New Zealand 2005* (revised 2008) give a guideline for the concentration of aluminium in drinking water of 0.1 mg/L.

Activated alumina can also remove some forms of arsenic from water, but it is not designed to remove microorganisms.

[2] Ions are atoms or molecules that have a negative or positive electrical charge. Fluoride is a negatively-charged ion.

REVERSE OSMOSIS



How it works

Reverse osmosis uses a membrane (a sheet, or hollow tube or fibre, of polymer) with very fine pores to remove dissolved substances from the water. To do this, water molecules are forced through the pores under pressure. The size of the dissolved molecules in the water determines how easily they will go through the pores. Only a small fraction of the water passes through the pores and is available at the outlet of the filter unit. The rest of the water, with an increased concentration of dissolved substances, goes to waste. Energy is needed to pressurise the water.

How much fluoride is removed?

Depending on the chemistry of the water and the material from which the membrane is made, reverse osmosis filters can remove 85–95% of the fluoride in the water

(Feenstra et al, 2007). The effectiveness of the membrane is not affected by the pH of the water, within the pH range typical of drinking-water.

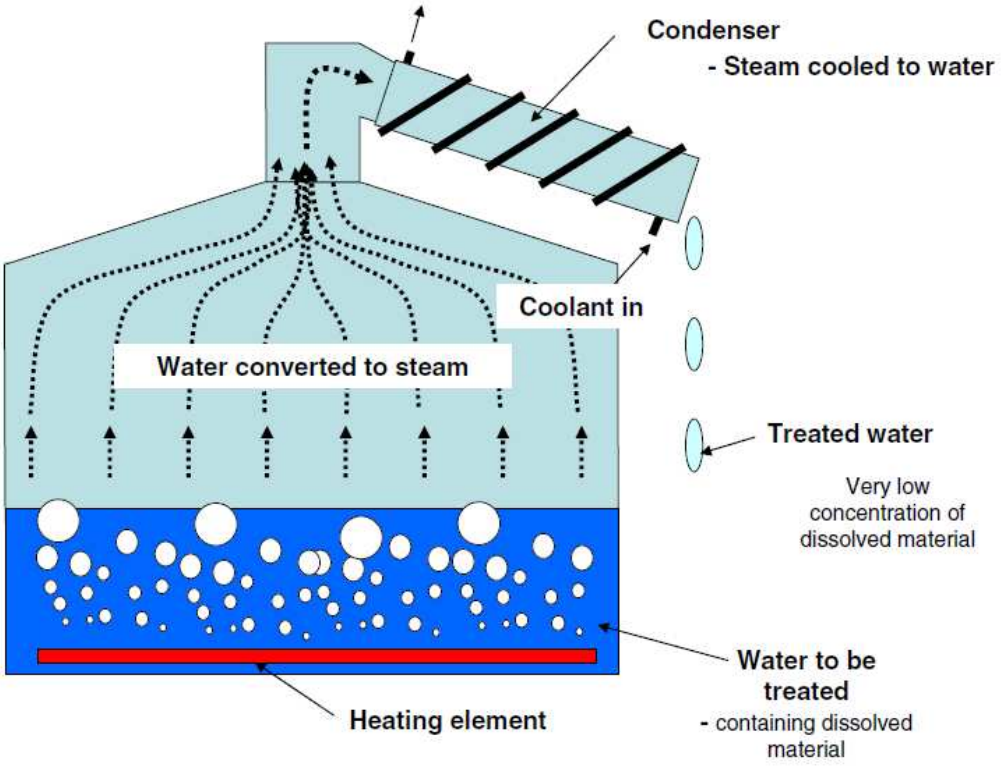
Other things to consider

Removal by reverse osmosis is not specific to a particular substance. As well as fluoride, the process will remove many other dissolved substances and bacteria from the water. A disadvantage of the technology is that the fine pores clog with time. Clogging of large scale treatment units is removed by chemical cleaning, however, this is not done with domestic units. The rate at which clogging occurs is slowed by installing pre-filters to reduce the levels of contaminants reaching the reverse osmosis unit.

Failure of the membrane, due to holes developing, may also occur, causing a loss in fluoride removal efficiency. While a major failure will become obvious from the loss of pressure at the inlet to the unit, a very small hole could easily go unnoticed. Ask how you will be able to tell when the membrane cartridge needs to be replaced?

Before purchasing one of these units, ensure that your water supply has enough pressure for the unit to operate.

DISTILLATION



How it works

Distillation units convert liquid water to steam and collect the condensed steam for use. The steam contains very little of the dissolved matter present in the water entering the unit. The liquid water produced from the condensed steam contains very little dissolved material. This process requires energy to heat the water.

How much fluoride is removed?

Domestic distillation has been reported to remove up to 99% of fluoride from water (Brown and Aaron, 2991), but much lower percentages have also been reported. The effectiveness of distillation is not affected by the water's pH level.

Other things to consider

Distillation, unlike adsorption treatment processes, does not become exhausted. Also, any failure in the system will become very obvious as no water will come out of the unit. You should check on the additional energy consumption you can expect, based on your daily consumption of water for drinking and cooking.

The material that is removed from the water during distillation remains in the distillation compartment of the unit. As a result, deposits develop in the distillation compartment and need to be removed for the unit to work efficiently. Manufacturers

may provide chemicals to help remove these deposits. The frequency at which this cleaning is required will depend on the amount and nature of the material dissolved in the water being distilled.

GENERAL COMMENTS

Several general points should be considered when choosing to remove fluoride from water.

a. To avoid treating water that you are not drinking, you are best to install a point-of-use (PoU) unit which is plumbed into your system just before the tap from which you wish to draw water. Water used for other purposes throughout the house is then not treated. To treat water that is used for other purposes, such as bathing or showering, you will need to place the treatment unit at a different location in your plumbing. A larger treatment unit will also be needed, and you will need to check on their availability from the salesperson.
b. The percentage of fluoride a treatment unit removes depends on several factors, which include, the treatment process used, the conditions under which the unit operates, the chemistry of the water, and the quality of the unit selected. Check the manufacturer's claims for fluoride removal and the conditions under which they are valid.
c. Activated carbon filters, which remove tastes from water, are probably the most widely used household filters. Some forms of activated carbon can remove fluoride, but unless you are told that an activated carbon cartridge is specifically designed for fluoride removal, it is best to assume it does not.
d. Advice to "boil water" is often given to ensure water is safe to drink in emergency situations. This is to kill harmful microorganisms. It does not remove fluoride or other dissolved substance from water, neither does freezing the water.
e. Reverse osmosis and distillation greatly reduce the concentrations of most dissolved substances in the water. As a result, they also remove important nutrients, such as calcium and magnesium. Awareness about the depletion of this source of nutrients is vital if drinking-water is an important source of them in your diet. Removal of these substances can also make the taste of the water less acceptable.
f. When selecting a device to remove fluoride from household water, look for certification that the unit can do what you want, as the effectiveness of units varies widely. It is also important to know when the unit is no longer doing its job, either because of a failure in the system or because of an adsorption

cartridge reaching exhaustion. Organisations, such as NSF (National Sanitation Foundation) International, produce standards against which the performance of units can be checked. NSF/ANSI (American National Standards Institute) Standards 58 and 62, cover the performance of reverse osmosis and distillation units, respectively. A certification guide is available http://www.nsf.org/business/newsroom/pdf/dwtu_certification_guide.pdf

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