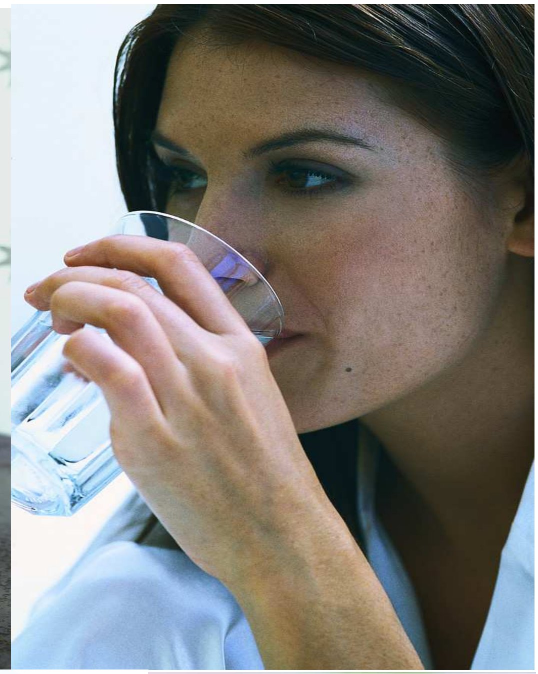
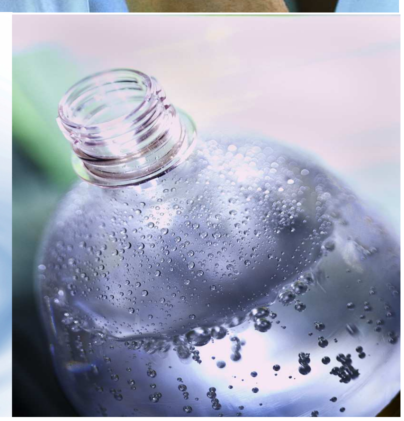
Grandpa Dave's

Emergency Preparedness & Disaster Survival Guide

WATER





"Natural disasters such as floods or earthquakes may pollute or disrupt water supplies.

Water is more essential than food in sustaining life.

It is wise to have an emergency storage of at least 14 gallons per person.
The water MUST be pure, treated to prevent microbial growth …."
ProvidentLiving.com

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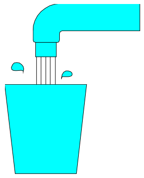
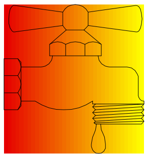
Water - Introduction



Water is essential for life. Most of us just take it for granted. We turn on the faucet and clean clear water comes out day and night. It is not until some major disaster or calamity occurs that the true value of water may truly become apparent. In some cases it **"becomes more valuable than gold".**



The purpose of this guide is to help individuals and families prepare for short term and long term interruption of water supplies … so we never have to be down to our **"last drop".** Many of us may be prepared with our 72 hour emergency kits which contain a bottle or two of water. But how many of us are really prepared for an emergency that could last for a week, a month, several months … and yes, perhaps even up to a year?

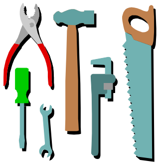
Here are some tough questions that we should have answers for today:

- Where will we get the water our family will need?
- How will we make sure that it is clean and free from harmful bacteria and germs which could injure our loved ones?
- How much should we store?
- How will we store it?
- How will we transport it??
- What will we do if we have to evacuate our homes to seek safety elsewhere?
- How will we process our year's supply of wheat, grains, beans, etc. if we don't have clean reliable water? What good will this food supply do us?

Many people through out the world are experiencing these difficulties today. There are many international organizations that are currently doing water projects for third world countries. One such project called the **"Clean Water for Nepal (India)"** project. In one of its reports it stated:

> *"As of the year 2000, one sixth of the world's population, roughly 1.1 billion people, lacked access to improved water supply, and two fifths or 2.4 billion people, lacked access to improved sanitation. Every year, approximately 3.4 million people die due to water-related diseases with the majority being young children under the age of five. Diarrheal diseases alone account for 2.1 million deaths per years. Other types of diseases associated with poor water quality include cholera, typhoid, arsenic poisoning schistosomiasis or "snail fever", and trachoma, which cause blindness. The risks of contracting these diseases can be considerably minimized with access to clean drinking water, adequate sanitation facilities, and proper hygiene practices."*

Could a disaster or calamity place us in the same situation as many of these other countries are in today? Many of the ideas that these organizations have learned through the years could help us if we were faced with similar circumstances. This guide has attempted to extract some of their ideas and information as well as from as many other resources as possible in order to present a comprehensive collection of these for you and your family.



Hopefully, by the time you have finished reviewing this guide, you and your family will have a **"tool box"** full of tools, ideas, suggestions, plans, etc. that will better prepare you for any eventuality. Not everything may apply to you, but if you can glean just a few **"golden nuggets"** of thoughts and ideas, then I will have accomplished my goal.

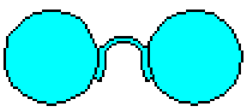
NOTE: I have gather most of this information from articles located on the web. These are for information only. I can't guarantee their accuracy … I encourage you to Google these articles and recommendations and then make your own determination which information you want to utilize.

If you have any questions, concerns, clarifications, ideas, suggestions … I would love to hear from you so that I may be able to pass them along. Please email me at davidjohnpotter@hotmail.com

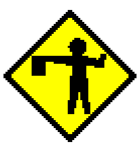
All the best,

Grandpa Dave ☺

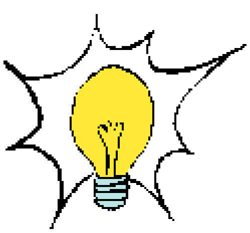
Meaning of Special Pictures



Good information.

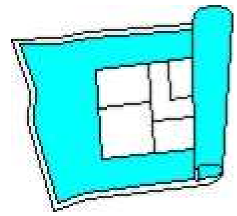


WARNING!! Read carefully.



A great idea or suggestion !!

Blueprints for Success



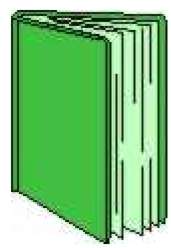
Every architect has a set of **blueprints** when they begin a new project. I suggest you design you own set of blueprints for this project.

Types of Plans

We have heard a lot about **72 hour/emergency plans**. However, few of us have plans dealing with water for longer periods … **1 week, several weeks, a month, several months** … **and even up to a year**. Each plan has different requirements. Each plan should be done in writing and though we may not be able to fulfill each plan, we can start preparing for each situation. Having the right blueprint will make the difference between success and failure.

I recommend that you begin today with **a three-ring notebook for your emergency preparedness information**. Set up the following sections:

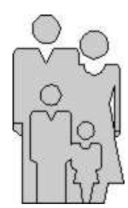
- Goals
- 72 hour Plan
- 1 Week Plan
- 1 Month Plan
- 2-3 Month Plan
- 1 Month Plan
- 6 Month Plan
- 1 year plan
- Information
- Articles
- List of expenses (costs of items)



Emergency Preparedness Binder

How Much Do You Need?

So how much do you really need? Good question!

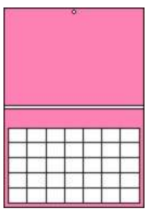


First of all you <u>must decide</u> how many people you will want to store for. Of course you need to include yourself, then those in your household, perhaps your extended family such as your mom and dad and brothers and sisters. What about your next door neighbor or those who you affiliate in your church and those your have some sort of responsibility over? Finally, you may want to consider having extra water in order to trade/barter with others.

Fill in the following chart:

	Number
Yourself	**1**
Those in your immediate household	
Your extended family	
Your friends, neighbors, others	
For bartering purposes	
Your Total Group	

How Many Gallons to Store



Now that you know how many … you need to determine the **length of time** you want to consider storing water for.

Experts feel that we should plan on **2 gallons a day per person**. One gallon would be for drinking and food preparation and the other gallon for sanitation and hygiene. Your 72 hour evacuation kit may not be able to handle 6 gallons per person … so I recommend a minimum of just a gallon or two. A year's supply would be about **<u>750 gallons per person</u>** … as you can see the impractically of storing a lot of water … so we need to look at other options.

Fill in the following chart:

	Gallons Per Person	**Gallons for your Group**
72 hours	6	
1 week	14	
4 weeks (1 month)	64	
12 weeks (3 months)	192	
24 weeks (6 months)	384	
52 weeks (1 year)	750	

WOW!   Do you really need that many gallons???   YUP!

But how? First, store as much water as you can reasonably store … **AND THEN** purchase **some type of water filtering/purifying kit** that will handle the rest of the volume of the water you have calculated above. I will talk about other sources of water, various types of storage contains you should use, and water filtering/purifying options later on.

<u>So how do you do this?</u>
Well, I like doing things in steps …
so here are the steps I recommend to start with.

Step 1: Put **several water bottles** in each of your 72 hour kits.
You can purchase bottled water for as little as 20-30 cents a bottle.
These bottles are sealed and can be stored for a while.

Step 2: Set aside a minimum of **14 gallons** per person in 5 gallon jugs.

Step 3: If possible, purchase a **55 gallon** drum for each person.

Step 4: Purchase some type of **water filtering/purifying kit** to handle the additional needs.

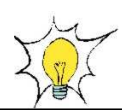
Sources of Water

In an emergency and you have to use other sources of water, consider **ALL SOURCES** as being **contaminated** and MUST NOT be used UNTIL it is **FILTERED and PURIFIED !!**

You do not want to chance that the water will make you or any of your loved ones sick. As a scout master for over seven years, I will always remember one scout that drank some river water that had gardia in it and he suffered diarrhea for a long time. You do not want for any one in your group to ever go through such an ordeal.

So the first thing you need to do TODAY … not during the emergency … but TODAY, is to identify all the potential sources of water your might have to use.

In the event of an emergency you may have time to take some type of action such as filling your bath tubs, sinks, and every type of container you might have.

Hot Water Heater	At the bottom of each hot water heater there is release valve that you can attach a hose to, I recommend that once a year you attach a hose to it and drain your heater as this will flush out settlement that will have settle to the bottom of your tank. I also recommend buying a **WHITE** hose and only using it for this purpose.
Water in toilet tank	I would highly recommend that you **DO NOT** use this water for drinking. If you must use this then process the water through a filter/purifier. There is usually 5 gallons in a tank.
Swimming Pools	Water from a swimming pool is to be used only for hygiene purposes and not for drinking. If you must use it for drinking, you must filter the chlorine and other chemicals out.
Outside sources	If you must find water from outdoor sources choose flowing bodies of water like rivers instead of ponds. Rivers coming down from the mountains make look clean … but practically all water will have bacteria in it. Most of the streams receive some water from mines up in the hills. The water coming from the mines is polluted with harmful chemicals and minerals.  If you have to get water from lakes or ponds you may want to have a good hand water pump or siphon.
Rain	Collecting rain water is a great idea … but there are good ways and bad ones. Collecting water from your roof is bad idea … it will contain particles from your shingles that could be very hazardous to your health. However you can build some simple contraptions to capture the water.
Holes in Ground	If there is any moisture in the ground, you can dig a hole. Place a pot in the bottom of it, place some plastic over the hole (weighted down with dirt or rocks so that it won't fall into the hole. Then place a heavy rock in the middle of the plastic so that that plastic dips down into the pan. Condensation will form on the inside of the plastic and then will drip down the plastic into the pot.
Trees	If there are small trees, you can cover them with plastic or a big plastic bag. Condensation will form on the inside and slowing drop to the opening at the bottom. Place a container at the bottom to

	catch the water.

Government Regulations / Standards

A very important but often over-looked issue deals with Standards that have been setup and testing centers which test the various filters. There are many products on the market that make claims that are not supported by tests … so buyer beware!! The following is some information concerning some of these sources. Links to these areas may be found at the end of this article.

NSF The Public Health and Safety Company.™ **NSF International**

The National Sanitation Foundation (NSF)is an independent, not for profit organization. For over 55 years the NSF has focused on public health, safety, and the environment.

The NSF has developed national standards and provides third Party conformity standards representing the interests of the public, industry and the regulatory community. NSF International helps protect us by certifying products and writing standards for food, water and consumer goods. As an independent, not-for-project organization, their ongoing public health commitment is to encourage everyone to live safer.

The NSF has various standards setup up. Each one is listed by a number and products are tested against these standards.

NSF listed Under Standard 51 listed material. This certification, received at the expense of the manufacturer, is a very important quality and fit for use standard meeting stringent NSF criteria. The National Sanitation Foundation is an independent, not for profit organization. For over 55 years the NSF has focused on public health, safety, and the environment.

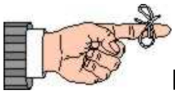
The NSF has developed national standards and provides third Party conformity standards representing the interests of the public, industry and the regulatory community.

Environmental Protection Agency (EPA)

The EPA is a government agency. It does not approve water filteration devices … it only registers them. A "Point-of-Use" (POU) filter containing silver based GAC must register that device with EPA, that does not mean is approved by EPA.

BASIC FACTS

As we proceed to discuss the various type of filters and purification methods, there are a few basic facts that you will need to understand.



REMEMBER: You must consider all water to be **contaminated and dangerous and it should be filtered and purified.** Contaminated water may look clean and may smell okay, but bacteria, microorganisms or toxins may still be lurking in the water.

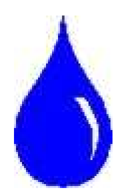
It is crucial to use **ONLY treated water** for drinking, cooking, dish washing, rinsing after hand washing, cleaning cooking or bathroom surfaces, making any prepared drink, making ice cubes, and for brushing your teeth.

Filtered vs Purified Water

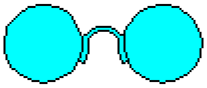
So exactly what is the difference between filtered water and purified water? And does it make any difference? Yes it does make a difference. If you are wanting to get rid of harmful organisms that may be in the water you most likely will need to purify the water. The following table shows the relative sizes of various organisms.

ORGANISM	**SIZE**
Giardia	5 microns
Cryptosporidium	5 microns
Cholera	.02 to .05 microns
E. Coli	.02 to .05 microns
Salmonella	.02 to .05 microns
Hepatitis 1	.0004 microns

Anything 1 micron rating or below will inhibit Cryptosporidium and Guardia as the cysts are larger than this in size. <u>**Viruses** cannot be inhibited by a filter with a micron rating of more than 0.01 microns</u>.



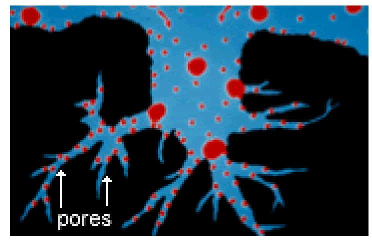
Filtered water: there are various types of filters ranging from just using a piece of cloth to highly dense ceramics. Water poured through a cloth or shirt could take out the dirt clods, leaves, twigs and other ‘big’ junk out of the water but still leave the water muddy. There are other filters made out of paper (coffee filters), sponges, plastics, sand, charcoal, rocks, etc. The smaller and tighter the holes are in the filter, the more stuff gets filtered out. However, the smaller and tighter the holes … the easier the filter gets clogged and has to be cleaned. Many times it is best to use a series of several filters, each successive filter taking out finer and finer particles so that the finest filter does what it does best. Some ceramic filters can filter out certain types of bacteria depending on their size. Some ceramic filters also are impregnated with silver which is used to kill the bacteria. Filters cannot remove cyanide.



NOTE: **Filters are "not" purifiers**. Filters should be combined with some type of purification process depending on the organisms you need to treat. NOT ALL FILTERS ARE ALIKE. THERE IS NO ONE SINGLE FILTER THAT CAN FILTER EVERYTHING OUT. For example, you need a special filter to take out arsenic or fluoride.

Pore Sizes ….. Absolute vs Nominal

Many companies advertise the "pore size" of their filters… touting how great their product is based upon a particular rating. This area is one that can be very confusing if you don't know about the different way pore sizes are measured.



The pore size of filter media is identified by the **diameter of the particle** that it can be expected to retain with a defined, high degree of efficiency. Pore sizes are usually stated in **micrometer or microns for short (µm)**, which equals one millionth of a meter. Pore size ratings refer to the size of a specific particle or organism retained by the filter media to a specific degree of efficiency. Ratings can be stated as either **nominal** or **absolute** pore size.

An absolute pore size rating specifies the pore size at which a challenge organism of a particular size will be retained with **100%** efficiency under strictly defined test conditions. Among the conditions that must be specified are: test organism (or particle size), challenge pressure, concentration and detection method used to identify the contaminant. Absolute micro-filters are used for critical applications such as sterilizing and final filtration.

A nominal pore size rating describes the ability of the filter media to retain the majority of particulate at **(60 - 98%)** the rated pore size. Process conditions such as operating pressure, concentration of contaminant, etc., have a significant effect on the retention efficiency of the filters.

Different Standards for Absolute and Nominal ????
To make life even more difficult, there are different standards being used in the market place today ... so just because they say they use an 'absolute' standard … watch out!

- A leading **POU/POE (domestic devices) water industry association** defines **"absolute"** to mean **85% rejection** at the stated micron ratings and at the recommended flow rate. Some POU filter manufacturers (aggressive marketers) using extruded and powdered activated carbon (CB and PAC) claim 0.5 µm "absolute" ratings under this "standard".
- In **industrial filtration** absolute rating provides a much stricter efficiency standard for the filter, typically **98-99%** percent rejection rate at the stated micron.
- The **high-purity water industry** (pharmaceutical, pre-treated RO feed water etc.) even defines absolute as a **99.99%** efficiency (4-log retaining efficiency) single

pass rejection rate or greater as with **Doulton ceramic candles** and cartridges (**100% at 0.9 µm absolute**).

NOTE: Wilderness campers and back-packers making untreated water potable using "water purifiers" follow the manufacturer instructions (e.g. "purifier" contact time w/water, etc.). British Berkefeld gravity filters will produce safe water for a camp site however are not practical for individual back-packers (bulky). **British Berkefeld "Mini Filter"** and **Katadyn's "Pocket Filter"** are the safest choice for individual wilderness hikers.

Preparing for Bio-terrorism on our water supplies

In order to handle Bio-terrorism you'll need:

- a laboratory grade Reverse Osmosis (RO) system,
- a filter with 1/2 micron or less absolute ANSI standard pore size,
- distillers and
- UV's to some extent.

Types of Filtering Materials

There are several different types of filtering materials. Each type is designed for a specific purpose. Either to reduce or eliminate a certain type of contaminate such as chlorine or fluoride … or to reduce or eliminate some type of living organism such as bacteria, cysts, or viruses. We will explore the two basic types:

- Carbon (Charcoal) Filters
- Ceramic Filters

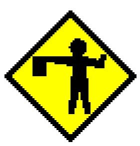
WARNING: Some of the information below is kind of technical in nature … I'm sorry ☹ Just skip over those parts that are hard to understand ….just find those 'golden nuggets' that will be of use to you and your family. ☺

Carbon (Charcoal) Filters

The first material we will discuss is made from **Carbon**. Most of these filters today are **charcoal, or activated charcoal**. Charcoal, which is mostly carbon, is the residue of partial burning or destructive distillation of organic material. When special heating or chemical processing is added to charcoal, it becomes much more absorptive, and is then referred to as **"activated charcoal".**

A charcoal filter works on the principle of **absorption**. Large volumes of gases, including most poisonous ones, stick to the charcoal, which is quite porous. (That's why it's used in gas masks.) Because it has such a large porous surface area, it absorbs a lot of impurities. Charcoal filters are used in icemaker filters, under-counter filters, countertop filters, whole-house filters, and more. minerals our bodies need.

Carbon filters are very important and efficient in the removal of some potentially hazardous **contaminants** such as **radon gas**, many dissolved organic chemicals and tri-halo-methane. In case the water supply has a low level of these contaminants, this filtration system can easily and effectively be used as a whole-house unit. However, cases where the level of these contaminants is persistently high**, these filters are not the solution for removal and purification**. In these cases, or when contamination cannot be eliminated by usage of carbon filters, it would be safest to choose an alternative water supply as the most cost and health effective system.

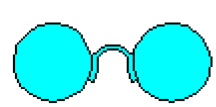


Replacement of Filters

When using a carbon filter**, it must be remembered that these need to be replaced periodically.** With continued usage, as the filter gets saturated with contaminants, it loses its effectiveness and must be replaced. Instead of replacing or delay in replacement can result in **contaminants** to be flushed into the drinking water. This can be unhealthy and must be avoided. All these filters have a rated life beyond which they should not be used. Therefore, it is important that before purchasing the unit, all information such as can the filter can be replaced, the frequency of replacement, where replacement filters may be purchased and how much they cost should be obtained from the dealer. This factor may influence your decision on the model and type of system being purchased.

Carbon filters may be susceptible to mould attack if left unused over extended periods. It is important to realize that a filter gathers the 'garbage' in your tap water, and the organic component of this garbage is quite capable of rotting. Add a little summer humidity to the already damp internals of a carbon filter and you may have a mould attack. Taste will always be the deciding factor, and if the taste of the water suddenly changes after an extended period of non-use, such as your annual vacation, change the filter. **NOTE: carbon filters reduce in efficiency the longer they are in use. For this reason regular filter replacement is essential.**

Carbon filters cannot change the pH balance of the water. If you have acidic water, you will still have acidic water, as the minerals causing the acidity will be dissolved and therefore will pass through the carbon filter.



Finite Capacity: you must keep in mind that any water treatment "filter" media have finite capacity in removing organic and inorganic compounds for example:

- **Inorganic arsenic** can occur in ground and or surface waters, and thus in drinking-water, it is mostly found as trivalent arsenite (As(III)) or pentavalent arsenate (As (V)).
- The arsenite form is several times more toxic (and more difficult to reduce) than arsenate therefore if your water source is none chlorinated. You will need to look for a filter that would remove both form of arsenic.

! Once the carbon has been used up and has absorbed all it can … it is very dangerous to continue using the filter. **<u>It must be replaced.</u>**

Forms of Carbon Filters

Most popular forms of activated carbon used in the treatment of "Point-of-Use" (POU) drinking water filters are

- **granular** activated carbon (GAC),
- **extruded** solid carbon block (CB) and
- **powdered** activated carbon (PAC).

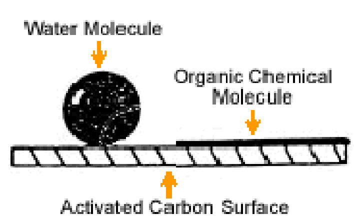
		
Powdered activated carbon used in **CB** and **PAC** cartridges	Fine granule carbon used in **GAC** cartridges	Coarse mesh carbon used for industrial and municipal gravity water filters

Granular Activated Carbon (GAC)

All activated carbon forms including granulated activated carbon (GAC) have a tremendous surface area resulting from its porous structure. GAC filters degree of effectiveness **<u>depends on the flow rate of the water and contact time with the water</u>**.

- If flow rate is <u>excessive</u> their efficiency could be as low as 0%
- If the flow rate is <u>slow</u> their efficiency can match and or exceed those of different carbon forms.

Activated carbon (AC) is a natural material derived from bituminous coal, lignite, wood, coconut shell etc., activated by steam and other means, and each one have different



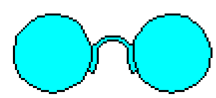
adsorption properties (e.g. bituminous carbon for high chlorine reduction capacity).

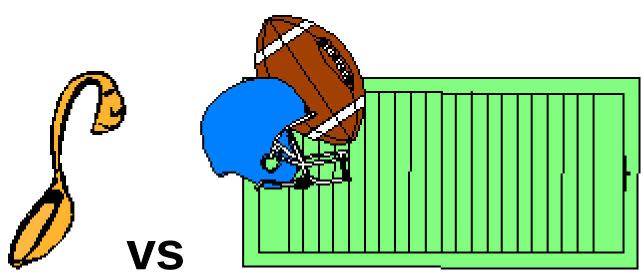
Some manufacturers use various blends of carbon to achieve specific water quality and contaminants reductionOne type of carbon filter is made from **<u>coconut husks in order to obtain a "sweet taste"</u>**. This absorbs impurities as the water passes through. This form of filter comprises possibly **95%** of those in use domestically.

Some charcoal filters are enhanced by the use of activated **nano-silver**, which provides extra antibacterial protection, killing around 650 known types of organisms. Silver based GAC's are effective in controlling bacterial growth and multiplications (bacteriostatic) **<u>only for a short time</u>** because the silver is in form of a "spray" over a small percent of granules (usually 1.05% of the total GAC content). As the water passes the granules "rub off" each other leaching the silver prematurely. A "Point-of-Use" (POU) filter containing silver based GAC must register that device with EPA, that does not mean is approved by EPA.

Most research suggests that silver impregnated carbon filters have **a very short-lived effectiveness** in preventing bacteria growth in a water filter system. There is **greater risk** that unhealthy levels of silver ions will be passed into your drinking water than from potential bacteria build-up in your carbon filter if proper maintenance of your system is followed.

<u>Minerals in solution can still permeate a charcoal filter. These minerals are essential to health.</u> This is one of the problems with distilled water … in that distilled water is void of the essential





For comparative purpose, a **teaspoon** of activated carbon have surface area the size of a **football field.**

Activated carbon surface properties are both **hydrophobic** and **oleophilic**; that is, **<u>they "hate" water but "love" oil.</u>** When flow conditions are suitable, dissolved chemicals in water flowing over the carbon surface "stick" to the carbon in a thin film while the water passes on.

This process is called ***adsorption.*** As a result of the adsorption process, activated carbon is an effective method in removing chlorine and it's by-products (TTHM's) and volatile organic compounds (carbon based VOC's).

Activated carbon filters remove/reduce many volatile organic chemicals (VOC), pesticides and herbicides, as well as chlorine, benzene, trihalomethane (THM) compounds, radon, solvents and hundreds of other man-made chemicals found in tap water. Some activated carbon filters are moderately effective at removing some, but not all, heavy metals. In addition, densely compacted carbon block filters mechanically remove particles down to 0.5 micron, including Giardia and Cryptosporidium, turbidity and particulates.

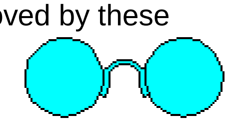
Both, man-made and naturally occurring including among others:

- alachlor
- atrazine
- benzene
- carbofuran
- carbon tetrachloride
- chlorobenzene
- 2,4-D
- dibromochloropropane (DBCP)
- O, P-dechlorobenzines
- forms of dichloroethylens
- 1, 2-dechloropropane
- cis-1,3-dichloropropylene
- toxaphene
- chlordane
- radon
- lindane
- simazine
- PCB's
- toluene
- xylenes etc., etc.

Because carbon filtering devices use carbon cartridges that have a porous surface, it allows the cartridge to absorb a variety of substances including THMs, odors and disagreeable tastes. Activated carbon filters are generally used to eliminate:

- **undesirable odors and tastes,**
- **organic compounds and**
- **to remove residual chlorine**.

Although some **iron, manganese, and hydrogen sulfide** will be removed by these higher quality activated carbon filters, a **manganese greensand iron reduction filter** is generally preferred to remove these contaminants as the effectiveness of carbon filter against iron and manganese is generally short-lived if the contaminant concentration is high.



Carbon filters absorb impurities as they pass through a carbon cartridge. As far as efficiency in terms of removal of contaminants is concerned - **these filters do not remove most inorganic chemicals, metals, microorganisms and nitrates** such as minerals/salts (hardness or scale-causing contaminants), antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, copper, fluoride, mercury, nickel, nitrates/nitrites, selenium, sulfate, thallium, and certain radio nuclides.

Removing these contaminants requires either a **reverse osmosis water filter system** or a **distiller** (some can also be removed by KDF-55 or manganese greensand).

Here is a chart that summarizes what these filters can remove and cannot remove.

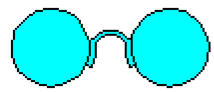
Arsenic	Bacteria and Viruses	Bad Tastes & Odors	Chlorine	Fluoride	Hydrogen Sulfide	Heavy Metals	Nitrates	Radon	Sediment	Iron	VOC's
○	○	●	●	○	◐**	◐	○	●	◐to ●	○	●

●= Effectively Removes ◐ = Significantly Reduces ○ = Minimal or No Removal

No form of carbon filter removes bacteria. In fact under quite normal operating condition all carbon forms can and do become **perfect breeding grounds for bacteria**, including pathogenic bacteria.

If the filter has not been used for **five or more days, you must clean the surface**. This can be achieved simply by running chlorinated water through the filter for at least 30 seconds before use.

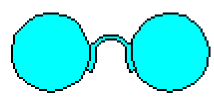
The effectiveness of a filter depends on the amount of carbon that is in the unit and also on how long the water stays in the unit.



As a norm, **the longer the water is in contact with the filter medium, the more time the carbon has to remove impurities.** Therefore, those filters that are packed with a large volume of charcoal tend to remove more organic material at the beginning of the cartridge life.

However, the advantage is that **the performance of these high volume filters tends to decrease less rapidly over time than it does for those containers with a small amount of charcoal.**

Necessity of Using Sediment Pre-Filters



GAC does not remove sediment / particulate material very well, so they are often preceded by a sediment filter. Sediment pre-filters also prolong the activate carbon cartridge life by eliminating gross contaminants that would otherwise clog the activated carbon thereby reducing the surface area available for absorption. Carbon block filters are generally better then GAC filters at removing sediment. Sediment Pre-Filters normally cost a few dollars and are well worth the cost and time and effort in utilizing. ☺

On a large scale such as municipal water treatment pools (gravity filters) for taste, odor and chemical reduction GAC is cheaper, very effective and can be re-used.

Maintenance of Carbon Filters
Activated carbon filters require very little maintenance, however, it is very important to ensure that filter replacement schedules are followed to ensure proper filtration at all times. Do not wait for bad tastes and odors to return to the water before deciding the filter needs replacement as this is an indication that the filter is no longer able to completely remove contaminants and that it has surpassed its service life.

Some filtering systems allow you to do a “backwash” which forces the water in the opposite direction. This allows for some cleaning of the carbon.

Home Made GAC Water Filters
One can make a relative simple GAC water filter using by standard PVC pipe, some fittings and few accessories for less than five dollars. ☺

Filter Ratings: BEWARE! Carbon filters are rated based up on the chemical that they are reducing. Some filters are rated at **10,000 gallons** while more expensive “block” water filters are only rated for **500 gallons** … why? The 10,000 gallon filter is probably rater for its chlorine reduction while the 500 gallon one is rated for reducing other contaminates such as lead, THM’s,etc.

Be careful on the type of filter you purchase and what contaminates you wish to reduce or eliminate.

Micron Pore Sizing vs Mesh Sizing

Carbon filters cannot be measured in micron pore size due to their granular state ... instead they are normally measured in mesh size similar to that of your window screen. Coarse carbon is used in different applications while in domestic POU finer mesh is used followed by a cloth like "filter" to prevent granule escaping.

“Channeling” vs “Dumping”

- **<u>"Channeling"</u>** is water passing through least resistant path of the granule bed avoiding contact time with carbon resulting lower effectiveness. As such, it is good to shake your filter every so often or to turn it over so that channeling doesn’t become too big of a problem.
- **<u>"Dumping"</u>** is sudden change in your water pressure releasing the trapped contaminants into your glass. "Dumping" can occur also if your carbon filter media is exhausted (over used). Some times this is visible as a "gray" water but most often is not. This phenomenon can also happen with PAC filters.

Which Carbon Filter to Purchase?

Good question !! You need to ask yourself the following question:
“**How clean do you want your drinking water to be**???? The old adage of “You get what you pay for…” is true. Make sure that the filter has been tested and certified for whatever it claims.

There are gadgets on the market which are made with just a small amount of GAC and ion exchange media. The most popular pitcher-style "filter" was developed many years ago in Germany to strip the water from calcium and magnesium (hardness). Why? In those days car batteries required periodic refill with water. The distilled water being so acidic was eating the lead cells while hard water was shorting the cells. Of all GAC filters these are the least effective and cheapest to buy however, the most expensive to use on ongoing basis (low capacity "filters").

NSF listed Under Standard 51 listed material. This certification, received at the expense of the manufacturer, is a very important quality and fit for use standard meeting stringent NSF criteria. The National Sanitation Foundation is an independent, not for profit organization. For over 55 years the NSF has focused on public health, safety, and the environment.

The **NSF standard 42** have 3 classes for chlorine reduction;
Class I is >75% reduction,
Class II is 50-75% reduction and
Class III is 25-50% reduction.

Most of those filters falls under **class III**. Know what class your filter is!

Granpda Dave's Recommendation:
Utilize a carbon filter in conjunction with a pre-filter and some type of ceramic filter.

****

Carbon Block (CB) Filters

Of all carbon forms **solid carbon block** (CB) filters are the most efficient and cost effective method of removing volatile organic carbon compounds (VOC's, insecticides, pesticides and industrial solvents) from drinking water.

These filters are a solidified form of honeycombed carbon. It is the **best form of filter** but flow rate is significantly slower than with loose charcoal. As such, this cannot be used in gravity fed filters.

By adding various ion exchange media (e.g. zeolite, activated alumina or other media) **heavy metal**, **MTBE**, **nitrate** and other water treatment effects can be achieved. Solid carbon block filters do not remove healthful, naturally-occurring minerals, require no electricity, and do not add salt or silver to the water, which provide for refreshing, delicious, and safer drinking water from your tap.

CB's are made of single or various blends of carbons combined with plastic polymers which are pulverized to a fine dust then shaped in varieties of forms under high pressure (600 to 800 tons). Unlike the other carbon forms, the CB's are industrial grade filters. They are made in various sizes and micron ratings (nominal), are physically strong therefore they **do not "channel" nor "collapse"** under pressure change, however they **"dump"** if their media is exhausted.

Most 1/2 micron nominally rated CB filters are effective in cysts and asbestos reduction (not removal). CB's are the best choice for POU filters.

If used for potable water, pre and or post-filtration, including a ceramic filter element, will ensure microbiological protection.

Ceramic Water Filters

- **Ceramic:**
  - PROS:
    - can remove some bacteria
    - can be washed and reused
    - great to filter out impurities down to .2-.9 microns in size
  - CONS:
    - Very fragile (once broken, they must be thrown away)
    - Ceramic gets thinner after each cleaning.
    - Needs a pre-filter if water is muddy or really junky
    - Ceramic filters without silver need to be sterilized before using.

Ceramic Water Filters

Ceramic water filters come as a cartridge that fits a normal bench top filter. At the core of the ceramic filter element is Diatomaceous Earth, a fossil substance, made up of tiny silicon shells left by trillions of microscopic, one celled algae called diatoms that have inhabited the waters of the earth for the last 150 million years.

Some ceramic filters incorporate nano-silver impregnated into a porous ceramic outer shell that can trap bacteria down to as low as .22 of a micron in particle size [1/100,000 of an inch].

Laboratories consider a filtering medium with an effective pore size of .01 micron to .45 micron to be bacteriologically sterile and .45 micron to 1.0 micron to be bacteriologically safe. Re growth of bacteria that becomes trapped either on the outside of the element or in the ceramic's pores is controlled by the silver which, on contact with water, releases small quantities of positively charged metals ions.

These ions are taken into the enzyme system of the bacteria's cell and thereby neutralize it. The flow rate of the ceramic filter can be renewed by brushing its outer surface under running water. As the top layer of ceramic and contaminants are brushed off and flushed away, a new layer becomes available.

Flow rate of ceramic water filters are slow.

Dept of Civil and Engineering Department - MIT
http://cee.mit.edu/index.pl?id=3096&isa=Category&op=show
Ceramic water filters are composed of basic materials readily available around the world - clay, water, and a combustible material such as sawdust or flour. The sawdust or flour particles vaporize during the firing, resulting in a porous material with pore sizes ideally ranging from 1 to 5 microns throughout the ceramic. "Most of the countries we've studied have a well-developed pottery or ceramics trade," remarks Dies, who has worked with potters making ceramic water filters.

Of the three main types of ceramic water filters (candle, pot, and disc), the candle filter is the most common. Dies describes it as looking like an upside-down candle, screwed into the base of the upper vessel of a two container water filter. Water is poured into the upper container, filters through the candle, and trickles into the lower container. The ceramic filter physically traps microorganisms and pathogens in the tiny pores. Determining the optimal pore size is tricky because if the pores are too big, they won't remove pathogens, but if the pores are too small, it takes so long for water to work its way through that people won't bother with the system. "It's a trade-off," explains Dies. "You want a high flow rate so that it's convenient, but small pore spaces to trap the microbial contaminants."

Ceramic filters should be scrubbed out once or twice a week to remove the accumulated biofilm which clogs up the pores. Here again, behavior and habits can turn a potentially helpful system into something useless or harmful. Some people use dirty water to rinse the filter, since they don't have clean water on hand after their filter clogs up. If people neglect to clean the filter for whatever reasons, the filters plug up and reduce the rate at which water passes through, making people less likely to wait for their clean water.

Ceramics started to become widely used for the filtration of drinking water in the 19th century. At that time, cholera outbreaks were a common occurrence in London. **Doulton & Co**., with their factory on the banks of the River Thames, were in the perfect position to join the fight against water-borne disease.

In general, the smaller the pore size of a filter and the more complicated the path the water takes through the filter medium, the more effective it is at removing particles from water. A ceramic has a small and complex pore structure, making it an ideal filter medium.

Fairey Industrial Ceramics Limited (FICL) has taken ceramic technology to the next level. We are able to accurately control the pore structure of our **Doulton®** and **British Berkefeld®** ceramic drinking water filters, ensuring excellent product consistency. Customers can, as a result of our exacting standards, expect the same high quality from our filters every time they are used.

Doulton® and **British Berkefeld®** drinking water filters have been so successful globally because they have a variety of advantages over other products in the market:

- **Highly effective barrier to particles and pathogens:** **Doulton®** and **British Berkefeld®** drinking water filters have a pore structure which has an Absolute filtration rating (defined as >99.99%) of 0.9 microns (less than 1000 th of a millimetre). Therefore, the ceramic is capable of removing sub micron particles and pathogenic bacteria from drinking water.

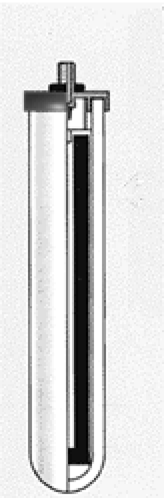
  A recent study by a leading UK University showed that use of **British Berkefeld®** drinking water filters in a community in Zimbabwe slashed cases of potentially fatal diarrhoea (a common problem in Africa caused by pathogenic bacteria and cysts in the water supply) to virtually zero. Our water filters have been proven to work in the most demanding conditions. This is why they are used by the major aid organisations.
- **Long life:** As confirmed by the user instructions supplied with the product, **Doulton®** and **British Berkefeld®** ceramic drinking water filters may be cleaned in order to prolong the life of the product. In this way, the filter can be re-used rather than replaced, giving it a much longer life-span than many other products on the market. On average, a **Doulton®** or **British Berkefeld®** filter candle will remain effective for up to 6 months (depending on usage and water quality) before it will need to be replaced.
- **Self-sterilising:** FICL's ceramics contain trace elements of silver. Silver inhibits microbiological growth, meaning that there is no need to sterilise **Doulton®** or **British Berkefeld®** filter candles, even when they are used over an extended

period.

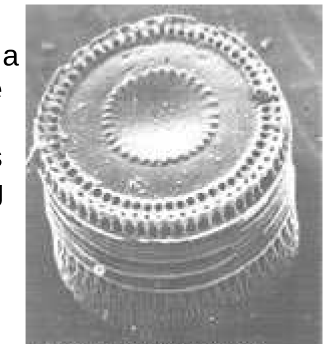
- **Natural:** FICL's ceramics are made from 100% natural elements. They do not add anything to the water they filter. This contributes to FICL's ability to pass the stringent **NSF®** testing procedures. Many other filter products add traces of chemicals to the water they filter.
- **Long-term value:** The extended life-span and effectiveness of **Doulton®** and **British Berkefeld®** drinking water filters make them a low-cost investment in the long term.
- **Combinations with other filter media possible:** Other filter media can be put inside **Doulton®** and **British Berkefeld®** ceramic drinking water candles to make them even more versatile. For example, activated carbon can be incorporated to remove chlorine, or an ion exchange resin to remove heavy metals such as lead.
- **Minerals maintained:** Using a **Doulton®** or **British Berkefeld®** ceramic drinking water filter does not remove those minerals from the water, which are beneficial to health.
- **No power required:** **Doulton®** and **British Berkefeld®** ceramic drinking water filters are some of the most versatile water treatment devices available today. They do not require electricity to function, which means that they are not vulnerable to interruption of power supplies, and can be used where there are no power supplies. They can be used literally anywhere in the world from an office block to a refugee camp.

Doulton Water Filter Ceramic Candle & Cartridge Technologies

Doulton Water Filter Ceramic Candle & Cartridge Technologies, taking the mysteries out of the drinking water filtration



Ceramics, a natural water filter - Sterasyl micro-filter



The skeleton of a diatom magnified 2,400 times using a scanning electron microscope

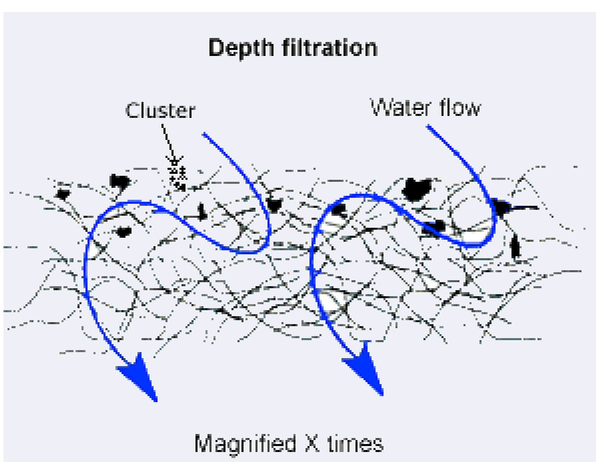
Doulton mines only the finest and purest kieselguhr or diatom earth often described as a silica-like sediment resulting from kiesel algae (one celled algae) deposited on the bottom of geological lakes and lagoons millions of years ago. This is the same material used in making the finest bone china (like of Royal Doulton) and numerous other applications.

The filter elements are produced using the latest ceramic techniques to provide a hollow porous ceramic which is fired at a temperature in excess of 1000℃. The chemically inert ceramic f ilter can be stored for eternity without losing its effectiveness.

Doulton ceramic filter particles from the water but leaves oxygen and mineral contents unchanged, which gives water it's spring-like freshness and taste (not "pure" but wholesome). Pathogens of the most varied diseases which are reliably filtered from the water include; cholera, typhus, cryptosporidium, amoebic dysentery, ecoli, colibacillose or bilharzia, anthrax spores among others.

Ceramic filtration technology is often called "dead-end filtration" and "depth filtration".

There are several mechanisms by which the ceramic element filters out particles as a dead-end filtration.



Most Popular Water Purification Technologies for Domestic Drinking Use (FAQ)

* Activated Carbon (AC)

* Granulated Activated Carbon (GAC)

* Extruded Solid Carbon Block (CB)

* Powdered Activated Carbon (PAC)

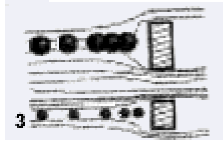
* Reverse Osmosis (RO)

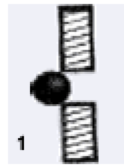
* Ultraviolet Radiation (UV)

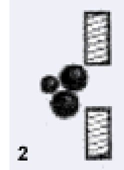
* Ion Exchange (IEX)

* Distillation or Demineralization (DI)

*Absolute vs. Nominal Ratings

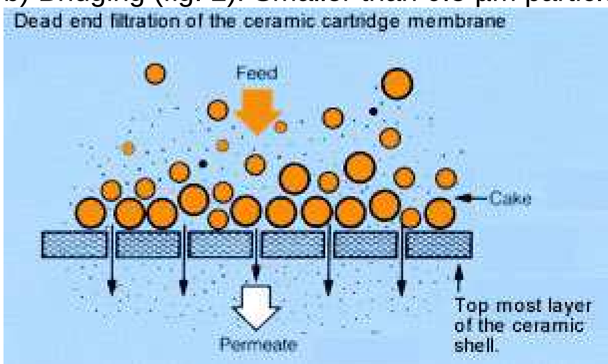






a) Direct interception or sieving (fig. 1): Particle of 0.5 µm and larger "runs into" a pore that is smaller than the particle of topmost layer of the ceramic and are captured as with absolute pore rated synthetic dead-end membranes.

b) Bridging (fig. 2): Smaller than 0.5 µm particles may be too small to be intercepted however two particles hitting the obstruction at the same time will form a bridge across the pore adhering to each other. Bridged particles may not plug the pore creating even smaller pore gradually forming a "filter cake". This "cake" creates a finer filtration for subsequent interception at the cost of decreased flow rate and eventually no flow rate.



Mechanical regeneration of the filter "cake" is simple. The topmost blocked layer can be removed with stiff brush or nylon scouring pad. This can be repeated many times before the filter has to be changed.

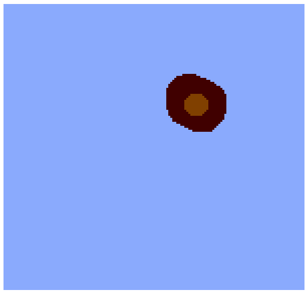
c) Inertial impaction (fig. 3): Particles flowing through the filter hits none porous surface barrier it become captured while the water flows around the barrier. Inertial impaction is more prevalent with smaller particles in range of 0.1 to 0.4 µm size as these particles are easily affected by molecular bombardment.

Unlike with synthetic membranes, all of the above methods of capture are dependable under variable operating conditions e.g. pressure surging, pulsing etc. with Doulton ceramics.

Ceramic depth filtration will filter out considerably smaller particles than equivalent pore size membrane for the following reasons:

a) Particles **intercepted** within the ceramic depth are much smaller than the pores measured by porometry. This is because particle laden water has to navigate through intricate maze of labyrinths. The path through the filter twists and turns trough sharp angles due to complicated ceramic structure and so the particles that may have penetrated the topmost layer become trapped within the structure.

To appreciate the distance and how difficult a path the water has to follow, consider that the wall thickness of the ceramic is 1000-2000 times greater than the pore size of the ceramic filter and the pores are sharp and jagged rather than smooth and round.



b) Small particles can combine with other particles to form a cluster of particles large enough to become trapped as a group or individual in dead end cavities.

c) Weak Van der Waals forces (adsorption fig. 4) attract the small particles to the ceramic, causing them to be adsorbed onto the wall of the ceramic. Depth filtration is very dependable as pressure surges are not affecting adsorption because the pressure is stabilized (drops by 50%) on the surface of the ceramic. Doulton ceramic depth filtration captures particles as small as 0.05 µm with greater than 90% efficiency.

Given favourable conditions, the accumulated bacteria could proliferate and grow unless prevented by some means.

To prevent this Doulton elements (except the Standard, Ceracarb and Ceramet) are manufactured with a small amount (about 0.07%) of pure silver (Ag) through-out the porous ceramic shell. Silver is a recognized bactericide, so when the bacteria comes into contact with the silver impregnated ceramic, their growth is inhibited. This self-sterilizing effect is known as the *bacteriostatic effect*.

Silver, a nature's water purifier (I.E. click refresh button to see silver animation)

Free silver ions (Ag^+) have a toxic effect on micro-organisms even in relatively low concentrations. They have a highly fungicidal, bactericidal and algaecidel effect. Medical studies describe silver ions a catalyst that disable the enzymes that microorganisms depend on to "breathe".

In the presence of air (oxygen in water), metallic silver forms silver oxide, which also has a bactericidal effect due to its adequate solubility. The destruction of viruses, bacteria, moulds, spores and fungi through contact with silver objects is termed the *oligodynamic effect*. To primitive life forms, oligodynamic silver is as toxic as the most powerful chemical disinfectants. This, coupled with its relative harmlessness to animate life (i.e. mammals), gives oligodynamic silver great potential as a disinfectant.

The best and most environmentally-friendly silver based disinfectants are capable of rendering stored water potable for long period of time as in space stations.

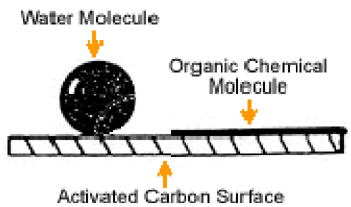
The silver leach rate from the Doulton ceramic is very low and always well below the national recommended limits or equivalent to having a meal using silver cutlery.

Do Doulton ceramic filter removes viruses?

Due to their tiny size viruses theoretically cannot be removed with a 0.2 micron or higher rated absolute filter (or any mechanical filter for that matter). If virus is a concern simply add a commercially available disinfectant such as silver (e.g. Katadyn's Micropur®) or iodine tablets. Doulton Supersterasyl candle will remove the unpleasant taste and odours of the iodine.

Physically viruses have electrical surface charge that attaches them to other larger particles (free ride). The tight pore-structure of any absolute sub-micron water filter (e.g. Doulton, Katadyn etc.) can remove "free ride" viruses however due to many variables no device should be relied upon viral control.

Activated carbon as another natural adsorber



Doulton uses high quality carbon blends obtained from different raw materials such as lignite, bituminous coal and coconut shells. Active carbon is used for water treatment due to its adsorbing effect with respect to organic and health endangering chemicals.

Activated carbon surfaces are both *hydrophobic* and *oleophilic;* that is, they "hate" water but "love" oil. When flow conditions are suitable, dissolved chemicals in water flowing through the carbon media "stick" to the carbon surface in a thin film while the water passes on. This process is call *adsorption.*

Substances affecting taste and odours such as chlorine, pesticides (lindane, DDT) and trihalogenmethanes (THM's) are removed by activated carbon. These substances are adsorbed on the large surface area of the active carbon. For visual purpose, one teaspoon of activated carbon have a surface area the size of a football field.

Active carbon is available in granulate (GAC filters), powder (PAC filters) or extruded solid carbon block form (CB filters).

Doulton Ceramic Candles and Cartridge Grades

Sterasyl membrane: (candle and cartridge form): Used for microbiological removal. The only ceramic element in the world to meet the stringent NSF antimony and arsenic extraction test featuring:

- >99.99% E.coli removal
- Tested with live Cryptosporidium cyst to 100% removal far exceeding EPA three log cyst reduction requirements
- 100% efficiency at 0.9 µm absolute (0.5 µm absolute ANSI standard)
- > 98% efficiency at 0.2 µm
- > 90% efficiency at 0.05 µm
- < 0.07 NTU turbidity reduction

Typical application: UV, RO and ozone pre-filter, point-of-use (POU) final polish filter, zero cyst tolerance in bottling water plants using our industrial multi cartridge filters and various other application requiring absolute filtration. Least expensive absolute filter on the market as it is cleanable and reusable for up 60 times. Backwash capable, self-sterilized, no bacteria grow through as encountered in most all synthetic membranes.

Available in candle and open both ends (DOE) cartridge style.

Supersterasyl candle: Used in British Berkefeld gravity filters is a Sterasyl shell packed with granular activated carbon. Available in 2"x7", 2.75"x7" and 2"x10" candle style with long threaded end cap. Custom size and end caps configuration available with minimum kiln firing requirements of 2400 units for all grades of elements.

Carbosyl elements: Sterasyl shell lined with fine activated carbon coating impregnated throughout the ceramic pore structure then re-fired in excess of 1000℃. Soon to introduce our inline filter fitted with Carbosyl candle as a replacement for the RO GAC final polish filter to control heterotrophic plate count (HPC)* bacteria commonly found in virtually all inexpensive RO systems. Available in 2" slimline and 2.75"x9.75" Imperial cartridge in case quantity by special order. 25 pcs. slimline and 9 pcs. per case Imperial size.

- Reduces HPC to meet TUV and Alpha Institute requirements. Test results of Carbosyl vs. RO GAC post filter>>
- Meets stringent European Union (EEC) stagnation requirements

Supercarb ceramic elements: Used in all residential pressure filters is a Sterasyl shell with solid carbon block insert. Economical three stage filtration available in candle and cartridge style.

Ultracarb ceramic elements: Used in all pressure filters is a Supercarb with ATS ion exchange medium incorporated into the carbon block for heavy metal reduction. Economical four stage filtration available in candle and cartridge style.

Megacarb ceramic candle: Used in all pressure filters is a Carbosyl shell with Ultracarb block inside with double the capacity of Ultracarb candle in addition of much higher VOC's and chemical reductions. The most powerful of all the above elements.

Supercarb, Ultracarb, Megacarb comparison table

Conclusion: Doulton ceramic filters are designed to convert raw water into high quality drinking water that will comply with the most stringent potable water standards all 100% naturally.

* Heterotrophic (HPC) is a harmless bacteria commonly found in all waters. In absence of disinfectants this bacteria colonize the reverse osmosis holding tank. As the bacteria die it creates foul odor therefore all RO's have GAC final filter to remove the odor out of the water. It should be clearly understood that no GAC filter remove any bacteria.

Most Popular Water Purification Technologies for Domestic Drinking Use

Point of Use Drinking Water Purification Technologies (FAQ)

With so many choices of purifiers and filters on the market. Where do I start?
Start by reading about Doulton ceramic technology and various other technologies currently in use. This will familiarize you with the different technologies available to treat your water. Next, go to our Product Selector and follow the steps. Of course, you can always feel free to contact us (*info@doultonusa.com*). We will make some recommendations to you based on your water supply and personal preferences.

Before purchasing a drinking water device determine which contaminants you want to remove, are these contaminants in your water, the degree of "purity" of the water etc. as there is no such a device or technology that **"does all"**.

Which point of use (POU) technologies other than Doulton are currently used in domestic water filtrations?
The most popular and economical method is Activated Carbon (AC). Other technologies are Reverse Osmosis (RO), Ultraviolet Radiation (UV), Ion Exchange (IEX) and Distillation or Demineralization (DI).

Are there more effective technologies other than the above mentioned such as EPA certified?
First of all, technologies are based on their physical properties and scientific facts that can be easily understood. Second, **EPA does not certify** POU water treatment devices. In U.S. any device containing man made or natural "purifier" such as iodine, chlorine, silver, "food grade" pesticides etc. must register that device with EPA (as with Doulton's Sterasyl element).

Stay clear of the products that you cannot understand how they work or use **pseudo scientific** (vague) terminologies such as; "pre coat technology", "FDA approved", "molecular sieving action", "electro kinetic", "solid carbon block technology", "redox technology", "NASA technology", "EPA certified purifier", "patented" or other mysterious "technologies". For more POU/POE nonsense terminologies visit this page: http://www.chem1.com/CQ/

What are the certification standards and who sets those standards for POU filtration devices?
The certification standards vary from region to region and some parts of the world don't have any. The certification standards are set by governmental institutions, industries associations and or combination of both. For example ISO (International Standard Organization, Zurich, Switzerland) sets world standards in manufacturing procedures (toughest to achieve and maintain), while in U.S., ANSI (American National Standard Institute) set standards. For example: In US for food equipment and POU devices NSF in collaboration with ANSI write standards that will meet EPA and FDA guidelines. NSF standards for POU filtration devices are 42, aesthetic contaminants (chlorine reduction) and 53, health related contaminants (cysts and turbidity reduction).

What is the difference between "tested by NSF" filter and a filter "tested to NSF standard"?
None. One was tested by NSF laboratory while the second one opted for an ANSI accredited laboratory. One have to keep in mind that all those tests cost thousands of dollars.

Which POU technology remove most contaminants out of the water?
A well designed and maintained distiller, laboratory grade* RO systems maintained and periodically tested by a qualified technician using high quality pre-treated water (*not to be confused with inexpensive domestic RO systems).

I am specifically concerned about removing parasitic cysts like cryptosporidium and giardia from my water. What is the best filtration or purification method for cysts?
Generally cysts size in range from about 3-7 microns and can be reduced by fine filters however **to completely remove 100% a filter pore size have to be at least 1 micron absolute** with greater than 99.99% efficiency. Many filters on the market claim cysts reduction using surrogates (AC fine test dust in 0.5-3 micron size range) test standards vs. live cysts method which is tougher and more accurate test.

For immunocompromised individuals the following POU labeled devices may or may not remove Cryptosporidium.

POU device labeled only with these words may not be designed to remove Crypto	POU device labeled with these words indicate should be able to remove Crypto
• *Pore* size of 1 micron or 1/2-micron filter • Effective against *Giardia* • Effective against parasites • Carbon filter, water purifier or softener • EPA approved - EPA does not approve or test filters • EPA registered - EPA does not register filters for Crypto removal • Activated carbon, removes chlorine • Ultraviolet light or UV purifier • Reverse-osmosis (without NSF testing) • Pentiodide resins, bacteriostatic	• Reverse-osmosis (with NSF testing), *ask for results* • *Absolute* pore size of 1 micron or smaller (w/>99.99% efficiency 4 log test standard protocol), *ask for results* • Distiller • Tested with live crypto cyst and certified to NSF Standard 53 for cyst removal, *ask for results* NOTE: There is general misconception even among medical professionals recommending reverse-osmosis not understanding operational and maintenance requirements of such POU device to be able to remove Crypto.

Most all carbon filters are in particulate reduction range.

Distillers and RO manufacturers often "claim" that natural minerals in water are not beneficial for you while POU manufacturers "claim" the opposite. Who's right?
Our view is that we should rely on minerals through food intake rather than water. On the other hand have you ever tried "pure" water? It's flat and lifeless, taste stale and is very acidic. Laboratory water should be "pure". Drinking water should be safe and wholesome, free from pathogenic bacteria and chemicals, full of oxygen and mineral content that gives water spring-like taste and freshness. Should you opt for "pure" drinking water then distilled water is much "purer" than reverse osmosis water even under best RO performance conditions.

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Reverse Osmosis (RO)-FAQ

RO systems with Doulton ceramic filter guard>>

Reverse osmosis (RO) is a membrane filtration process separating dissolved salts from a water stream. In RO, not only are insoluble particles retained by the membrane but also molecules and ions in solution. Concentration of ions near the membrane sets up ‘polarization’ phenomena which results in an increase in the osmotic pressure of the solution to be treated, sometimes followed by precipitation. The continuing flow of input water under high pressure (>200 psi) flushes the membrane, which removes the ion concentrations and/or precipitates.
RO systems are not normally "water efficient" and wastewater rejected by the system may be significant. Purchase and installation costs can be significant. **RO membrane are notoriously prone to scale and bacterial build-ups and ruptures**. Slime-forming bacteria can cause rapid deterioration of performance. If you own a Doulton filter you'll know what "slime-forming bacteria" is. When you clean the ceramic candle it is the pinkish slippery bio-film that built up on the surface slowing your filter flow rate.

High end laboratory and industrial RO systems rejects high degree of organic and inorganic compounds producing high quality pharmaceutical and or industrial grade water. To achieve this producers pre-treat the water using various pre-treatment methods such as passing through pre-filters, ion exchange resin beds etc. Under right pressure (>200 psi.) and temperature the pre-treated water is then pumped through two RO membranes connected in series (double pass) rejecting dissolved compounds in molecular and ionic state. These systems are constantly maintained and monitored by trained personnel using sophisticated equipment.

RO water lacks minerals and oxygen, hence the "flat", "stale" taste when used for drinking.

In all cases, a Doulton ceramic pre-filter will prevent membrane bacterial fouling. RO plants producing potable water often use Doulton ceramics as a final polish filters (physical barrier).

Distillation- FAQ

Distillation or **demineralization** is usually an effective method of preparing safe drinking water. However, carry-over's of volatile organic compounds (herbicides and/or pesticides) may be an issue since they may be evaporated and re-condensed with the water.

Like RO, distilled water is very acidic and should be stored in glass container in order to prevent leaching (recontamination). Since is virtually dematerialized it is often called "starving", "thirsty" or "hungry" water. Like RO, **distilled water lacks minerals and oxygen**, hence the "flat", "stale" taste when used for drinking. Distilled water is mainly used for industrial processes such as electronic circuit boards etching and rinsing, photographic's and other applications.

In most cases, pre-filtration, including a ceramic filter element, will improve the effectiveness of a distillation system by improving the quality of supply water.

Distillers

People believed that the purest water had the least chance of allowing harmful organisms to enter the body, and distillation certainly rids water of all impurities. However in recent years there has been growing awareness of distilled water's effects on the balance of minerals in the body, plus the acidic result that a typical distiller creates.
People now realize that dissolved minerals in the water are more natural than pure water, and serve an important function in supporting the body's immune system and metabolism.

Ultraviolet Radiation UV-FAQ

Ultraviolet systems (UV) expose supply water to intense ultraviolet radiation, which kill pathogenic bacteria (cholera, typhoid, salmonella dysenteriae, etc.), virus however is not effective against cysts.

Since UV is not a physical filter, suspended particles (or turbidity) in the water could “shade” bacteria from the direct rays from the UV source “live” bacteria and virus could pass through the system. For this reason a good UV systems have ceramic cartridge as a pre and final filter. The following factors can reduce the UV performance:

- Iron and hardness, which build up on the quartz sleeve is a process industry known as "fouling".
- Iron, decayed organic matters, tannins and any UV energy absorptive material commonly found in tap water.

If you own a UV without Doulton ceramic pre-filter and rely on it for microbiological protection make sure to clean the quartz sleeve often.

UV, by itself, does not remove any particulate matter or turbidity. It does not remove volatile organic compounds such as pesticides or insecticides. Purchase, installation, operating and maintenance costs should be considered before selecting UV as a drinking water treatment system.

Ion Exchange IEX- FAQ

Most popular Ion exchange (IEX) media in POU for heavy metals reduction is Engelhard's ATS media, zeolite etc. Various IEX resins are often used for industrial processes for specific water use. Ion exchange theory in layman language is simply gaining and loosing atoms (swapping atoms). In drinking water for example soluble lead is a positive ion whilst chlorine is a negative ion (cat ions+, anions-). Most common ion exchange in rural area (well water) is "Softener".

An other popular often called "**emerging technology**" or "**redox technology**" etc. is IEX media used in POU is KDF 55 (copper zinc alloy in granule form) for it's high chlorine reduction. By simply swapping atoms this metal alloy turns chlorine into harmless chloride.

Many POU "makers" using this alloy claim soluble lead reduction, bacteriostatic proprieties, some go as far as cysts and bacteria removal and a host of other "miracles". We simply don't know what does it do with the lead, does it convert it to a particulate lead or what pH operating water conditions must be used? Under what condition is bacteriostatic?. If you plan on buying a POU using KDF media, do your investigating as to performance claims. KDF 55 is widely use for shower and garden filters which are impressively compact and effective de-chlorinator.

For more info on this and other **water pseudo science "magic's"** visit Dr. Stephen Lower page, a professor of chemistry>

Conclusion

There is a range of water purification products on the market and there is Doulton. Effective and cost efficient drinking water treatment technology.

-
- **Ceramics with Silver**
    - PROS
        - Silver can act as a bactericide.
        - Ceramics do not need to be sterilized.
    - CONS
        - I recommend that one purchase ceramics that that have SILVER impregnated through out the entire ceramics. Some manufactures only coat the inside and outside of the ceramic. As such, after cleaning the outside so many times, the effectiveness of the Silver outside layer is greatly reduced. I only recommend **DOULTON** filters which have been made in England for over a hundred years and have been tested by the NSF, universities and labs around the world.

- **Ceramics with Carbon Centers**
    - PROS
        - These filters combine the best of the ceramic capabilities with the properties of the carbon filtration
        - This is the type of filter that is utilized in most 'gravity' type filters. Though slow, they do provide great filtered water. Most 'gravity' filters allow for 1 or more of these filters. This allows for filtering greater volumes of water.
    - CONS
        - The life of the carbon insert will run out way before the life of the ceramic filter. As such, the cost per gallon is very high. The **Doulton** ceramic filter with the carbon insert (SuperSterasyl) is only rated for about **600 gallons** while the ceramic is rated for **2600 gallons**. If you are not using this in a gravity fed system, I would recommend purchase a separate carbon filter in conjunction with the ceramic filter.
- **Reverse Osmosis**

. Reverse Osmosis Filters

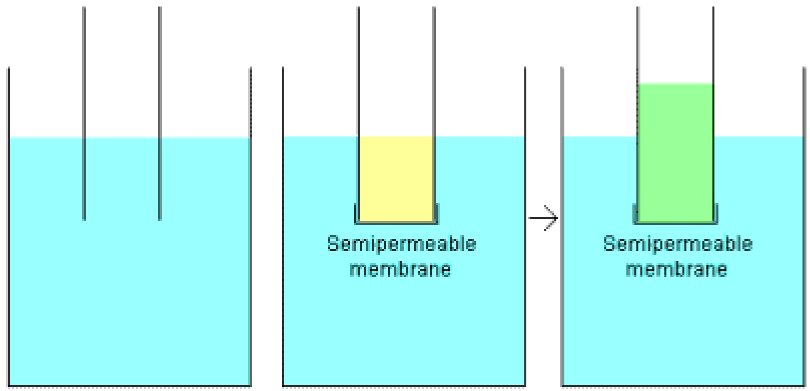
Originally developed to process water in submarines, the reverse osmosis process basically draws water through an extremely fine membrane. The membrane act like an extremely fine filter to create drinkable water from salty (or otherwise contaminated) water. The contaminated water is put on one side of the membrane and pressure is applied to stop, and then reverse, the osmotic process. It generally takes a lot of pressure and is fairly slow, but it works. The result is extremely finely filtered water.

However, as already mentioned, water without minerals can be a health problem. Dr. Zoltan Rona has authored an excellent paper on *'Pure Water'* recommending in no uncertain terms against its continued consumption. According to the U.S. EPA, "Distilled water *(which is identical to RO water ~Ed)*, being essentially mineral-free, is very aggressive, in that it tends to dissolve substances with which it is in contact. Notably, carbon dioxide from the air is rapidly absorbed, making the water acidic and even more aggressive. Many metals are dissolved by distilled water." Dr Rona adds; "Longevity is associated with the regular consumption of hard water (high in minerals). Disease and early death is more likely to be seen with the long term drinking of distilled water." As Reverse Osmosis produced water is identical in nature to distilled water we can make the same assumptions.

Another type of water filtration system available today is reverse osmosis. That's the technical name for the process of water being pushed through an ultra-fine semi-permeable membrane, where it separates the tap liquid into the pure permeate which is diverted to a storage tank for later use; the brine concentrate is diverted down the drain. The water is stored in a pressure tank and is treated to a final activated-charcoal polishing filtration stage to remove all remaining odors and tastes before dispensing the purified water into your glass. The disadvantage of reverse osmosis systems is that they waste a lot of water – for every gallon of purified water produced, two gallons are wasted.

How does reverse osmosis work?

http://www.howstuffworks.com/question29.htm
To understand "reverse osmosis," it is probably best to start with normal osmosis. According to Merriam-Webster's Collegiate Dictionary, **osmosis** is the "movement of a solvent through a semipermeable membrane (as of a living cell) into a solution of higher solute concentration that tends to equalize the concentrations of solute on the two sides of the membrane." That's a mouthful. To understand what it means, this picture is helpful:



On the left is a beaker filled with water, and a tube has been half-submerged in the water. As you would expect, the water level in the tube is the same as the water level in the beaker. In the middle figure, the end of the tube has been sealed with a "semipermeable membrane" and the tube has been half-filled with a salty solution and submerged. Initially, the level of the salt solution and the water are equal, but over time, something unexpected happens -- the water in the tube actually rises. The rise is attributed to "osmotic pressure."

A **semipermeable membrane** is a membrane that will pass some atoms or molecules but not others. Saran wrap is a membrane, but it is impermeable to almost everything we commonly throw at it. The best common example of a semipermeable membrane would be the lining of your intestines, or a cell wall. Gore-tex is another common semipermeable membrane. Gore-tex fabric contains an extremely thin plastic film into which billions of small **pores** have been cut. The pores are big enough to let water vapor through, but small enough to prevent liquid water from passing (see this page for more information on Gore-tex fabric).

In the figure above, the membrane allows passage of water molecules but not salt molecules. One way to understand **osmotic pressure** would be to think of the water molecules on both sides of the membrane. They are in constant Brownian motion. On the salty side, some of the pores get plugged with salt atoms, but on the pure-water side that does not happen. Therefore, more water passes from the pure-water side to the salty side, as there are more pores on the pure-water side for the water molecules to pass through. The water on the salty side rises until one of two things occurs:

- The salt concentration becomes the same on both sides of the membrane (which isn't going to happen in this case since there is pure water on one side and salty water on the other).
- The water pressure rises as the height of the column of salty water rises, until it is equal to the osmotic pressure. At that point, osmosis will stop.

Osmosis, by the way, is why drinking salty water (like ocean water) will kill you. When you put salty water in your stomach, osmotic pressure begins drawing water out of your body to try to dilute the salt in your stomach. Eventually, you dehydrate and die.

In reverse osmosis, the idea is to use the membrane to act like an extremely fine **filter** to create drinkable water from salty (or otherwise contaminated) water. The salty water is put on one side of the membrane and pressure is applied to stop, and then reverse, the osmotic process. It generally takes a lot of pressure and is fairly slow, but it works.

Other types of water filters are ion exchange and distillation. Ion exchange is designed to remove dissolved salts in the water, such as calcium. This system actually softens the water or exchanges natural-forming mineral ions in the water with its own ions, thereby neutralizing their harmful effect of creating scale build-up. The ion exchange system was originally used in boilers and other industrial situations before becoming popular in home purifying units, which combine the system with carbon.

Distillation is the simple process of boiling water to create steam. The steam cools and condenses to form pure mineral-free water droplets which are deposited in a container. When combined with carbon, the result is 99.9% pure contaminate-free water. These systems are extremely efficient and reliable, and are regarded today as one of the most effective ways to remove contaminates from any water, from any source.

Summary of filtration systems and what they do and don't do:

Activated Carbon Filters – Do: absorb organic contaminants that cause bad taste and odor; some models remove chlorination byproducts; some models remove cleaning solvents and pesticides. Don't: remove metals such as lead and copper; remove nitrate, bacteria or dissolved minerals.

Ion Exchange Units – Do: remove minerals, particularly calcium and magnesium that make water "hard"; remove fluorides; some models remove radium and barium. Don't: soften water if it has oxidized iron or iron bacteria, which clogs the system when the ion-exchange resin becomes coated.

Reverse Osmosis Units – Do: remove nitrates, sodium, other dissolved inorganic and organic compounds; remove foul tastes, smells or colors; possibly reduce the level of some pesticides, dioxins and chloroform and petrochemicals. Don't: remove all inorganic and organic contaminants.

Distillation Units – Do: remove nitrates, bacteria, sodium, hardness, dissolved solids, most organic compounds, heavy metals, and radionuclides; kill bacteria. Don't: remove some volatile organ contaminants, certain pesticides and volatile solvents; stop bacteria from recolonizing on the cooling coils during inactive periods.

About the Author

Gareth Marples is a freelance article writer providing valuable tips and advice for consumers purchasing water purification systems, understanding the benefits of drinking water and the facts about the West Nile Virus. His numerous articles offer moneysaving tips and valuable insight on typically confusing topics.

This article on how "How Water Filters Work" reprinted with permission.

Do your homework before you choose a water filter

Since there are so many choices in models and designs in water filters, there are a few things you'll need to do before making your choice:

Have your water tested. Ask your local water utility for the Municipal Drinking Water Contaminant Analysis Report – it'll tell you what's in your drinking water.

Figure out how much water you use. That'll determine what type of filter you buy, whether it be a refillable pitcher, a faucet-mount, or an under-the-sink carbon-filtration system.

Have replacement filters available. Pitchers and faucet-mount filters must be changed every 1-3 months. If you use old filters, you're putting back all the contaminants you took out of the water. Keep in mind that over the course of a year, you'll be spending about $100 for replacement filters.

Violet Radiation Systems

UV systems use high frequency light to irradiate water through a glass element. Water passing the element is exposed to the light, which kills all living organisms.

UV systems are very common in Third world hotels etc where the possibility of serious disease occurring from local water consumption is high, especially from fecal matter in the water.

Although an excellent sterilizing system, it is impossible to know whether the system is always working without a laboratory analysis of the output water. For this reason the more sophisticated systems incorporate an hour counter so a new element can be replaced at a safe interval.

http://www.epa.gov/safewater/radionuclides/index.html

Most drinking water sources have very low levels of radioactive contaminants ("radionuclides"), most of which are naturally occurring, although contamination of drinking water sources from human-made nuclear materials can also occur. Most radioactive contaminants are at levels that are low enough to not be considered a public health concern. At higher levels, long-term exposure to radionuclides in drinking water may cause cancer. In addition, exposure to uranium in drinking water may cause toxic effects to the kidney.

To protect public health, EPA has established drinking water standards for several types of radioactive contaminants combined radium 226/228 (5 pCi/L); beta emitters (4 mrems); gross alpha standard (15 pCi/L); and uranium (30 µg/L).

This web site is designed to provide you with information about radionuclides in drinking water and provide guidance materials to help the states and water systems comply with the standard.

- Basic Information - Learn more about the sources of radionuclides, health effects and frequently asked questions.
- Radionuclides Rule - Get updated information on the radionuclides rule, including quick reference guides. The history of the rule-making is also featured.
- Compliance Help - If you are a public water system or state, visit this page to get available tools and training information on how to comply with the rule.

What are radionuclides?
A nuclide isa general term applicable to all atomic forms of an element. Nuclides are characterized by the number of protons and neutrons in the nucleus, as well as by the amount of energy contained withibn the atom. A radionuclide is an unstable form of a nuclide. They may occur naturally, but can also be artificially produced. The Office of Air and Radiation has additional information about radioactivity and specific types of radionuclides.

- Understanding Radiation
- Radionuclides

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What radionuclides are regulated in drinking water and what are their health effects?
The regulated radioactive drinking water contaminants are:

Contaminant	MCL (year promulgated)	Source	Health Effect

Combined radium-226/-228	5 pCi/L (1976)	Naturally occurs in some drinking water sources.	Some people who drink water containing radium –226 or -228 in excess of the MCL over many years may have an increased risk of getting cancer.
(Adjusted) Gross Alpha	15 pCi/L (not including radon or uranium) (1976)	Naturally occurs in some drinking water sources.	Some people who drink water containing alpha emitters in excess of the MCL over many years may have an increased risk of getting cancer.
Beta Particle and Photon Radioactivity	4 mrem/year (look-up table) (1976)	May occur due to contamination from facilities using or producing radioactive materials.	Some people who drink water containing beta and photon emitters in excess of the MCL over many years may have an increased risk of getting cancer.
Uranium	30 µg/L (2000)	Naturally occurs in some drinking water sources.	Exposure to uranium in drinking water may result in toxic effects to the kidney. Some people who drink water containing alpha emitters in excess of the MCL over many years may have an increased risk of getting cancer.

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How do radionuclides get into drinking water?
Most drinking water sources have very low levels of radioactive contaminants ("radionuclides"), which are not considered to be a public health concern. Of the small percentage of drinking water systems with radioactive contaminant levels high enough to be of concern, most of the radioactivity is naturally occurring. Certain rock types have naturally occurring trace amounts of "mildly radioactive" elements (radioactive elements with very long half-lives) that serve as the "parent" of other radioactive contaminants ("daughter products"). These radioactive contaminants, depending on their chemical properties, may accumulate in drinking water sources at levels of concern. The "parent radionuclide" often behaves very differently from the "daughter radionuclide" in the environment. Because of this, parent and daughter radionuclides may have very different drinking water occurrence patterns. For example, ground water with high radium levels tend to have low uranium levels and vice versa, even though uranium-238 is the parent of radium-226.

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Are radionuclides more common in some parts of the country?
Most parts of the United States have very low "average radionuclide occurrence" in drinking water sources. However, some parts of the country have, on average, elevated levels of particular radionuclides compared to the national average. For example, some parts of the mid-West have significantly higher average combined radium-226/-228

levels. On the other hand, some Western states have elevated average uranium levels compared to the national average. However, in general, average uranium levels are very low compared to the MCL throughout the United States. While there are other radionuclides that have been known to occur in a small number of drinking water supplies, their occurrence is thought to be rare compared to radium-226, radium-228, and uranium.

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Can drinking water be contaminated by man-made radionuclides?
A very small percentage of drinking water systems are located in areas that have potential sources of man-made radioactive contamination from facilities that use, manufacture, or dispose of radioactive substances. Drinking water contamination may occur through accidental releases of radioactivity or through improper disposal practices. Water systems that are vulnerable to this type of contamination are required to perform extensive monitoring for radioactive contamination to ensure that their drinking water is safe. These radionuclides are regulated under the "beta particle and photon radioactivity" standard.

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Does EPA regulate tritium in drinking water?
Tritium is a beta particle emitter which forms in the upper atmosphere through interactions between cosmic rays (nuclear particles coming from outer space) and the gases comprising the atmosphere. Tritium can be deposited from the atmosphere onto surface waters via rain or snow and can accumulate in ground water via seepage. Tritium is also formed from human activities, including production of electricity, nuclear weapons, nuclear medicines used in therapy and diagnosis, various commercial products, as well as in various academic and government research activities. Natural tritium tends not to occur at levels of concern, but contamination from human activities can result in relatively high levels.

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What systems must meet the requirements of the 2000 Radionuclides Rule?
The rule applies only to community water systems, which are water systems with at least 15 service connections or that serve 25 or more persons year-round. EPA will further consider a future proposal to regulate radionuclides levels in drinking water served by non-transient non-community water systems. These are water systems that serve at least 25 of the same people more than six months per year, such as schools, churches, nursing homes, and factories that supply their own water.

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How did the 2000 Radionuclides Rule address Uranium?
Exposure to uranium in drinking water may cause toxic effects to the kidney. In 1991, EPA proposed an MCL of 20 µg/L, which was determined to be as close as feasible to the maximum contaminant level goal (MCLG) of X µg/L. Based on human kidney toxicity data collected since that time and on its estimate of the costs and benefits of regulating uranium in drinking water, EPA determined that the benefits of a uranium

MCL of 20 µg/L did not justify the costs. Instead, EPA determined that 30 µg/L is the appropriate MCL, because it maximizes the net benefits (benefits minus costs), while being protective of kidney toxicity and carcinogenicity with an adequate margin of safety.

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How did the 2000 Radionuclides Rule change monitoring requirements?
Under the old rule, community water systems only tested water from a “representative point” in the distribution system. The old monitoring requirements did not protect every customer, since water quality may vary significantly within the distribution system. To ensure that water served to all customers meets the MCLs for radionuclides in drinking water, the revised rule required that future monitoring be performed such that all water entering the distribution system is tested. The monitoring frequency requirements were also changed to be more consistent with the “Standardized Monitoring Framework” that other drinking water standards use.This improves consistency in monitoring requirements and provides monitoring relief for those water systems that have very low contaminant levels.

In addition, the new rule corrected a monitoring deficiency in the 1976 framework for monitoring for combined radium-226 and -228. Under the old rule, it was assumed that radium-226 and gross alpha levels could be used to screen for radium-228. Since then, EPA has collected substantial evidence that this assumption is false. The correction involves separate monitoring requirements for radium-228, further ensuring that drinking water system customers will be protected from harmful radioactive contaminant levels.

- 2000 Radionuclides Rule
- Analytical Methods
- Rule-Making History

In 2000, EPA revised the radionuclides regulation, which had been in effect since 1977. The revisions required new monitoring provisions to ensure that all customers of community water systems will receive water that meets the Maximum Contaminant Levels for radionuclides in drinking water. EPA also issued a standard for uranium, as required by the 1986 amendments to the Safe Drinking Water Act. The current standards are: combined radium 226/228 of 5 pCi/L; a gross alpha standard for all alphas of 15 pCi/L (not including radon and uranium); a combined standard of 4 mrem/year for beta emitters. The new MCL for uranium is 30 µg/L.

- Radionuclides final rule (December 7, 2000)
- Fact Sheet on Final Rule
- Quick Reference Guide for the Radionuclides Rule (PDF 2 pp, 107 K) (About PDF)
- National Primary Drinking Water Regulations - Code of Federal Regulations 40 CFR Part 141

Analytical Methods

- Approved Methods for Radionuclides

In 2004, EPA issued a final rule with three additional analytical methods that use inductively coupled plasma mass spectrometry (ICP-MS) technology for compliance determinations of Uranium in drinking water.

- National Primary Drinking Water Regulations: Analytical Method for Uranium

Rule-Making History

In 2004, EPA published minor corrections to the Radionuclides Rule to identify a detection limit for uranium and to clarify text in the rule.

- June 29, 2004 - National Primary Drinking Water Regulations: Minor Corrections and Clarification to Drinking Water Regulations; National Primary Drinking Water Regulations for Lead and Copper

In 2000, EPA published a Notice of Data Availability (NODA) to update the public and the regulated community with new information that had become available since the 1991 proposal. The Agency also developed a Technical Support Document, which provides background information and further describes the analyses discussed in the NODA, and the preliminary Health Risk Reduction and Cost Analysis, which presents the analyses of projected impacts, costs, risk reductions, and benefits for the uranium NPDWR and the new monitoring requirement for radium-228.

- Notice of Data Availability – April 21, 2000
- Technical Support Document (PDF 164 pp, 505 K) (About PDF)
- Preliminary HRCCA (PDF 183 pp, 743 K) (About PDF)

In 1997, EPA held a public meeting to discuss regulatory issues associated with the 1991 Radionuclides Rule proposal.

- Meeting Summary.

In 1991, EPA proposed revisions to the July 9, 1976 rule. The final rule published in 2000 finalized this 1991 proposal.

- 1991 Proposal (July 18, 1991) - 56 Federal Register 33050

Drinking Water Problems: An Overview

Problems with tap water are a growing concern. Here's how to deal with poor drinking water.

"I suspect that in the next 50 years, we will see a shift from oil to water as the cause of great conflicts between nations and peoples." This chilling statement was made by Wally N'Dow, Secretary-General of a recent United Nations conference. Because of growing population, urbanization and pollution, the world is becoming thirstier for clean water. And though this drought is felt most severely in developing nations, Americans are beginning to see the ripples as domestic waters grow troubled.

Despite decades of controlling water-borne diseases and contamination through conventional chlorination and treatment, in 1993, a newly recognized parasite gave serious gastro-intestinal disorders to over 400,000 people in Milwaukee, Wisconsin. Meanwhile, other headlines have continued report other problems: "Missouri Farmers Suffer from High Rates of Cancer," "Nitrates in Rural Water Exceed Federal Health Standards," "Urban Water Tainted by Lead from Aging Pipes," "Smog-Reducing Chemical May Threaten Ground Water." It's no wonder Americans now consume 2.5 billion gallons of bottled water per year.

What about you? Should you join the rest of America and buy your water at the grocery store? Should you ladle-up a few hundred dollars for a state-of-the-art filtering system? Or should you trust the tap?

To answer this question, you will have to do your homework. First, find out where your water comes from and determine what tests, if any, might be needed. Then, when you know what you're dealing with, consider the solutions.

The Basics

For most of our drinking water, municipal utilities draw ground water from aquifers, rock strata and springs beneath the surface, treat it for impurities and pipe it to our homes. A relatively few remote or rural homes pump drinking water directly from private wells.

Chlorination and other treatments are used to kill bacteria and microbes that cause water-borne diseases. Although only a handful of acute, water-based sicknesses normally occur in the U.S. each year, that huge Milwaukee outbreak was the harbinger of bad news. During the past three years, trace amounts of that dangerous parasite-- Cryptosporidium parvum-- have appeared in many public systems across the country. Though in most cases these truly are harmless trace quantities, the parasite can survive conventional treatment.

The gastrointestinal distress that "Crypto" causes is uncomfortable but not life threatening to most people, but it can be serious or lethal for AIDS patients and others with suppressed or weak immune systems, including children and elderly people. The Environmental Protection Agency (EPA) has issued an advisory suggesting that people at risk boil or filter their drinking water with an appropriate filter or drink bottled water that is known to be free of Crypto. If you're in doubt, speak with a health-care provider. In the very near future, large water systems will be monitoring for this parasite.

Largely because of improved detection capabilities, an ocean of microscopic contaminants has been found in treated drinking water in recent years. When present, these contaminants are usually in extremely low concentrations, but long-term exposure to higher levels has been linked to cancer and other diseases. Perhaps most disturbing is the fact that these pollutants are evidence of dangerous chemicals trickling into our water supplies which, without proper controls and disposal methods, will only get worse.

For the public's protection, Congress enacted the Clean Water Drinking Act in 1974 and strengthened it in 1986, setting minimum water quality standards for all water utilities that serve at least 25 people or 15 service connections. These standards limit the allowable amounts of pollutants found in drinking water, measured in maximum contaminant levels (MCLs), but there is no guarantee that all utilities comply with the regulations. Enforcement is difficult on national, state and local levels; not all known contaminants are on the list; and all testing isn't necessarily accurate.

Fortunately our biggest water suppliers, large metropolitan systems, tend to have the best drinking water because they have the equipment and resources for frequent, mandated testing--the frequency of testing depends on the number of people served. It's also somewhat reassuring to know that, when something does go wrong, utilities are required to notify their customers. Wells are another story. Private wells and systems that serve fewer than 25 people or 15 service connections are regulated only by state and local laws or by their owners.

The Hit List

What are the contaminants that put us at risk? The EPA categorizes the culprits as follows. A chart listing maximum contaminant levels and suspected health risks is available through the EPA printing office. For a copy or more information, contact the EPA's National Safe Drinking Water Hotline at (800) 426-4791.

* Organic chemicals are pesticides, solvents, and other chemicals that seep into ground water supplies. Some are known as volatile organic chemicals (VOCs) because they change (they may evaporate, for example). Most are linked with cancer and/or nervous system, liver and kidney disorders.

In the organic group, trihalomethanes (THMs) are sometimes created after water has left a treatment plant, when chlorine may react with leaves and other decaying animal and plant matter. A substance that can result from this process is chloroform, a suspected carcinogen.

* Inorganic chemicals include dangerous metals such as mercury, lead and arsenic; sodium; nitrates and nitrites; asbestos; fluoride; and a variety of natural minerals. Some inorganics are associated with a variety of health problems. Lead is known to cause brain damage and is highly toxic to infants and pregnant women, even in minute doses. It usually comes from lead water pipes, old pipe solder, or lead-based brass fixtures.

* Radon and other radio nuclides are present in the water of certain regions. These can enter the air you breathe through showers and steam--you don't have to drink the water. They come from naturally occurring radon, uranium, and radioactive waste and are known to increase cancer risk.

* Microbes, parasites, protozoa, bacteria and viruses are, by far, the most common cause of immediate, acute illnesses from polluted water. They occur in nature or often result from "back flows" of septic waste into the clean-water supply. They're much more common in wells than in metropolitan water systems.

Drinking Water Problems

How to Test Your Drinking Water

Unless issued by your local health department, avoid "free home water testing" offers--they are normally a come-on to get you to buy water treatment devices after a couple of carefully staged tests. The only way to be sure that your water has certain harmful pollutants is to have it tested by an independent lab.

Unfortunately, you must test for each type of pollutant separately, which can be very expensive. If you get your water from a municipal utility, quality can change daily so most tests are worthless--and usually unnecessary. Nevertheless, it may be a good idea to check for lead because lead can leach into the water from old lead-based plumbing.

You can also discover plenty of information without testing. Call your health department or water supplier and request copies of water treatment reports and note any violations. Find out the frequency and scope of the tests. Ask whether your area is known for any special hazards, especially those that might enter water between the treatment plant and your tap.

If you have a well, at the very least check it once for mineral content, lead and radon (where radon is a threat) and once or twice a year for bacteria and nitrate. If you have concerns about contaminants in well water, contact your local health department for recommendations. They may handle certain tests, such as bacterial testing. A partial chemical test that will detect magnesium, calcium, sodium, iron, fluoride, chloride and nitrate is usually relatively affordable. To look for chemicals such as solvents, pesticides and petroleum products can be very expensive, because each requires its own test.

Find an independent testing lab by asking your water utility or the state health department for a recommendation or looking under "Laboratories" in the Yellow Pages. Or you can contact one of the mail-order laboratories that specialize in water analysis at an affordable price, such as National Testing Labs (800-458-3330) or Suburban Water Testing (800-433-6595). They will send you the proper supplies and instructions for collecting a sample, which you mail back. A lead-only test costs about $35; a comprehensive test for bacteria, organics and inorganics runs from $119 to $145.

Water Quality

MAINS/MUNICIPAL WATER

- Municipal water quality can be highly variable: It comes from multiple sources.
- It has varying levels of contamination.
- It has variable quality control.
- It is treated in different ways with chlorine and other chemicals in variable quantities.

In addition to chemicals, which are added in order to treat it, municipal water contains many naturally occurring substances, a multitude of micro-organisms, and a host of other pollutants that are washed into the water supply from the surrounding land. Many of the naturally occurring minerals in water can be beneficial to health. Some of the other substances can be extremely harmful, especially if imbibed over a long period.

The best way to maintain the beneficial minerals while removing the harmful pollutants is to use a **Doulton®** or **British Berkefeld®** ceramic drinking water filter.

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Bottled Water

Bottled water, assuming that it is not purified mains water, has the advantage of coming from a single source and so maintenance of quality should be much easier than for mains water.

However:

- It is extremely expensive, mainly due to the packaging and transport involved.
- It has variable quality, depending on the source, and the company producing it.
- In some cases, the controls on bottled water are not as stringent as the ones on municipal water.
- Once unsealed, a bottle of water can become a breeding ground for bacteria and algae. This is a common problem with bottle water coolers, especially when they are in direct sunlight.
- By definition, bottled water is not on tap!

There is no need to spend huge amounts of money on bottled water when you can filter your mains water cheaply with a **Doulton®** or **British Berkefeld®** ceramic drinking water filter. They not only remove harmful contaminants, but can also greatly improve the taste. FICL Ceramic filters are frequently incorporated into mains connected water coolers for this very reason.

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Private Water Supplies

Private water supplies taken from wells, streams, rainwater collection tanks, and other sources do not have the benefit of any treatment by water companies. As a result, they tend to be:

- Unchlorinated, which often leads to bacteriological contamination**.**
- Full of unwanted particles**.** These can be anything from mud and silt, to rust from old pipework. Not the kind of thing that you want to be swallowing.
- Prone to Cryptosporidium and Giardia contamination from animal faeces, which leach into water supplies from the surrounding land.

Frequently Asked Questions About Doulton or Berkefeld Systems

Q1) When does a ceramic filter element need cleaning?
A1) Once the flow out of the filter becomes noticeably less than normal.
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Q2) How do I clean a filter candle?
A2) Use a scouring pad (similar to 3M "Scotchbrite"). Ensure that the end of the plastic

mount does not come into contact with unfiltered water and dirty hands. Rubber gloves are recommended to be used during cleaning and NEVER use soap or detergents!
Return top

Q3) My filter candle blocks up too regularly, what can I do about it?
A3) In some water conditions, there is so much particulate or turbidity in the water supply that the filter element becomes blocked much quicker than in normal conditions. In these circumstances, it is beneficial to use a pre-filter upstream of the ceramic candle. This prevents the candle from becoming blocked too quickly, minimises cleaning and so extends the life of the ceramic filter.
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Q4) When does a ceramic filter element need replacing?
A4) This depends on the type of candle being used:

Sterasyl™
Should be replaced once cleaning fails to restore the water flow. However, we usually recommend that Sterasyl™ candles are replaced after 10,000 litres of water have passed through the candle, to guarantee optimum performance.

Super Sterasyl™, Carbosyl™, Supercarb™, and Ultracarb™
In combination filter elements (ceramic shells containing other types of filter media) cleaning the ceramic will not extend the life of the internal material. For example, the 'life' of the carbon block in Supercarb™ or Ultracarb™ filter elements is determined by the concentration of chlorine and/or volatile organic compounds in the water supply. The particulate and turbidity concentration in the water supply govern the life of the ceramic. This means that the life of the ceramic might or might not exceed the capacity of the carbon insert, depending on the water quality. Whichever point is reached first – the six months usage or the ceramic becoming blocked to the extent where cleaning does not restore the flow – governs when the filter element requires replacing.

In most cases, the filter element should be replaced after 6 - 12 months of daily use. The following flow guidelines can be used to guarantee optimum performance:

Super Sterasyl™ 2,000 litres or 535 US gallons
Carbosyl™ 1,496 litres or 400 US gallons
Supercarb™ 3,740 litres or 1000 US gallons
Ultracarb™ 2,244 litres or 600 US gallons

After this amount of water has passed through the filter element, the filter will need to be replaced to guarantee optimum performance.
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Q5) I don't have a flow meter to gauge the amount of water that my filter has treated. How can I estimate how much water has passed through the filter?
A5) On average a family of four uses approximately 8 litres of water per day for cooking and drinking. Therefore, based on 10 litres/day for four people the life of your filter can be estimated in time rather than capacity.
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Q6) Do I need to sterilise the candle after cleaning?
A6) The ceramic shell of Sterasyl™, Super Sterasyl™, Carbosyl™, Supercarb™, and Ultracarb™ filter elements all contain trace amounts of silver to prevent microbiological growth. These elements are self-sterilising and should NOT be sterilised after cleaning. In the case of combination filter elements, boiling will damage the internal components of the element.
Return top

Q7) How do I keep my filter housing clean?
A7) The filter housing is best cleaned by unscrewing the body from the head and wiping the surface and the inside of the body with a soft cloth dampened with warm water. IMPORTANT – DO NOT ATTEMPT TO CLEAN THE FILTER HEAD, WHICH COULD CAUSE CONTAMINATION OF THE FILTERED WATER.
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Q8) What happens if I leave the filter unused for a period of time?
A8) If normal use of the filter is interrupted by holidays or vacations, growth of harmless heterotrophic bacteria may result in a 'flat' or 'stale' taste for a period of time when use

of the filter resumes. This is especially true for the filter elements that contain activated carbon such as the Super Sterasyl™ (contains granular activated carbon), the Supercarb™ and Ultracarb™ (both contain an extruded activated carbon core). Flushing the filter system for several minutes after any prolonged period of inactivity should eliminate the problem.
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Q9) What is the difference between temporary and permanent hardness in water?
A9) Hardness caused by the presence of positively charged metal ions. Total hardness is measured as the equivalent of milligrams per litre of calcium carbonate. Temporary hardness only contains metal carbonates and bicarbonates, the most typical being calcium carbonate. Temporary hardness is precipitated from water when heated and is responsible for the furring of heating elements and metal pipes. Permanent hardness consists of non-carbonate based metal salts, and does not precipitate out on heating.
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Q10) Will my Doulton® or British Berkefeld® filter element remove hardness?
A10) Unfortunately filtration does not remove hardness from water so Doulton® or British Berkefeld® filter elements will not affect the hardness in drinking water. Hardness can be removed by water softening, deionisation or magnetic and electrical conditioning devices.
Return top

Q11) Will hardness affect the performance of an Ultracarb™ filter element?
A11) The ATS media used in our Ultracarb™ filters will adsorb lead, even in the presence of calcium and magnesium ions. This is proven in the NSF certification testing. One of the test protocols for metal(s) reduction calls for testing at high pH, high TDS conditions to simulate use in hard waters. Filter elements containing ATS have to pass this part of the test protocol before they can receive NSF certification.
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Q12) Will my Doulton® or British Berkefeld® filter element remove Aluminium?
A12) The Doulton® and British Berkefeld® range of ceramic water filters are only suitable for the removal of aluminium in particulate form. They are not proven to be suitable for treating dissolved aluminium. To treat water containing soluble aluminium, ion exchange resin, distillation or reverse osmosis must be used.
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Q13) Will my Doulton® or British Berkefeld® filter element remove Arsenic?
A13) No, Arsenic is likely to be in a dissolved state, to remove arsenic passage through activated alumina is the best method.
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Q14) Will my Doulton® or British Berkefeld® filter element remove all types of bacteria?
A14) No. The large number of different species of bacteria of different shape, size and growth characteristics, preclude the ceramic filter from being effective against all of them.

The pathogenic bacteria that FICL claim to be effective against have been qualified by test data from independent test laboratories or are extrapolated from test data of similar microorganisms (please seek advice from FICL on permitted extrapolated claims).

Although the ceramic will filter all types of heterotrophic bacteria to some extent, it should be noted that any harmless bacteria of this type passing through the ceramic may multiply downstream of the filter. Since these heterotrophic bacteria are harmless, normally there are no problems and some heterotrophic bacteria are reported to be beneficial to health. However, if normal use of the filter is interrupted by holidays or vacations, growth of these bacteria may result in a ‘flat' or ‘stale' taste for a period of time when use of the filter resumes. This is especially true for the filter elements that contain activated carbon such as the Super Sterasyl™ (contains granular activated carbon), the Supercarb™ and Ultracarb™ (both contain an extruded activated carbon core). Any system containing activated carbon, which will reduce residual levels of free chlorine, will result in an increase in plate counts over a short period of time until a constant state of equilibrium is established. The UK Drinking Water Inspectorate water regulations call for the water to be regularly monitored for consistency as used, therefore since an equilibrium point is reached in the filtered water, the filters comply with the regulations. The presence of this type of heterotrophic bacteria does not constitute a health problem since the organisms present will be harmless and a suitable

level of consistency would be established. Flushing the filter system for several minutes after any prolonged period of inactivity should eliminate the problem.
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Q15) Will my Doulton® or British Berkefeld® filter element remove Chloramine?
A15) Chloramine may be removed by passing through a bed of activated carbon, but requires much greater contact time with the carbon than chlorine, so a slow flow rate through the carbon must be ensured. Unfortunately although the Doulton® or British Berkefeld® Super Sterasyl™, Carbosyl™, Supercarb™, and Ultracarb™ filter elements contain activated carbon, they may reduce levels but will not remove chloramine because there is insufficient contact time with the carbon.
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Q16) Will my Doulton® or British Berkefeld® remove diesel, petroleum or MTBE?
A16) The ceramic part of our filter elements will not take out any of these organic materials. The activated carbon in the Supercarb™ and Ultracarb™ filter elements will have some effect. However, to remove these types of materials requires much greater quantities of activated carbon and much longer contact time than our filters can provide.
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Q17) Will my Doulton® or British Berkefeld® filter element remove Fluoride?
A17) No. Fluoride salts are soluble in water. To remove dissolved fluoride, passage through activated alumina is the best method.
Return top

Q18) Will my Doulton® or British Berkefeld® filter element remove Iron?
A18) The Doulton® and British Berkefeld® ranges of ceramic water filters are only suitable for the removal of iron in particulate form. They are not proven as suitable for treating dissolved iron. To treat water containing soluble iron, the iron must be oxidised to induce precipitation prior to filtration. Alternatively distillation or reverse osmosis can be used.
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Q19) Will my Doulton® or British Berkefeld® filter element remove Legionella?
A19) Since Legionella has a similar morphology to E-coli, our ceramic filter elements should provide similar protection against Legionella . However, Legionella is capable of slow regrowth downstream of the filter, so if just one organism passes through the ceramic it could eventually colonise the water delivery system. Therefore it is important to regularly disinfect downstream of the filter or fit a UV light just after the filter.
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Q20) Will my Doulton® or British Berkefeld® filter element remove Manganese?
A20) No, to remove Manganese, oxidation treatment and filtration can be done, or for low levels of contamination, Green sand or Inversand can be used.
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Q21) Will my Doulton® or British Berkefeld® filter element remove Nitrates?
A21) Unfortunately the ceramic filter elements will not remove nitrates. In the home the only effective method that can be used to remove nitrates is ion exchange media.
Return top

Q22) Will my Doulton® or British Berkefeld® filter element remove Oestrogen and Synthetic Oestrogen?
A22) There has been a limited amount of research into Oestrogen and Synthetic Oestrogen, and so we do not have quantifiable test data on the effectiveness of our products in removing it. Due to the chemical properties of Oestrogen, we believe that activated carbon would be effective in reducing it. However until better test methodology is available, we are unable make a claim.
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Q23) Will my Doulton® or British Berkefeld® filter element remove Pseudamonas aeroginosa?
A23) Pseudomonas aeroginosa is a potential coloniser of water system networks and is similar in size to E-coli. FICL candles should therefore, in theory, show a similar reduction efficiency for Pseudomonas aeroginosa as for E-coli. However, since this organism is rapid growing and may recover quickly, without physically testing FICL ceramic filters with this type of organism, it is impossible to predict a performance claim. FICL is not prepared to attempt a prediction of performance, since the filters provide a <99.99% barrier, but do not provide 100% barrier to E-coli. A limited number of cells may pass through the filter which, unlike E-coli, may form colonies down stream of the

filter. It would be more suitable to combine filtration with a disinfection stage to ensure removal of Pseudomonas aeroginosa.
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Q24) Why does the pH of my drinking water increase when I use my ceramic filter?
A24) The slight increase in the pH of water passed through the ceramic filters is due to the presence of the mineral Wollastonite in the ceramic. Wollastonite is slightly soluble and alkaline, so may partly dissolve in the water as it passes through the filter causing a minor pH shift which is harmless. No health based guideline value for pH in drinking water has been proposed by the WHO, although accompanying notes to the guidelines state that the pH range is often in the range of 6.5-9.5. In general there is little evidence to suggest that pH in potable water of around 9-10 is of public health significance.
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Q25) What level of bacterial contamination can the ceramic cope with before I need to use something else?
A25) In the absence of conclusive data regarding the levels of infective doses for specific pathogens, the FICL microbiological laboratory has been testing our filter elements for many years using an influent challenge of 6 log of E-Coli to substantiate the 4 log E-coli reduction claim that we make. This level of protection offered by the filters is more than adequate in all protected waters and the vast majority of moderately contaminated surface waters. However, if the level of contamination in the water exceeds levels of 10^4 (4log) an additional treatment must be used such as disinfection or UV light treatment. It would be extremely unusual for water having a greater level of contamination than 10^4, to be considered suitable as a potable water source.
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Drinking Water

Common Water Contaminants

In order to be sure which contaminants your water contains, it is best to get a sample of your water professionally tested in a laboratory.

Commonly occurring, potentially harmful contaminants in mains water around the world include:

- Pathogenic Bacteria
- Cryptosporidium, Giardia, and other cysts
- Chlorine (taste & odour)
- Lead

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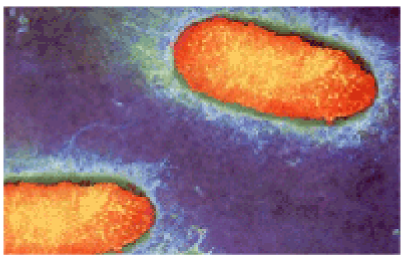
PATHOGENIC BACTERIA:



Common pathogenic bacteria found in water supplies include:
- E-coli
- Salmonella
- Legionella
- Cholera
- Salmonella Typhi (Typhoid)
- Shigella
- Klebsiella

These bacteria are not often found in chlorinated mains water supplies, but are often found in unchlorinated private water supplies, and stored water. Stored water, whether it is in a water tank or a bottle, is the perfect breeding ground for bacteria. It does not take long for the bacteria to multiply sufficiently to reach infective dose (disease causing) levels.

Pathogenic bacteria are responsible for many of the common types of potentially fatal water-borne disease around the world. **Doulton®** and **British Berkefeld®** water filters have been proven by independent laboratory testing to be highly effective against pathogenic bacteria.

Bacteria	% Reduction	Illness Caused	Symptoms
Salmonella typhus	>99.999%	Typhoid Fever	Fever, headaches, apathy, weakness, abdominal pain, and a rose coloured skin rash.
Shigella	>99.999%	Shigellosis or Bacterial Dysentery	Abdominal pain, fever, diarrhoea, mucus and blood in excreta.
Vibrio cholerae	>99.99%	Cholera	Nausea, vomiting, abdominal pain, diarrhoea, severe dehydration followed by collapse, shock and in many cases death
Klebsiella Tarragona	>99.999%	Gastroenterocolitis	Diarrhoea and abdominal cramps
E-coli	>99.999%	Gastroenterocolitis	Diarrhoea and abdominal cramps

Which Filter?
Any **Doulton®** or **British Berkefeld®** filter. (Sterasyl™, Super Sterasyl™, Carbosyl™, Supercarb™, Ultracarb™)

All our filters have Absolute filtration ratings (defined as >99.99%) of 0.9 microns, which is more than sufficient to remove most pathogenic bacteria. **Please note:** these filters are **not** available for sale in California.

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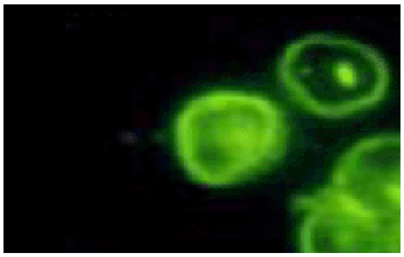
CRYPTOSPORIDIUM, GIARDIA, AND OTHER CYSTS:



Water-borne cysts such as Cryptosporidium and Giardia are very common in water supplies all over the world.These cysts are particularly worrying because:

- They can be found in human and animal faeces, so it is relatively easy for them to find their way into water supplies.
- They have a low infective dose. In other words, you do not have to ingest many cysts to become ill.
- They can cause problems of the stomach and digestive tract, including potentially life-threatening diarrhoea.
- They are resistant to chlorine and other chemicals, so traditional water treatment methods are not sufficient to guard against them.
- They can survive for long periods in the environment.

The simplest and best way to get rid of cysts is by using absolute filtration of less than 1 micron (1 thousandth of a millimetre).

Doulton® or **British Berkefeld®** water filters are the ideal solution. Independent testing has shown that they remove >99.999% of Cryptosporidium and Giardia cysts.

Which Filter?
Any **Doulton®** or **British Berkefeld®** filter All our filters have Absolute filtration ratings (defined as >99.99%) of 0.9 microns, which is more than sufficient to remove most cysts.

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CHLORINE (taste & odour) :

In many areas of the world, chlorine is added to mains water in the treatment works in order to disinfect the water and minimise bacteria growth in the water distribution network. Chlorine is extremely effective at killing bacteria, but unfortunately there are a number of drawbacks to its use:

- The dead bacteria are NOT removed from the water. Most people would not like the idea of swallowing large numbers of micro organisms, whether or not they are dead.
- Chlorine can react with organics in the water to produce trihalomethanes (THMs). These are known carcinogens (i.e. they can cause cancer).
- It has an unpleasant taste.

Activated carbon is the best way to remove chlorine. FICL has developed a range of filters which combine the benefits of a ceramic filter with added activated carbon to remove chlorine.

Which Filter?

For mains supplies, use Supercarb™ or Ultracarb™. For gravity filters, use Super Sterasyl™

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RUST & OTHER PARTICLES:

The source of rust particles in water is usually old iron pipe work, which is especially common in places with mains supplies dating back many years.

Other particles of numerous types commonly found in mains water come from the pipes used to transport the water and from the original source. The size and number of these particles depends very much on the nature of the water source and of the water distribution network. Despite the best efforts of the water treatment companies there is likely to be some particulate contamination in mains water, even if it is not visible to the naked eye.

Independent testing has verified that **Doulton®** or **British Berkefeld®** water filters effectively remove >99.99% of particulate; that is, 0.9 microns or larger, and 99.9% of particulate in the range of 0.5 to 0.8 microns is reduced. For water with heavy particle contamination, a pre-filter should be fitted before the ceramic filter. This will prevent premature clogging of the ceramic filter.

Which Filter?
Any **Doulton®** or **British Berkefeld®** filter. All our filters have Absolute filtration ratings (defined as >99.99%) of 0.9 microns, which is more than sufficient to remove particles of all kinds.

For water with a very high concentration of large particles a 5 micron pre-filter is also available from FICL and can be fitted in series with the ceramic filter.

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LEAD:

The very harmful effects of lead especially for children and pregnant women are well known. It can cause mental and physical retardation, behavioural problems, and learning difficulties in children. In adults, too much lead can cause high blood pressure, strokes, and heart disease. In men it can adversely affect sperm counts.

Lead does not tend to be present naturally in water supplies. It leaches into water from lead pipes in older houses, and from lead solder used to join other types of metal pipes in newer houses. Even very small quantities are harmful.

Which Filter?
Ultracarb™. Ultracarb™ filters contain a special ion exchange resin which specifically removes lead.

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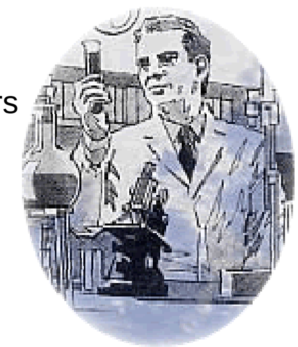
FILTER MANUFACTURES

DOULTON

- **Doulton** ceramic water filters have been continually manufactured for over 170 years. The first water filters were manufactured in the early 1800's at Doulton & Co.'s Lambeth works on the banks of the River Thames. At that time Cholera outbreaks were a common occurrence and Doulton water filters soon began to play a vital role in controlling this disease.

  The early innovation associated with the Doulton name has continued well into the twenty first century with an increasingly sophisticated range of water filtration products being developed to meet the needs of modern water purification systems.

  Doulton ceramic water filters provide clean, safe and affordable wholesome drinking water for residential, industrial and institutional use - for travel and marine purposes, disasters and emergency situations.



  Doulton ceramic water filtration element exceeds US Public Health CDC/EPA guidance on drinking water for people with severely weakened immune systems. Far exceed EPA three log cysts removal standard.

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N.J. Butler, M.Sc., F.I.Biol., A.I.F.ST. -- tested the Royal Doulton ceramic filtration element for bacteria removal efficiency, and stated: "*Providing the physical integrity of the filter elements is intact these can be used to produce sterilized water.*"

Absolute (defined as >99.99%) filtration rating	0.9 micron
Nominal (defined as >99.9%) filtration reating	0.5 to 0.8 micron
E.coli bacteria	>99.99%
Salmonella Typhi (Typhoid)	>99.999%
Vibrio Cholerae (Cholera)	>99.99%
Klebsiella Terrigena	>99.999%
Shigella disinteriae	>99.999%
Cryptosporidium	>99.999%
Giardia	>99.999%

This data, from tests conducted by independent laboratories, demonstrates the removal capabilities of Doulton's ceramic purification element. This does not imply that these contaminants are present in individual water supplies.

It should be clearly understood that the concentration of bacteria fed to the filtration element is artificially high in order to simulate a challenging test for the ceramic element. The most aggressive "real life" condition would normally be at least 1000 times less severe.

Professor A. Dodin, a scientist at the prestigious Institute Pasteur, tested the Doulton filtration element against cholera and other pathogenic bacteria and stated: " *The Doulton filtration element is excellent for the prevention of bacterial contamination."*

PERFORMACE OF THE VARIOUS DOULTON FILTERS

http://www.faireydrinkingwaterfilters.com/images/performance/table.pdf

- **KATADYNE**

The following is from the KATADYNE web site:
http://www.katadyn.com/brands-products/katadyn/tab/product-categories.html

Katadyn is a Swiss company and the global Number One when it comes to individualized water purification systems and products. We have been developing water filters, chlorine- and silver-based sterilization agents and mobile desalinators for travel, outdoor, camping and marine applications since 1928. Numerous armed forces and relief organisations around the world use our products for survival and life-saving.

Katadyn Filters

Endurance Series

Endurance Series products from Katadyn offer ultimate reliability and durability. Highest quality construction allows use in extreme conditions. These products offer maximum water capacity and produce up to 100 times more water than standard water filters.

- Expeditions, camps and professional use
- Ultimate reliability and durability
- Perfect for 1–4 persons
- Also for extremely turbid water
- Very high filter capacity and product life

Backcountry Series

Backcountry Series products from Katadyn are ideal for camping, backpacking and trekking. They are lightweight, compact and the easiest way to make safe water. Backcountry Series products are the favourite choice for all-around use.

- Camping, trekking and backpacking
- Great for all-around use
- Perfect for 1–2 persons
- For clear and slightly turbid water
- From huts to camp grounds

Ultralight Series

Ultralight Series products from Katadyn are the lightest water systems available on the market. They are designed for solo use and perfect for business trips, in hotels or at sports.

- Weekend trips, day excursions and travel
- Light solo use
- Perfect for one person
- For clear water
- In the outdoors or at hotels

•

Katadyn Micropur

The World Health Organisation (WHO) attributes 80% of all travel diseases to drinking water. It is advisable to always use Micropur as a precaution.

Micropur can be used by itself with clear water, or in combination with a Katadyn filter in turbid water. Micropur Forte eliminates bacteria and viruses, which can occur in hotel tap water and public fountains. Reaction time: 30 minutes.

Katadyn Desalinators

Katadyn Desalinators

Katadyn is a leading manufacturer of efficient and convenient water desalination systems. On your voyage, fresh water is one of the few things you will absolutely need every single day. The freedom to make your own fresh water anytime will make a significant improvement to your cruising lifestyle. Katadyn marine products – compact, simple and durable – will satisfy the most demanding mariners.

- **Sand Filters**
  - PROS:
    - Used successfully in third world countries
    - Can get rid organisms if setup correctly
    - Used in third world countries
  - CONS:
    - Heavy, large
    -

- **Earth Filters**
  - PROS:
    - Can be used to filter out radiation
  - CONS:
    - Heavy, large
    - No testing results have been found
-
- **KATADYN Filters**
  - PROS:
    - Can be used to filter out radiation
  - CONS:
    - Heavy, large
    - No testing results have been found

Types of Filtering Process

Gravity Fed:

- TYPES:
  - Most gravity fed filter systems can be put on a counter top. It consists of two chambers, one which holds the dirty water and in which the filter resides. The second chamber receives the water from the first one. This is the slowest type of gravity fed system.
  - A water container (bucket) placed at an elevated location … top of the stairs, top of a car, on a hill … and then siphoned down to a set of filters which then empties into a clean water container. The flow through will increase the high the dirty water container is in regards to the filters.
- PROS:
  - These can put these on your kitchen counters
  - Come in a variety of sizes
  - Normally utilizes a ceramic/carbon filter
  - Can be made out of two 5 gallon buckets and just the filters.
  - Counter top filters are the slowest, however if you can place the water container with the dirty water in a higher location and have it feed into filters down below, the water through put is greatly increased.
  - There are additional filter cartridges that are now available that treat arsenic and fluoride. These attach to the bottom of the ceramic filters.

- CONS:
  - Take up space on your counter
  - Very slow flow through. It takes several hours for it to filter several gallons.
  - Can be very expensive if you buy the metal ones.
  - Some manufactures of the filters make unsubstantiated claims about the life of their filters and what they can filter out. BUYER BE WARE !!

-

Pressure Fed (faucet) :

- TYPES:
  - Counter top housings that connect directly to the faucet.
  - Under the counter housings which are connected directly to the water line.
- PROS:
  - Greatest water flow of all various water fed options.
  - Can have as many different types of filters as you want, a ceramic, a carbon, one for fluoride, one for arsenic, etc. … just add an additional filter housing with the filter you want.
  - Is used for all your daily drinking/cooking needs.
  - Saves money over buying your bottled water. Just refill your water bottles.

- CONS:
  - Only faucet mounted ones are portable in case of an emergency.
  - Have to remember to clean the ceramic ones and replace the other ones on a periodic basis.
  -

Hand Pump Fed:

- TYPES:
  - GrandpaDave.com has one that utilizes a regular garden sprayer. You simply connect the sprayer to the water filter housings., then fill the sprayer with the dirty water, pump the handle and instant filtered water is available.
  - Katadyne – hand pump filters are designed for low volume output such as needed in camping and hiking.
- PROS:
  - Portable. Take anywhere you go and filter any water.
  - Can satisfy your immediate water needs in cases of emergency
  -
- CONS:
  - The Sprayer only holds about a gallon of water (you can purchase bigger sprayers).
  - As the water flows through, the pressure decreases causing a decrease in water flow so you have to pump again.
  - For older people or those with disabilities, this type of filter may be hard to use.
  - Katadyne pumps are limited to the type of ceramic/charcoal filters they supply. You cannot add on additional filters.

Pour-through (portable filters)

- TYPES
  - Then there are pour-through (portable) filters. These are used effectively to remove **contaminants** from water on recreational vehicles, on boats or at campsites. However, in this case, you have to make sure that the water started with is suitable for drinking (potable water). Water poured through the filter flows into a container, is collected and consumed. This is the simplest form of all carbon filters, especially if it is the non-powered variety. There also exist models that are powered and operate on a 115-volt current; there are some others that operate on a 12-volt line or battery. The rate of filtration in the units that are powered is much higher when

compared to the non-powered filters. Some of those operating on a 12-volt battery can filter up to 1-1/4 gallons (4.7 liters) in two minutes.

- PROS
  - Portable, easy to use
- CONS
  - Can only filter out certain elements
  - More costly than other methods.

Purified Water

Purified water is water that has been treated so that the smallest of viruses and other things are killed off. There are several ways to purify water.

Ultraviolet

Ultraviolet radiation treatment is very effective for inactivating cysts as long as the water is not cloudy. Viruses and cysts can hide behind particles in the water so that the ultraviolet rays can't reach them. As such, they are still in the water. Ultraviolet radiation does not leave any residual disinfectant in the water.

The following is taken from the web site: **http://www.ultraviolet-light.com/**

Principles of UV Disinfection

In a typical UV system, approximately 95 percent of the radiation passes through a special quartz glass sleeve and into the untreated water that flows in a thin film over the lamp. The glass sleeve keeps the lamp at an ideal temperature of 104 °F. UV radiation affects microorganisms by altering the DNA in the cells and impeding reproduction. UV treatment does not remove organisms from the water, it merely inactivates them. The effectiveness of this process is related to exposure time and lamp intensity as well as general water quality parameters. Since lamp intensity decreases over time with use, lamp replacement is a key maintenance consideration with **UV disinfection**. In addition, UV systems should be equipped with a warning device to alert the owner when lamp intensity falls below the germicidal range.

Used alone, **UV radiation** does not improve the taste, odor, or clarity of water. UV light is a very effective disinfectant, although the disinfection can only occur inside the unit. There is no residual disinfection in the water to inactivate bacteria that may survive or may be introduced after the water passes by the light source. The percentage of microorganisms destroyed depends on the intensity of the UV light and the contact time. If material builds up on the glass sleeve, the light intensity and the effectiveness of treatment are reduced.

Either **sediment filtration** or activated carbon filtration should take place before water passes through the unit. Particulate matter, color, and turbidity affect the transmission of light to the microorganisms and must be removed for successful disinfection.

UV is often the last device in a treatment train (a series of treatment devices), following **reverse osmosis**, **water softening**, or **filtration**. The UV unit should be located as close as possible to the point-of-use since any part of the plumbing system could be contaminated with bacteria. It is recommended that the entire plumbing system be disinfected with chlorine prior to initial use of a UV system.

How Does Ultra Violet Disinfection Work?

Some essentials of operation of **Ultra Violet disinfection** must be understood to appreciate its effectiveness. In a typical ultra violet system, approximately 95 percent of the radiation passes through a special quartz glass sleeve and into the untreated water that flows in a thin film over the lamp. The lamp is maintained at an ideal temperature of 104 ℉ by the glass sleeve. Now what does the Ultra Violet radiation achieve? It basically affects alters the DNA in the cells of these microorganisms and thereby impedes their reproduction. Please keep in mind that Ultra Violet treatment it merely inactivates organisms and does not remove from the water.

Therefore, effectiveness of this process is directly dependent related to the lamp intensity, the exposure time of the organisms to the radiation and the general water quality parameters. Since we know that the intensity of the lamp decreases with time and usage; it is imperative that lamps are periodically replaced as a key maintenance consideration with respect to ultra violet disinfection. It is a great idea to see that the ultra violet systems being procured is equipped with a warning device to alert the owner when lamp intensity falls below the germicidal range. This would ensure that you replace the lamp before intensity deteriorates to unacceptable levels.

It has been proven that **Ultra Violet light** is a very effective disinfectant despite the fact that the disinfection can only occur inside the unit. Its drawback is that there is no residual disinfection in the water to inactivate bacteria that may survive or may be introduced after the water passes by the light source. When it is used independently, ultra violet radiation does not alter, change or improve the taste, odor, or clarity of the water. The percentage of microorganisms destroyed controls the level of disinfection that takes place and this is directly dependent on the intensity of the ultra violet light and the contact time that the water has with the radiation. If some material builds up on the glass sleeve and the intensity of the radiation reduces this adversely impinges on the effectiveness of the treatment.

For a more complete treatment, it is advised that either sediment filtration or activated carbon filtration should take place before water passes through an ultra violet treatment unit. Usage of sediment filtration or activated carbon filtration would ensure that particulate matter, color, and turbidity - factors that affect the transmission of light to the microorganisms - are removed before ultra violet treatment is applied for successful disinfection.

Since there is nil residual **disinfectant** after usage of ultra violet treatment, it is advised that this should be used close as possible to the point of use as possible. This is to obviate the fact that any part of the plumbing system could be contaminated with bacteria and usage of water that is passing through a plumbing system after ultra violet treatment defeats the very purpose for which it was established. Most often, this is the last device in a treatment train (which is a series of treatment devices), and could be used following treatments such as reverse osmosis, water softening, or filtration. Another safety measure to be adopted could be disinfection of the entire plumbing system with chlorine prior to initial use of an Ultra Violet system.

Capacity of Ultra Violet Disinfection Systems

The capacities of **Ultra Violet Treatment** Systems vary from 0.5 gallons per minute (gpm) to several hundred gpm. This is designed a holistic, in-line, point-of-entry system that treats all the water used in the house. However, there are certain point-of-use devices (treating water from a single tap) that may include ultra violet as a final disinfection method. This is especially used with train systems such as reverse osmosis. The effectiveness of Ultra Violet treatment depends upon intensity of radiation and contact of bacteria with radiation. To ensure that particles are not shielded in the water, pretreatment to remove turbidity may be required. While the **Ultra Violet treatment** system is very effective, it has an upper limit to the number of bacteria that can be treated. An upper limit for ultra violet disinfection is 1,000 total coliforms/100 mL water or 100 fecal coliforms/100 mL.

To summarize, Ultra Violet Radiation Treatment System for water purification is an effective system. System effectiveness is dependent on the intensity of the lamp and this must be ensured with periodic cleaning/replacement. The system is best used at the point of use after a pre filtration such as carbon filtration and reverse osmosis.

Ultra Violet Disinfection : Uses

Scientifically it has been established that ultra violet radiation has disinfection properties that inactivate bacteria, viruses and some other microorganisms. **Ultra Violet** does nothing for cysts and worms. It does not effectively treat Giardia lamblia or Cryptosporidium cysts. These need to be removed from water by the process of filtration.

Another few cases in which the process of ultra violet for disinfection is not recommended is if the untreated water contains very high levels of coliform (this is the indicator organism that is the basis for bacteriological water tests), or if there is substantial color or turbidity (cloudiness) in the water. This is because for the required effectiveness, the light intensity of ultra must reaches the organism in question. Therefore, there should be nothing present in the water that would shields and protect the organism from radiation.

When considering for household usage, ultra violet treatment offers a great option especially if it is being used as a second stage for chlorinated water from a public supply. This is especially applicable when the home has a treatment device like an activated carbon filter which removes chlorine and thus allows bacterial growth. These are the cases where **ultra violet** would provide a final disinfection of the water supply and make it absolutely pure for consumption.

Boiling Water

- Boiling water will kill most types of disease-causing organisms and is the most reliable method of purifying water easily. Bring the water to a rolling boil for two minutes. Add one minute for each 5,000 feet of elevation. Let it cool. If it tastes flat, pour it back and forth between containers several times to add air to the mix which will improve the taste. You may also add a pinch of salt for each quart/liter. Boiling will not remove toxins. Boiling can be a problem if fuel is either not available or too costly to use.

Distillation

- Distillation involves boiling water and then collecting the condensation. This will remove salt and other solid impurities. It is relatively inefficient and time consuming but is a good means of water purification.

http://www.ag.ndsu.edu/pubs/h2oqual/watsys/ae1032w.htm

What impurities will distillers remove?

The distillation process removes almost all impurities from water. Distillers are commonly used for removing nitrate, bacteria, sodium, hardness, dissolved solids, most organic compounds, heavy metals, and radionucleides from water. Distillers remove about 99.5 percent of the impurities from the original water.

What impurities are not removed?

Distillers can allow 0.3 to 0.5 percent of water impurities to exist in the storage container after distilling.

Some volatile organic contaminants (VOCs), certain pesticides and volatile solvents, boil at temperatures very close to water (207-218 degrees Fahrenheit). These types of contaminants will not be substantially reduced in concentration by distillation. Properly equipped distillers can reduce VOC concentrations effectively.

Although bacteria are removed by distillation, they may recolonize on the cooling coils during inactive periods.

Water Testing

Before you buy a water treatment unit, you should know what impurities are in your water supply. To determine the types and amounts of impurities in your water, you should have it analyzed by a certified laboratory. The results of the water test will help determine the best water treatment system to use.

If you obtain water from a private water supply (you supply your own water), you also make the final decision about water testing. However, it is recommended that testing be done on a regular basis. When problems do occur, more frequent testing may be required until a solution is found.

Community water supplies are monitored and treated to protect users from health threatening water impurities. Ask your water supplier for a copy of the latest water test results.

The Distillation Process

Distillers use heat to boil water into steam which is condensed back into water and collected in a purer form. When water boils, it leaves impurities behind in the boiling chamber. The rising steam passes into a cooling section and condenses back into a liquid. The condensed liquid (water) then flows into a storage container (Figure 1). Distillers remove almost all of the impurities from water supplies. As water is heated the impurities in the boiling chamber increase in concentration. The water left behind in the boiling chamber is discarded and the process is started over.

Distilled water has a bland taste, because the dissolved minerals that give water a pleasing taste have been removed. Distilled water should be stored under sanitary conditions in plastic, glass or stainless steel containers.

Household distillers are designed for providing water for drinking and cooking. It is not economical to distill water for other uses like flushing toilets, bathing, washing clothes, and cleaning.

Types of Distillation Equipment

Distillers are commonly made of stainless steel, aluminum, and plastic materials. These materials do not absorb impurities from water and are easy to clean.

There are two types of distillers: batch units and continuous flow units (Figures 2 & 3).

Batch Distillers: Water is poured directly into the boiling chamber. The unit is turned on and the water is heated to boiling. When all the water in the boiling chamber is evaporated, the unit shuts off. Distilled water is removed from the storage container for household use. Batch units can range from 1gallon countertop units to 10gallon floor units. Batch distillers produce from 3 to 10 gallons of distilled water per day. The smallest distillers are about the same size as a coffee maker.

Continuous flow units: Continuous flow or automatic units are connected to the water supply line. The water level in the boiling chamber is maintained by a float valve connected to the water supply. As distilled water is removed from the storage tank, the unit turns itself on and starts producing more distilled water. A discharge line periodically removes the concentrated impurities from the boiling chamber. Distilled water is either stored in a container or is piped to the use area.

Distiller accessories: Additional storage containers, transfer pumps and special kitchen taps can be installed adjacent to a distiller. Increased storage capacity will only be advantagous for continuous flow units. For example, you can install a kitchen tap and an under-the-sink reserve tank that has a level switch to turn on a small transfer pump. This pump transfers water from the distiller to a storage container located under the sink (Figure 4). When the under-the-sink reserve tank empties it turns on the transfer pump to refill the reserve tank. When the distiller's storage tank empties, it turns itself on and fills the storage containers.

How are volatile organic compounds (VOC) removed?

Distillers can remove VOCs by three methods: 1) gas vents, 2) fractional columns and 3) activated carbon filters (ACF). Distillers that use a combination of VOC removal methods are more efficient than one single method.

Gas vents are small holes drilled into the passage leading to the cooling coils. Gas vents allow VOCs to escape the distiller before they enter the cooling section coils. These holes (one or two) are usually from .045 inches to .065 inches in diameter.

Fractional column distillers (Figure 5) use differential cooling to remove VOCs. VOCs are removed when they condense in a different section of the fractional column than where water does. Fractional distillers usually cost more than distillers with gas vents or ACF cartridges.

Activated carbon filters (ACF) trap VOCs (refer to Activated Carbon Filtration in the Treatment Systems for Household Water Supplies Series). The ACF units are normally located at the end of the cooling coils and remove the VOCs prior to entering the distilled water storage container. ACFs can also be placed in the water supply line to reduce VOCs entering a distiller.

Removal of VOCs in distillers without gas vents, fractional columns or ACFs can also be accomplished with some success by discarding the first pint (1/2 liter) of distilled water in the storage container.

Proper Maintenance

Minerals and other residues accumulate in the boiling chamber as water is boiled away. These minerals and compounds need to be removed occasionally. The boiling chamber of a distiller should be emptied about once a week. When distillation is continuous, the boiling chamber should be emptied more often. If these materials (scale and sediment) are not removed periodically, a distiller becomes inefficient.

Mineral scale buildup from hard water can be difficult to remove without the use of an acid-type cleaner. Commercial cleaning agents are available. The cleaners usually contain sulfamic acid or other organic acids. DO NOT use strong mineral acids like hydrochloric, sulfuric or nitric to clean distillers. Strong acids can damage stainless steel and aluminum. Check the owners manual or consult your local distiller dealer for the appropriate cleaner to use.

To remove the scale buildup from a distiller, fill the distiller with the proper acid mixture to approximately 1/2 inch above the mineral line. Let the acid solution sit for the proper amount of time, then discard and rinse.

An alternative cleaning agent is vinegar because it contains acetic acid, a weak organic acid. Pour a 50 percent solution of vinegar into the distiller to about 1/2 inch above the top of the mineral line. Let the unit sit over night, then discard and rinse. If mineral scale is still present, increase the vinegar concentration or cleaning time.

Other regular maintenance duties may include replacing the ACF cartridge and keeping the gas vent holes free of mineral deposits. These steps are necessary to ensure that distillation units equipped to remove VOCs will effectively perform that function.

Lifespan: The lifespan of any distiller depends on the levels of impurities in the raw water supply, how often the distiller operates, and how often the distiller is cleaned. A good distiller should last 10 to 15 years with proper maintenance and routine cleaning. The most common repair for distillers is replacing a heating element or a cooling fan.

Cost of Distillation

Equipment Purchase Price

Distillers cost from $200 to $1500 for home use models. Counter top distillers will range from $200 to $500 and automatic models from $600 to $1500. In addition to the purchase cost, there are yearly operation costs. These include electricity, chemical cleaners, and possibly replacement ACFs. Yearly operation costs depend on how often a distiller is used.

Examples of purchase cost:

For about $250, you can purchase a 5 quart batch unit (about the same size as a coffee maker). Five quarts of raw water are poured into the boiling chamber. The unit is plugged in, and the distillation process starts. Distilled water is stored in an external plastic container. The unit shuts off automatically when the boiling chamber is empty. It has a maximum output of 4 gallons per day.

For about $1200, you can purchase a 10-gallon per day continuous flow unit with a 4-gallon storage container. When water is removed from the storage container, the unit refills the boiling chamber and begins distilling. The unit shuts off when the storage container is filled. Typical dimensions of this system are about 3 feet high by 2 feet wide by 1.5 feet deep.

Operation Costs

Distiller operation costs are directly related to the amount of distilled water you will use daily. The largest operation cost is electricity. Small batch distillers range from .25 to .30 gallons per kilowatt-hour (gal/KWH) and larger automatic continuous flow distillers range from .30 to .34 gal/KWH.

The electrical cost is easy to calculate:

$$\text{Cost} = 0.024 \times \frac{\text{Wattage of unit}}{\text{Production (gal/day)}} \times \text{Cost of electricity (\$/KWH)}$$

or

$$\text{Cost} = \frac{\text{Wattage of unit}}{1000} \times \text{time to distill 1 gallon (hrs)} \times \text{cost of electricity (\$/KWH)}$$

For Example:

1100 watt distiller produces 8 gal/day (3hr/gal)
and electricity costs $0.10/KWH

$$\text{cost} = 0.024 \times \frac{1100}{8} \times 0.10 = \$0.33/\text{gal or (33 cents/gal)}$$

or

$$\text{cost} = \frac{1100}{1000} \times 3 \times 0.10 = \$0.33/\text{gal}$$

Typical electrical cost for a family of four will range from $275 to $400 per year (or $22 to $34 per month), because the average family of four uses 3 gallons/day (1100 gallons/year) of water for drinking and cooking. Consult the owners manual or check with a dealer for the cost of a ACF cartridge replacement for a particular distiller. Cleaning cost increases with increased distiller operation.

Total Cost over the life span of a distiller

The total cost of running a distiller includes the purchase price (or rental cost) and cost of operation (electricity and maintenance cost). Typical operational costs range from $0.35 per gallon to $0.50 per gallon. Bottled distilled water, in comparison, costs from $0.30 to $1.50. Based on the example below, it will cost an average family of four $38.60 per month for distilled water or $456.50 per year.

Example of Total cost of distilled water per gallon:

Lets assume for $800 you could purchase a 1100 watt distiller that would last 10 years at full production of 8 gallons/day and electricity costs $0.10/KWH. How much will a gallon of distilled water cost?

Cost assumptions:
electricity = $0.10 / KWH
repairs & cleaning = 10% of purchase price/year
10 year life span
1100 watt unit produces 8 gal/day
purchase price = $800

Total cost per gallon over ten years
Purchase price
$800/8(gal/day)/365(days/year)/10years = $0.027/gal
(based on continuous operation)

Electricity
1100wt/1000(wt/KWH) X 3(hr/gal) X $0.10KWH = $0.33 /gal
Repairs & Cleaning

$800 X 0.10/8(gal/day)/365(days/year)
(annual cost = 10% of purchase price) = $0.027/gal
TOTAL $0.384/gal
(38.4 cents/gal)

A typical distiller might realistically only run 60 to 70 percent of the time. The above total cost per gallon was figured at full production. If the distiller ran 70 percent of the time, the cost per gallon would increase by $0.0314 per gallon. The distiller idle time varies with how much distilled water is needed by the user. Based on the example above, it will cost a typical family $38.60 per month ($456.50 per year) for distilled water.

What are the advantages of distillers?

Distillers remove almost all of the impurities found in water, produce sodium free water, and are relatively easy to maintain. Most distillers are mechanically simple.

What are the disadvantages of distillers?

Distillers have small capacities and use considerable energy to process water. Because of the small capacities, distillers are limited to point-of-use systems. Distillers without gas vents, fractional columns, or ACF units will not remove VOCs. Heat generated by a distiller must be dissipated into the surrounding environment.

Items to consider when purchasing a distiller

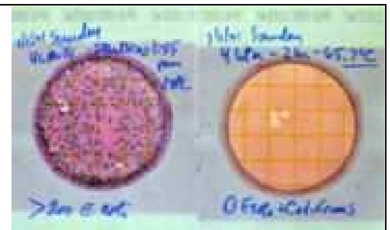
- Test your water for impurities. A distiller might not be the best treatment alternative.
- How much distilled water does your household need? (per day, per year)
- What type of distillers will fit into your needs?

- How easy is the distiller to clean and/or repair?
- What type of convenience level should a distiller offer? (manual or automatic operation)
- What will you do with the by-products of distillers -- waste water, waste heat, old ACF cartridges?
- Is it designed to remove VOCs? Some distillers are designed to remove VOCs but many are not.
- What is the cost of maintenance?
- Purchase price does not directly indicate a distiller's performance. A moderately priced unit might work as well as expensive units.
- Don't buy more equipment than you need.
- Choose a reputable dealer -- Get guarantees in writing and read them thoroughly.
- Beware of advertising that is too good to be true.
- Equipment should carry UL and NSF or AWQA approval.

Pasteurizing Water

Most people think you must boil water in order to kill off the bad organisms. However, after searching on the internet I found an alternative … Pasteurizing Water using solar technology. Not only does this not use valuable fuel as when boiling, but it can be accomplished just by using the properties of the sun.

This is The following information is from a web site called:
http://solarcooking.wikia.com/wiki/Water_pasteurization



E. coli bacteria (left plate) thrive in water sources, but are easily through solar water pasteurization (right plate)

"Millions of people become sick each year from drinking contaminated water. Children are especially susceptible. An estimated 1.5 billion cases of diarrhea occur each year, resulting in the death of nearly 2 million children. Worldwide, about 1.3 billion people do not have access to safe drinking water, including nearly half the population of sub-Sahara Africa. Yet, in many of the most severely effected regions, sunshine is an abundant source of energy that not only can cook food, but can also heat water to temperatures that kill harmful microbes, making water safe to drink. This procedure is called solar **water pasteurization**.

It has been known since the late 1880s, when Louis Pasteur conducted groundbreaking research on bacteria, that heat can kill pathogenic (disease-causing) microbes. Most people know that contaminated water can be made safe by boiling. What is not well known is that contaminated water can be pasteurized at temperatures well below boiling, as can milk, which is commonly pasteurized at **71°C (160°F) for 15 seconds**.

The chart below indicates the temperatures at which the most common waterborne pathogens are rapidly killed, thus resulting in at least 90 percent of the microbes becoming inactivated in one minute at the given temperature. (The 90 percent reduction is an indicator frequently used to express the heat sensitivity of various microbes.) Thus, five minutes at this temperature would cause at least a 99.999 percent (5 log) reduction in viable microbes capable of causing disease. "

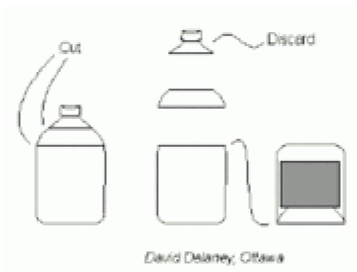
Microbe	**Killed Rapidly At**
Worms, Protozoa cysts *(Giardia, Cryptosporidium, Entamoeba)*	55°C (131°F)
Bacteria *(V. cholerae, E. coli, Shigella, Salmonella typhi),* Rotavirus	60°C (140°F)
Hepatitis A virus	65°C (149°F)

(Significant inactivation of these microbes actually starts at about 5°C (9°F) below these temperatures, although it may take a couple of minutes at the lower temperature to obtain 90 percent inactivation.)

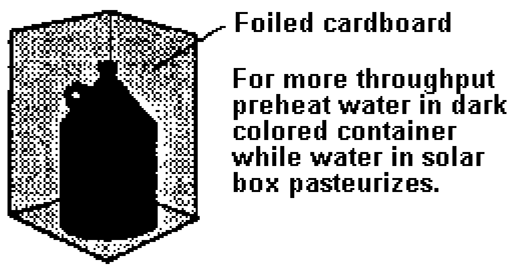
Pasteurizing water in a solar cooker

A standard solar cooker can be used to pasteurize water by simply replacing the food to be cooked with the water to be heated.

Other simple solar pasteurization devices



A pasteurizer made from a large plastic jug



How is pasteurization accomplished?

Traditional fuels can be used to pasteurize water, but on sunny days solar energy can be used as well. Simple solar cookers can pasteurize water for a family at a rate of about one liter per hour. Solar Cookers International's reusable water pasteurization indicator (WAPI) can be used to determine when water heated by solar or conventional means has been heated to a high enough temperature to make it safe.

Don't you need to boil water for 20 minutes to sterilize it and make it safe to drink?

No, it is only necessary to heat water to 65°C (149°F) to pasteurize it.

What is the difference between sterilization and pasteurization?

Sterilization kills all of the organisms in the water, while pasteurization kills only those organisms that can cause harm to humans.

What common disease organisms are killed by pasteurizing water?

Guardia, cryptosporidium, endameba, the eggs of worms, cholera, shigella, salmonella bacteria and those that cause typhoid, the enterotoxogenic strains of E. Coli, Hepatitis A, and also rotavirus which is a major cause of disease in children are all killed or inactivated at 65°C. "

Here is another web site which talks about this subject:
http://almashriq.hiof.no/lebanon/600/610/614/solar-water/idrc/

Chemicals

- o Chemical disinfection methods are somewhat effective. This method may not kill the cysts caused by some organisms which can be disease causing (Giardia and Cryptosporidium, for example). The two primary chemicals used to treat water are **chlorine and iodine**. Both are safe with some exceptions noted below. Be aware that the colder the water, the less effective is the chemical treatment. Alternatively, if water is very hot, the chlorine will become volatile and ineffective. Chemical treatment will not remove toxins.

Chlorine

- o **CHLORINE**: This can be used as either the liquid form of common, unscented household bleach or as chlorine dioxide tablets sold in some sporting goods and outdoor supply stores. Chlorine dioxide tablets are effective but need at least 4 hours to work. Do not use scented bleaches, non-chlorine bleaches or bleach which contains detergent. Optimally the bleach should be less than three months old.

  Add the amount shown in the table below, mix it thoroughly, and allow it to stand preferably covered for a least 30 minutes. If the water does not have at least some slight chlorine odor, repeat the dosage and allow it to stand for at least 15 minutes. If the chlorine odor or taste is too strong, allow the water to stand exposed to air or pour back and forth between clean containers to aerate the water which will remove some of the chlorine. Typical household bleaches will be 5.25% available chlorine. The sodium hypochlorite must be at least 4% to purify water. If this is your available bleach, use 8 drops (1/2 tsp) per gallon of clear water or 2-4 drops per quart. Optimally, replace the chlorine liquid bleach every 608 weeks. For other dilutions , use the following chart:
- o

Percent Available **Chlorine**	Drops to be added per Quart/Gallon of Clear Water	Drops per Liter Of **CLEAR** water	Drops per Liter Of **CLOUDY** water
1%	10 per quart 40 per gallon	10	20
4-6%	2 per quart 8 per gallon	2	4
7-10%	1 per quart 4 per gallon	1	2
Unknown	10 per quart 40 per gallon	10	20

http://clorox.com/products/faqs.php?prod_id=clb#faq2

Q. Can Clorox® Regular-Bleach be used to disinfect water?

A. Yes. When boiling of water for 1 minute is not possible in an emergency situation, you can disinfect your drinking water with Clorox® Regular-Bleach as follows:

1. Remove suspended particles by filtering or letting particles settle to the bottom.
2. Pour off clear water into a clean container.

3. Add 8 drops of Clorox® Regular-Bleach (not scented or color-safe) to one gallon of water (2 drops to 1 quart). For cloudy water, use 16 drops per gallon of water (4 drops to 1 quart).
4. Allow the treated water to stand for 30 minutes. Water should have a slight bleach odor. If not, repeat and wait another 15 minutes. The treated water can then be made palatable by pouring it between clean containers several times.

Q. What organisms does Clorox® Regular-Bleach kill?

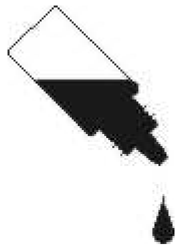
A. ***Bacteria*** *Staphylococcus aureus (Staph.)*
Salmonella choleraesuis
Pseudomonas aeruginosa
Streptococcus pyogenes (Strep.)
Escherichia coli O157:H7 (E. coli)
Shigella dysenteriae

Fungi
Trichophyton mentagrophytes (can cause Athlete's Foot)
Candida albicans (a yeast)

Viruses
Rhinovirus Type 37 (a type of virus that can cause colds)
Influenza A (Flu virus)
Hepatitis A virus
Rotavirus
Respiratory Syncytial Virus (RSV)
*HIV-1 (Human Immunodeficiency Virus)**
Herpes simplex Type 2
Rubella virus
Adenovirus Type 2
Cytomegalovirus

Conversion Chart – Drops to Teaspoons

Here are some conversions that can be useful:

	15 drops = ¼ teaspoon 30 drops = ½ teaspoon 60 drops = 1 teaspoon 180 drops = 1 Tablespoon 360 drops = 1/8 cup which is also equal to 2 Tablespoons 1 drop = 0.05 ml

IODINE

- **IODINE:** Iodine should not be used with those on thyroid medication, lithium medication, pregnant women, those with allergies to iodine or shellfish, or people with active thyroid disease. It appears safe for short term use (3 months) for others. Add the recommended amount, mix it well in the water and let it stand for at least 30 minutes. You can add a small amount of vitamin C 950mg.) to the water to improve the taste or other powered drink flavorings. There are also commercially available iodine tablets in sporting goods or outdoor supply stores. Use them according to directions. Once these bottles are opened, they should be used wit the specified time frame. Iodine has been shown to be more effective than chlorine-based treatments in inactivating Guardia cysts**.**

Type of Iodine	Percent Iodine	Amount/quart or liter/gallon of **CLEAR** water	Amt/quart or Liter/gallon of **CLOUDY** water
Iodine Topical Solution	2%	5 drop qt 20 drops per gallon	10 per quart 40 drops per gallon
Tincture of Iodine	2%	5 drops per quart 20 drops per gallon	10
Povidone-Iodine	10%	8 drops per quart 32 drops per gallon	16

Reverse Osmosis Method

Reverse osmosis is a proven technology that has been used successfully on a commercial basis. One of the better known uses of RO is the removal of salt from seawater. Household RO units typically deliver small amounts (2 to 10 gallons per day) of treated water and waste 3 to 20 times the amount of water treated. Reverse osmosis units remove many inorganic contaminants from household drinking water supplies. The removal effectiveness depends on the contaminant and its concentration, the membrane selected, the water pressure and proper installation. RO units require regular maintenance and monitoring to perform satisfactorily over an extended period of time. Before purchasing an RO unit or any other water treatment equipment, purchasers should test their water to be certain that treatment is needed and that the equipment being selected is appropriate to the problem requiring treatment. All costs need to be considered when comparing competitive systems and when making purchase or rental decisions.

Learn how reverse osmosis works from this article from this web site:
http://www.howstuffworks.com/question29.htm and
http://www.ag.ndsu.edu/pubs/h2oqual/watsys/ae1047w.htm

What impurities will reverse osmosis remove?

Reverse osmosis (RO) has become a common method for the treatment of household drinking water supplies. Effectiveness of RO units depends on initial levels of contamination and water pressure. RO treatment may be used to reduce the levels of:

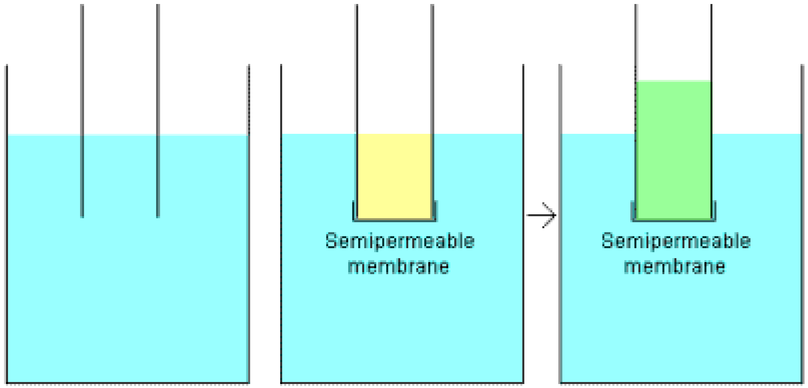
1. Naturally occurring substances that cause water supplies to be unhealthy or unappealing (foul tastes, smells or colors).
2. Substances that have contaminated the water supply resulting in possible adverse health effects or decreased desirability.

RO systems are typically used to reduce the levels of total dissolved solids and suspended matter. The principal uses of reverse osmosis in Minnesota and the Dakotas are for the reduction of high levels of nitrate, sulfate, sodium and total dissolved solids.

RO units with carbon filters may also reduce the level of some SOCs (soluble organic compounds) like pesticides, dioxins and VOCs (volatile organic compounds like chloroform and petrochemicals). An RO unit alone may not be the best solution for these types of contaminants, but installing a properly design-ed RO unit to reduce the levels of other contaminants may provide a reduction in SOCs and VOCs.

How does reverse osmosis work?

To understand "reverse osmosis," it is probably best to start with normal osmosis. According to Merriam-Webster's Collegiate Dictionary, **osmosis** is the "movement of a solvent through a semipermeable membrane (as of a living cell) into a solution of higher solute concentration that tends to equalize the concentrations of solute on the two sides of the membrane." That's a mouthful. To understand what it means, this picture is helpful:



On the left is a beaker filled with water, and a tube has been half-submerged in the water. As you would expect, the water level in the tube is the same as the water level in the beaker. In the middle figure, the end of the tube has been sealed with a "semipermeable membrane" and the tube has been half-filled with a salty solution and submerged. Initially, the level of the salt solution and the water are equal, but over time, something unexpected happens -- the water in the tube actually rises. The rise is attributed to "osmotic pressure."

A **semipermeable membrane** is a membrane that will pass some atoms or molecules but not others. Saran wrap is a membrane, but it is impermeable to almost everything we commonly throw at it. The best common example of a semipermeable membrane would be the lining of your intestines, or a cell wall. Gore-tex is another common semipermeable membrane. Gore-tex fabric contains an extremely thin plastic film into which billions of small **pores** have been cut. The pores are big enough to let water vapor through, but small enough to prevent liquid water from passing (see this page for more information on Gore-tex fabric).

In the figure above, the membrane allows passage of water molecules but not salt molecules. One way to understand **osmotic pressure** would be to think of the water molecules on both sides of the membrane. They are in constant Brownian motion. On the salty side, some of the pores get plugged with salt atoms, but on the pure-water side that does not happen. Therefore, more water passes from the pure-water side to the salty side, as there are more pores on the pure-water side for the water molecules to pass through. The water on the salty side rises until one of two things occurs:

- The salt concentration becomes the same on both sides of the membrane (which isn't going to happen in this case since there is pure water on one side and salty water on the other).
- The water pressure rises as the height of the column of salty water rises, until it is equal to the osmotic pressure. At that point, osmosis will stop.

Osmosis, by the way, is why drinking salty water (like ocean water) will kill you. When you put salty water in your stomach, osmotic pressure begins drawing water out of your body to try to dilute the salt in your stomach. Eventually, you dehydrate and die.

In reverse osmosis, the idea is to use the membrane to act like an extremely fine **filter** to create drinkable water from salty (or otherwise contaminated) water. The salty water is put on one side of the membrane and pressure is applied to stop, and then reverse, the osmotic process. It generally takes a lot of pressure and is fairly slow, but it works.

Disadvantages of reverse osmosis units

RO units use a lot of water !!!!!. **They recover only 5 to 15 percent of the water entering the system.** The remainder is discharged as waste water. Because waste water carries with it the rejected contaminants, methods to re-cover this water are not practical for household systems. Waste water is typically connected to the house drains and will add to the load on the household septic system. An RO unit deliver-ing 5 gallons of treated water per day may discharge 40 to 90 gallons of waste water per day to the septic system.

Filters versus Purifiers.

The difference between filters and purifiers is defined by the EPA: A filter must be capable of **“4 Log"** contaminant reduction, and a purifier must be capable of a **“7 Log"** contaminant reduction. 4 Log (simple filtration) means at least 99.99% of contaminants are removed, leaving no more than 1 part per ten thousand of the original contaminant. This “filtration level" of reduction is sufficient for many conditions. The higher “purification” reduction of **7 Log means that 99.99999%** of contaminants are removed, leaving no more than 1 part per ten million of the original contaminant (1000x the effectiveness of the “filter” specification.) Systems that achieve this"purifier level" of performance provide ultra-pure water not only in normal conditions, but also in circumstances of extreme and highly dangerous contamination. **The products displayed on this page are Berkey® Purifiers** — the highest performing water treatment products available in the world today!

If using a source of water that might contain extreme bacteriological or viral contamination, it is recommended that two drops of plain chlorine or iodine be added to each refill before filtering. This will kill minute pathogens such as viruses. The disinfectant will then be filtered from the water entirely, removing its odor, color and taste.

Manufacturing water purifier and filtration systems has become a huge business in the industrialized countries of our planet. Companies manufacturing water purifier and filtration systems in the U.S. ship them to developing countries. Foreign companies manufacturing water purifier and filtration systems ship them to the U.S.

Some of these water purifier and filtration systems are intended for municipal water treatment, while others are manufactured for home use. All must adhere minimally to the World Health Organization (WHO) guidelines. Companies manufacturing water purifier and filtration systems for use in the U.S. must adhere to EPA and FDA regulations as well.

U.S. government standards from the EPA require two different levels of water “cleaning” for purifier and filtration systems.

*** Filtration Systems:** Any type of water filtration system must remove at least 99.99% of bacteria, chemicals, and other contaminants. Filtration systems must also remove lead and other harmful metals and minerals. This is considered “4 Log” or simple filtration.

*** Purifier Systems:** All water purifier systems must provide “7 Log” reduction of contaminants. If you have “7 Log” contaminant reduction, your purifier has removed 99.99999% of bacteria, chemicals, and other contaminants.

What This Means to You

If you are directly involved in manufacturing water purifier and filtration systems, this means your products all must be of high quality, and will require constant testing to be sure they conform to government standards. Your filtration systems must all remove the proper percentage of contaminants, as must your purifiers. You cannot sell a filtration system and make claims that it purifies water. All must meet EPA requirements.

If you are not directly involved in manufacturing water purifier and filtration systems, the difference between purifiers and filtration systems may seem minimal. It may seem as though it doesn't matter whether you purchase a purifier or a water filtration system. At a glance, removal of 99.99% or 99.99999% of contaminants may not look like a huge difference.

What it means, however, is that a purifier must be one thousand times (1000x) as effective as a filtration system! To put it another way, you have a choice as to how clean you want your water. Are you content to remove just "1 bug" from your water glass, and leave 999 bugs in there? Or would you rather remove "1000 bugs" from your glass of water? Drinking water purifiers must give you super-clean water in even the most highly contaminated and dangerous circumstances.

Challenge to Manufacturers

Our challenge to manufacturers is to make clean water available to all who need it. Manufacturers should be working to reduce the costs of manufacturing water purifier and filtration systems so that they are more readily available in remote areas and undeveloped countries. People in those countries urgently need filtration systems, whereas we in developed countries have very potable water flowing from our municipal water supply. Those in need often cannot afford clean water, though, given the current costs of manufacturing water purifier and filtration systems.

Manufacturers need to couple their desire for profit to humanitarian compassion, and create ways to provide purifiers, or at least filtration systems, at much lower cost.

 Anna Hart invites you to read more of her articles about water purifiers and filtration systems at http://www.healthydrinkingwaterblog.com Anna has also posted information on that site about solar purifiers. If you want to learn about inexpensive solar drinking water purifiers, you won't want to miss her article on that subject.

The reason for the six-month limitation is that the carbon within the PF-4 filters extracts contaminates that can be nutrients on which bacteria can grow. If the filters are used longer than six months "grow-through" can occur.

The best way to gauge when to replace the filters is to do the following:

1) Keep a track of how many times per week you need to refill your system.

2) Then multiply that figure times the capacity in gallons of your particular system (for example the Berkey light™ system is 2.75 gallons) to determine Total Gallons Used Per Week.

3) Finally divide the Total Gallons Used Per Week into the 1000 gallons and that will tell you how many weeks before the filters should be replaced.

4) Next calculate the future date for replacement (52 weeks per year) and write that date on a sticker and attach it to the bottom of your system for future reference.

By the way, if you have been using your fluoride reduction filters for some time now, you can still use the above formula to determine when to replace the elements. Just count forward from the date you purchased your elements.

What is the life of the PF-4 filters?

Each set of four PF-4 filters is will last for 1,000 gallons or six months whichever comes first. The reason for the six-month limitation is that the carbon within the PF-4 filters extracts contaminates that can be nutrients on which bacteria can grow. If the filters are used longer than six months “grow-through” can occur.

What is the life of the PF-2 filters?

Each set of two PF-2 filters is will last for 1,000 gallons. Since these elements contain pure fluoride and arsenic reduction media and no carbon, there is no six-month limitation rule as is the case with the PF-4 elements.

Water supplies in a PANDEMIC

A reader who must remain anonymous has sent me an important analysis of how we could lose safe water in a pandemic. I've re-paragraphed it for easier online reading. A PDF is available at the end of the post. While it's based on American practice and regulation, I suspect that similar problems face water systems all over the industrial world.

Water Supplies in a Pandemic

I work for a state agency assisting the water supply industry for my state. As such, I have access to water treatment plant operators and an understanding of water supply systems. My purpose in telling you this is to establish credibility.

I am definitely not authorized to speak publicly for my agency. HOWEVER, as a Civil Engineer (Professional Engineer) in the business, and as a private citizen, I've made an analysis that I'd like to share with you.

Obviously, there are lots of concerns about how people might contract ordinary flu and other diseases. Let me discuss a transmission route that is LIKELY to occur in the event of a pandemic: namely the public water supply systems.

The water supply system

First, let me describe the supply system. The source of public drinking water is typically surface streams and reservoirs. There are communities, most often in rural settings, that get their water primarily from wells and springs. But the great majority of cities and towns in the USA get at least a portion of their water from surface sources.

Water is piped to the water treatment plant where the water is held, temporarily, in large ponds. The water is taken into the treatment plant where large materials are screened out and then the water is put through a series of filters. These include flocculation, and sand filters that remove even small particles down to bacteria sizes.

However, viruses are so small they cannot be filtered out. That's one of the main reasons for chlorination, along with killing any residual bacteria. State law requires there be "log 4" reduction in virus count. That is, 1/10, 1/100, 1/1,000 down to 1/10,000 reduction in virus count. And every treatment plant tests the water to determine that the log 4 reduction is being achieved.

Test results are routinely submitted to drinking water regulatory agencies. Sometimes during normal operation, treatment plants cannot conform and are required to take corrective actions to regain compliance. See concluding comments below.

During normal day-to-day operations the raw water (term used for water before treatment) contains all the stuff that is in rivers and reservoirs. This includes bird and animal fecal droppings, as well as dead and decaying plant and animal matter. Not a pretty sight, but that's the way it is.

Now, in the USA these plants operate quite well and every day provide people with clean, non-contaminated drinking water. Pretty amazing when you consider the volumes of water -- billions of gallons per day. When was the last time you heard about a water-borne disease outbreak??

What happens in a pandemic

Anyway, now let's consider what happens to this system during a pandemic.

Obvously, there is a concern for sufficient numbers of qualified personnel to properly operate all aspects of the system from pumps, valves, and filters to the chlorination equipment. But here's the "pandemic kicker". Ducks and geese having the disease (recall they shed the virus in large amounts even before becoming symptomatic) deposit their droppings in the streams, reservoirs, and in the holding pond right outside the treatment plant. And, of course, when they die their contaminated bodies float and decompose in those surface water sources.

In addition, sewage treatment plants quite commonly discharge to streams and thus some levels of human excrement also end up in surface water supplies. This too, is ongoing day-to-day. Quite simply, sewage treatment plants do not remove all pathogens or chemicals. This is the source of pesticides, herbicides, pharmaceuticals, and other "endocrine disruptors".

We all live downstream

Recall the slogan, "we all live downstream". Well, we really do live downstream. So, flu-contaminated human waste is also in the raw water stream that supplies drinking water treatment plants.

Sewage treatment plant effluent is also used in many areas of the country for "water reuse" such as to water golf courses and other "non-contact" (to humans) uses. On a day-to-day basis these human wastes are removed like the other wastes from the drinking water.

So, during a pandemic, the raw water sources contains both bird and human-generated flu virus.

Speaking to the manager of a large water treatment plant, I find the following. During the summer a typical chlorine stockpile for water treatment is no more than one week. Summer means the greatest water demand during June, July and August. The chlorine is delivered to the drinking water via compressed gas bottles. One bank (say 12 cylinders) is on-line while the other bank of 12 is full and waiting to be put on-line. That's a typical hard plumbing hookup. During the winter, when water demand is lower, the bank may last more than one week.

Not if, but when, there is absenteeism at the chlorine generating plant, the chlorine supply will not be there. MAJOR problem! Without chlorine, the flu virus (along with other infectious agents) could be supplied to the public. Unless the water supply is turned off.

To add to credibility of this scenario, I'd direct you to one water supplier, in Denver, that has made plans to prepare for a pandemic scenario. The article makes good reading up until he talks about chlorine, which is beyond his control. These folks have even taken to stockpiling a 30-day supply of chlorine. After that, they face the decision of supplying contaminated water, or shutting off the supply to the public. See the following, which I think I got from your website.
http://www.rockymountainnews.com/drmn/local/article/0,1299,DRMN_15_4626378,00.html

Another pandemic consideration is the length of the flu pandemic. In 12 to 18 months there will be equipment malfunctions in the vast array of equipment throughout the automated system. What breaks and when it breaks could affect the ability to treat the water (water filters through chlorination dispensing) and deliver it (pumps, valves, control systems).

It could be that, after some critical item (or combination of items) breaks, no water will be delivered during a pandemic.

Well, maybe you already knew this stuff. But this supplies some detail of this industry. In my military survival training I learned that water was the most crucial item to life. Recall also that hydration of flu patients is a key item, crucial to their survival. And clean, uncontaminated water could be in seriously short supply to millions of people during a pandemic. Might I suggest individuals seriously consider stockpiling water along with whatever else they do to prepare for a pandemic.

Download water_supply_pandemic.pdf

May 08, 2006 at 05:50 PM | Permalink

Posted by: Name | May 08, 2006 at 06:05 PM

Crawford, Please convey my thanks to your source for providing this information. It is a subject to which I've given great thought.

My family has a private well that is only good as long as we have power. The issues we face are:

1. Assuming a pandemic continues for a prolonged period--and given that you can't survive without water much more than three days, that ain't going to take much--I will not be able to store enough water for my family.

2. I have ruled out a generator to run the well pump as a viable alternative given that I don't believe a fuel supply will be guaranteed.

3. Aside from being expensive, water purification pills can only be used for a maximum of six weeks per the manufacturer.

Taking these things into consideration, I have based my family's water preps on resources that will be available regardless of the degree or scope of a pandemic.

Three things we have in abundance where we live (and where a lot of your readers live, too, I bet) are an abundant supply of surface water, solar energy, and gravity.

I would be interested to know your source's thoughts on my water supply plan as I think it might be helpful to others in my situation.

We will do a combination of rainwater collection and surface water collection.

Because even the roof water we collect will potentially be contaminated with H5N1, all water gathering and handling regardless of source will be done using universal precautions.

Water will first be pasteurized using a solar pasteurizer (available online for about $20) to kill the virus (CIDRAP and other sources say that H5N1 is killed during pasteurization). This is a method used in developing countries around the world to kill other waterborne viruses.

Once the water is pasteurized, we will filter it through a gravity-fed Big Berkey water filter utilizing four Black Berkey filters. According to my research, the Big Berkey filters are used by NGOs the world over in developing countries to remove waterborne bacteria and other contaminants, including heavy metal contaminants from roofing materials and other noxious substances.

(FYI, I am in no way connected to the Big Berkey company or any solar pasteurizer manufacturers, nor do I or anyone I am related to stand to gain financially from the sale of either of these products.)

Aside from H5N1, rainwater and surface water pose multiple other health risks that the *combination* of solar pasteurizing and Big Berkey appear to address.

I stress *combination* in case anyone is reading this thinking they can get away with one or the other. Either method alone is *insufficient* according to my reading and conversations with representatives from various companies.

Again, I'd love to know your source's thoughts on my plan, particularly if s/he thinks it has flaws that could put my family at risk.

I am not including links to the companies from which I purchased my equipment. If your source thinks this plan is viable, I will, with your permission Crawford, post those links to help others who may be interested in learning more about these methods.

Here is a prorotype design for a UV sterilizer for home use that costs about $41. Note, however, that adenoviruses, and so presumably influenza viruses, take the highest dose to kill.

http://rael.berkeley.edu/uvtube/uvtubeproject.htm

Very doable.

Water Purification Using Clorox Bleach - New Information From Red Cross

7-17-2000

Information for anyone who responds to inquiries about water treatment after disasters:

The Red Cross National Headquarters has received inquiries from the public about the fact that the Clorox Company is introducing a new product, **"Clorox Ultra",** which increases the concentration of Sodium Hypochlorite from 5-1/4% to 6%, and adds Sodium Hydroxide to the mix, which has not been in Clorox before. I contacted the Clorox Company for an explanation. Their explanation follows.

Yes, it is true that Clorox is changing the concentration of its regular household laundry bleach from having a 5-1/4% concentration of Sodium Hypochlorite to 6%, and that they have added Sodium Hydroxide to the formula. They are doing this to reduce the size of the containers and in response to market research. They are introducing "Clorox Ultra" slowly across the country, starting in the West and Midwest. It will be on the East Coast by fall. They will completely eliminate offering the "old" Clorox bleach upon introduction of the "new" Clorox Ultra.

However, the Clorox representative stated that the new formula has been tested and is safe to use to treat water at home. The only reason why it has not been approved by the EPA for use is simply that the company has not completed that process yet. (It takes a long, long time for all that paperwork.)

How To Use Chlorox

The recommendation to use for water treatment remains the same:

1. Filter out/remove any solid impurities.

2. Add 16 drops of the bleach per gallon of water and stir. This is the same recommendation for either the 5-1/4% or 6% concentration.

3. Let stand 30 minutes.

4. If it smells slightly of chlorine, you can use it.

5. If it does not smell of chlorine, add another 16 drops and wait another 30 minutes.

6. If it still does not smell of chlorine after two doses, discard it and find other water.

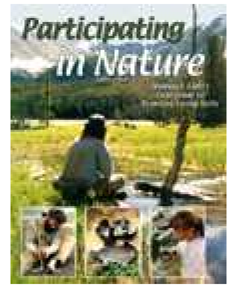
If you have further questions or individuals who contact you with technical questions about Clorox Bleach that you can't answer, let me know, and I can give you the name/number of the Clorox representative to refer these people to.

Sincerely,

Rocky Lopes Community Disaster Education American Red Cross National Headquarters

Iodine & Iodine Crystals for Water Purification

Text adapted from
Participating in Nature:
Thomas J. Elpel's Field Guide to Primitive Living Skills



Iodine can be used in several different forms for water purification: as tablets, liquid, or crystals. **Iodine tablets** are available at most camping supply stores, and they are very effective at killing anything in the water, but they have a short shelf life even when new, and rapidly lose potency after opening. The tablets also give the water a nauseous taste and can be harmful if used over an extended time period. Renee and I only used tablets once. We brought some iodine tablets on our 500 mile walk across Montana. The one time we used them was to flavor the water at Two Dot, Montana because the alkaline town water tasted worse than the iodine tablets!

A 2% tincture of liquid iodine from the drug store, like that used in a first aid kit, can be used as a less expensive alternative to tablets. Just add 8 drops to one quart of water and let it sit for about fifteen minutes before drinking. But make sure it is fresh iodine, since it too has a short shelf life.

The best form of iodine for water purification seems to be **USP-grade resublimed iodine crystals**. The crystals "sublime" from a solid to a gaseous state without passing through a liquid phase in between. A small pinch of iodine crystals (4-8 grams) can be re-used almost indefinitely for water purification.

Water is added to the iodine crystals in a one or two ounce bottle and allowed to sit until the water is saturated with iodine. Warming the bottle against the body or in sunshine will allow the water to hold more iodine. This saturated iodine water (but not the crystals) are then added to your canteen or water bottle. The temperature of the water in the canteen doesn't matter; it can be very warm or ice cold. But wait a good twenty minutes for the iodine to kill everything before you have a drink.

Iodine crystals sound almost like alchemy or a great placebo at first, since the crystals can be re-used indefinitely. But I finally tried it myself, and the treated water certainly had the smell and flavor of water treated with tablets, although it was not nearly as strong. Apparently there is enough iodine in the water to do the job. The difference in taste may be simply that the iodine sublimes into a gaseous state, rather than dissolving into a liquid form. The iodine flavor becomes less and less noticeable the longer the water sits, suggesting that the iodine slowly escapes from the water.

Iodine crystals are nearly inert, but they will evaporate (sublime) into the air if the cap is left off the bottle. They will also completely sublime into water if placed in a large enough volume.

Polar Pure Water Disinfectant

Iodine Crystals Destroy Water-Borne Pathogens

(Including *Giardia* cysts and micro-organisms that pass through filters)

Polar Pure Water Disinfectant uses pure crystallized iodine in a unique delivery system to destroy water-borne pathogens including giardia cysts and micro-organisms (viruses) that pass through filters. Simply add water to your Polar Pure bottle.

Pure iodine crystals are stable and slightly soluble in water but evaporate easily. Keep your Polar Pure bottle filled with water to maintain an iodine-saturated solution and tightly capped to avoid iodine loss.

When used as directed, a saturated iodine solution for disinfection is maintained in the filled Polar Pure bottle. This saturated solution is then used to disinfect your drinking water at an optimal concentration of 4 - 5 ppm iodine per quart/liter of water.

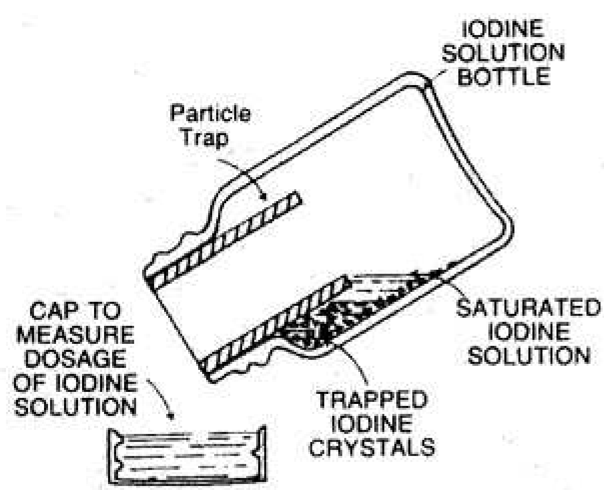
Saturation concentration varies with the solution temperature, but a green dot on the liquid crystal chart on the Polar Pure bottle shows how many capfuls are needed for disinfection.

Polar Pure Water Disinfectant can be used for backpacking, camping, hiking, water sports, bicycling, foreign travel, hunting and fishing, emergency kits. The small size and easy use make Polar Pure the choice of many outdoors enthusiasts and those concerned with emergency preparedness.

- Polar Pure does not deteriorate with extremes in temperature
- has an indefinite shelf life
- is safe and fully effective to use as long as you can see iodine crystals at the bottom of the bottle
- one bottle treats up to 2000 quarts of water at less than 1/2 cent per quart
- dosage chart is printed on the bottle
- bottle cap is used to measure and decant solution -- no other equipment needed
- small size and light weight makes it convenient for backpacking and travel
- essential for emergency preparedness

Directions for Using Polar Pure

Polar Equipment utilizes a unique bottle design featuring a particle trap to prevent loss of iodine crystals during decanting for water treatment. Your bottle cap is used to measure the required amount of Polar Pure for each quart of water.



- Polar Equipment recommends that each person carry his or her own bottle of Polar Pure to ensure sufficient quantities of safe drinking water.
- For proper water disinfection, you must use a water container that can be tightly closed to eliminate possible iodine vaporization.
  Quart or liter sized bottles with screw tops are recommended.

Step One--Prepare the solution: Fill your Polar Pure bottle with water. Set aside. Solution will be ready to use in one hour.

Step Two--Treat your water: When your Polar Pure solution is ready, pour the required capfuls of solution into your quart container(s) of water. A green dot on the DOSAGE TABLE on the bottle of POLAR PURE indicates the amount of solution required for your QUART / LITER of water. Warmer solution will be more saturated so fewer capfuls will be needed.

Temperature of Solution	Capfuls per Quart
95°F (35°C)	1.2
86°F (30°C)	1.3
77°F (25°C)	1.5
68°F (20°C)	2
59°F (15°C)	2.5
50°F (10°C)	3.5
41°F (5°C)	4

Let treated water stand (tightly covered) for 20 minutes before use. Water to be treated that is colder than 68 F will take longer.

Step Three--Refill Your Polar Pure Bottle: Refill your Polar Pure bottle with water and tightly cap. The solution will be ready to use in one hour. It is best to keep your bottle filled and ready to use at all times.

Maximizing the use of Polar Pure

One bottle of Polar Pure is capable of treating between two and six quarts of water at one time before refilling. The amount of Polar Pure needed varies with the solution temperature. Warmer solution will have a higher concentration of iodine and fewer capfuls will be required.

One way to maximize the use of the saturated solution is to warm the bottle of Polar Pure. This can be achieved by warming the bottle against your body, or by placing it in a dry, sunny spot prior to use.

Holding a piece of fabric over the mouth of your quart container when filling with water is recommended to act as a pre-filter blocking large organic particles (bugs, leaves, etc.), thereby increasing the efficiency of Polar Pure.

Eliminating iodine taste / smell: Iodine taste (actually odor, sensed in the nose) is usually unnoticed below 2-3 ppm (parts per million). Any flavoring, sugar, or vitamin C can be added to the water AFTER the necessary disinfection time.

Protect filled bottle of Polar Pure from freezing Once your Polar Pure bottle is filled with water, it is important to avoid freezing. The bottle could crack due to expansion of the liquid inside if frozen. If you are hiking in freezing conditions, keep the bottle in an inside pocket close to your body or with you in your sleeping bag. **The effectiveness Polar Pure is not altered by freezing.** When not in use, store your bottle of Polar Pure where it will not freeze between uses. You may empty the bottle between uses if you prefer. Emptying the bottle is not necessary and it is best to have it filled and ready to use when needed. Some liquid will be retained in the bottle when emptied.

Polar Pure Water Disinfectant

Owner Review by Rick Allnutt

Product information

Manufacturer: Polar Equipment
Purchased in February 2003, Reviewed July 2003
Manufacturer Web Site: Polar Equipment
Listed weight: 3 oz (85 g)
Weight as measured: (with water added) 4.8 oz (136 g)
(measured in grams, calculated in ounces)

Field information

Tested on 12 day hikes, two overnight trips in Ohio, and 2 section hikes of the Appalachian Trail totaling 8 nights. Day hikes were in several Ohio state parks during the winter of 2003. Overnight trips were at Zalinski State Forest. The Appalachian Trail sections were from Hot Springs, NC to Erwin, TN and from Waynesboro, VA to Montebello, VA. Temperatures ranged from 30 F (minus 1.1 C) to 92 F (33.3 C).

Review

Polar Pure consists of a dark glass bottle with about thirty small beads of crystalline iodine inside the bottle The glass is thick and very strong. The dimensions of the bottle include a diameter of 1.5 in (3.8 cm) and a height of 3 in (7.6 cm). The opening of the bottle has been modified with a short piece of tube, whose diameter slides into the mouth of the glass bottle. The tube is glued into the opening so that when poured, the crystals of iodine remain in the bottle, while much of the liquid can be poured out.

The bottle has directions printed on the outside surface, and several spots of thermal reactive paint which act as a thermometer to show the temperature of the bottle. Knowing the temperature is essential in determining how much liquid to pour from the bottle into water which needs to be disinfected.

When I bought the bottle it was empty of liquid. I filled it with tap water. The directions say to let the water be in contact with the iodine beads for at least 20 minutes before using the solution to disinfect water - longer if the water is below 68 F (20 C). The iodine beads dissolve iodine into the water, making a saturated solution of iodine. It is this saturated solution which gets added to water to chemically disinfect the drinking water. Once the solution is added to the drinking water, it needs to be in contact with the water for a half hour before the water is consumed.

The amount of solution a liter of drinking water requires depends on the temperature of the Polar Pure bottle. The colder the bottle is, the less iodine is dissolved. The amount recommended per quart (.95 l) is listed in capfuls of solution. This ranges from 4 capfuls at 41 F (5 C) to 1.2 capfuls at 95 F (35 C).

(A capful is about 2 tsp (10 ml). When full, I can pour 4 capfuls out of the bottle.) I find it most useful to keep the bottle in my pants pocket where it stays warm, and the heat makes the right dose from 1.5 to 1.2 capfuls. It is a bit of a bump in the pants pocket, but not large enough to make this difficult. The ring retains some of the solution in the bottle.

I find that the recommended amount of Polar Pure can be tasted, but is not overpowering. Somewhere, I heard one user say that after a day or two in the woods, the taste of the iodine treated water is "fresh" tasting. I like to think along these patterns myself.

One of the advantages of the Polar Pure system is that it can be used to disinfect my water container many hundreds of times. After using some of the iodine solution to purify water, the bottle is then filled with water again. Wait another 20 minutes and it is as though you have a new bottle again. With the grains of iodine supplied, the manufacturer states that from 500 to 1000 liters of water can be purified. The bottle does not expire at any time after it is opened. I believe a thru hiker could finish the entire Appalachian Trail with a single bottle of Polar Pure. From my reading, many have.

I have done some reading about the toxicity of iodine. While the substance can be acutely toxic, use at the recommended levels appears to be safe, even daily for periods of months. The beads should not be ingested whole, and children should be protected from accidental ingestion. The cap seems to offer little protection from accidental unscrewing by an unsupervised child. It does not appear the entire contents of the package are a lethal acute poisoning dose to an adult. Those who use the product might be wise to do a little reading on their own about iodine to reassure themselves that the product, as intended to be used, is not harmful to their long term health.

One of the advantages of Polar Pure is its effectiveness for many organisms. While filters are good at removing the larger particles of Giardia and many bacteria, most are not effective against pathogenic viruses. One of the advantages of iodine solution is its effectiveness against viruses.

The heavy glass container seems unnecessary. It is obvious that a much lighter container could be provided for backpacking, decreasing the weight by up to 75 percent. This could make carrying the bottle in a pocket much more comfortable and perhaps safer. If the instructions pointed out the advantages of carrying the bottle in a pocket warmed by body temperature, the product would also be improved.

My three favorite features of Polar Pure

- Simple, inexpensive
- Effective for Giardia, bacteria, and viruses
- Light Weight

Two things which could be improved

- Decrease Weight
- Improve instructions

Personal biographical information of tester

-Name: Rick Allnutt
-50 year old male
-6'0" (183 cm) 195 lb (88.5 kg)
-Email: rick at flyfisher-kayaks dot com
-Home: Dayton, Ohio
-Backpacking Background: My recent intense interest in ultralite hiking began in late 2002. Since then I have done much day hiking on the Ohio Buckeye Trail and local state forests. Backpacking trips have included hiking the 20 mi (32 km) loop in Zalinski State Forest, Ohio, and two section hikes of the Appalachian Trail: 67 mi (108 km) in North Carolina/Tennessee and 35 mi (56 km) in Virginia. Other historical experience includes 6 backcountry canoe trips into the Boundary Water's Canoe Area spanning 35 years, and hiking Philmont Scout ranch as a 14-year-old Eagle Scout.

Water Storage Guidelines

Commercially bottled water in PETE (or PET) plastic containers may be purchased. Follow the container's "best if used by" dates as a rotation guideline. Avoid plastic containers that are not PETE plastic.

If you choose to package water yourself, consider the following guidelines:

Containers

- Use only food-grade containers. Smaller containers made of PETE plastic or heavier plastic buckets or drums work well.
- Clean, sanitize, and thoroughly rinse all containers prior to use. A sanitizing solution can be prepared by adding 1 teaspoon (5 ml) of liquid household chlorine bleach (5 to 6% sodium hypochlorite) to one quart (1 liter) of water. Only household bleach without thickeners, scents, or additives should be used.
- Do not use plastic milk jugs, because they do not seal well and tend to become brittle over time.
- Do not use containers previously used to store non-food products.

Water Pretreatment

- Water from a chlorinated municipal water supply does not need further treatment when stored in clean, food-grade containers.
- Non-chlorinated water should be treated with bleach. Add 1/8 of a teaspoon (8 drops) of liquid household chlorine bleach (5 to 6% sodium hypochlorite) for every gallon (4 liters) of water. Only household bleach without thickeners, scents, or additives should be used.

Storage

- Containers should be emptied and refilled regularly.
- Store water only where potential leakage would not damage your home or apartment.
- Protect stored water from light and heat. Some containers may also require protection from freezing.
- The taste of stored water can be improved by pouring it back and forth between two containers before use.

Additional Information

Note: The following links are not to official Church publications but are provided as additional resource material:

Water Information – From Fema

http://www.fema.gov/plan/prepare/water

How Much Water do I Need?

You should have at least a three-day supply of water and you should store at least one gallon of water per person per day. A normally active person needs at least one-half gallon of water daily just for drinking.

Additionally, in determining adequate quantities, take the following into account:

- Individual needs vary, depending on age, physical condition, activity, diet, and climate.
- Children, nursing mothers, and ill people need more water.
- Very hot temperatures can double the amount of water needed.
- A medical emergency might require additional water.

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How Should I Store Water?

To prepare safest and most reliable emergency supply of water, it is recommended you purchase commercially bottled water. Keep bottled water in its original container and do not open it until you need to use it.

Observe the expiration or "use by" date.

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If You are Preparing Your Own Containers of Water

It is recommended you purchase food-grade water storage containers from surplus or camping supplies stores to use for water storage. Before filling with water, thoroughly clean the containers with dishwashing soap and water, and rinse completely so there is no residual soap. Follow directions below on filling the container with water.

If you choose to use your own storage containers, choose two-liter plastic soft drink bottles – not plastic jugs or cardboard containers that have had milk or fruit juice in them. Milk protein and fruit sugars cannot be adequately removed from these containers and provide an environment for bacterial growth when water is stored in them. Cardboard containers also leak easily and are not designed for long-term storage of liquids. Also, do not use glass containers, because they can break and are heavy.

If storing water in plastic soda bottles, follow these steps
Thoroughly clean the bottles with dishwashing soap and water, and rinse completely so there is no residual soap.Sanitize the bottles by adding a solution of 1 teaspoon of non-scented liquid household chlorine bleach to a quart of water. Swish the sanitizing solution in the bottle so that it touches all surfaces. After sanitizing the bottle, thoroughly rinse out the sanitizing solution with clean water.

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Filling Water Containers

Fill the bottle to the top with regular tap water. If the tap water has been commercially treated from a water utility with chlorine, you do not need to add anything else to the water to keep it clean. If the water you are using comes from a well or water source that is not treated with chlorine, add two drops of non-scented liquid household chlorine bleach to the water.Tightly close the container using the original cap. Be careful not to contaminate the cap by touching the inside of it with your finger. Place a date on the outside of the container so that you know when you filled it. Store in a cool, dark place.Replace the water every six months if not using commercially bottled water.

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Last Modified: Tuesday, 08-May-2007 16:04:12 EDT

Prepare for Disasters Before they Strike: Build A Disaster Supplies Kit

There are six basics you should stock for your home in the case of an emergency:

water, food, first aid supplies, clothing and bedding, tools and emergency supplies, and special items for medical conditions.

Keep the items that you would most likely need during an evacuation in an easy-to carry container. Below is a comprehensive list of what should be included in your kit – recommended items are marked with an asterisk(*).

Possible containers include a large, covered trash container, a camping backpack or a duffle bag.

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Water

- Store water in plastic containers such as soft drink bottles. Avoid using containers that will decompose or break, such as milk cartons or glass bottles. A normally active person needs to drink at least two quarts of water each day. Hot environments and intense physical activity can double that amount. Children, nursing mothers, and ill people will need more.
- Store one gallon of water per person per day.
- Keep at least a three-day supply of water per person (two quarts for drinking, two quarts for each person in your household for food preparation/sanitation).*

Additional Information

- Water sources during an emergency

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Food

Store at least a three-day supply of non-perishable food. Select foods that require no refrigeration, preparation or cooking, and little or no water. If you must heat food, pack a can of sterno. Select food

Item in My Preparedness Kit	Yes	No
Water	☐	☐
Food	☐	☐
Medications and Special Items	☐	☐
Tools and Supplies	☐	☐
Sanitation	☐	☐
Clothing and Bedding	☐	☐
Emergency Car Kit	☐	☐
Important Family Documents	☐	☐
First Aid Kit	☐	☐
Reset		

What's in your preparedness kit?

Purchase your Preparedness Kit at the Redcross Store now!

items that are compact and lightweight.

Include a selection of the following foods in your Disaster Supplies Kit:

- Ready-to-eat canned meats, fruits, and vegetables
- Canned juices
- Staples (salt, sugar, pepper, spices, etc.)
- High energy foods
- Vitamins
- Food for infants
- Comfort/stress foods

Additional Information

- Food supplies during an emergency

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First Aid Kit
Assemble a first aid kit for your home and one for each car.

- (20) adhesive bandages, various sizes.
- (1) 5" x 9" sterile dressing.
- (1) conforming roller gauze bandage.
- (2) triangular bandages.
- (2) 3 x 3 sterile gauze pads.
- (2) 4 x 4 sterile gauze pads.
- (1) roll 3" cohesive bandage.
- (2) germicidal hand wipes or waterless alcohol-based hand sanitizer.
- (6) antiseptic wipes.
- (2) pair large medical grade non-latex gloves.
- Adhesive tape, 2" width.
- Anti-bacterial ointment.
- Cold pack.
- Scissors (small, personal).
- Tweezers.
- CPR breathing barrier, such as a face shield.

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Non-Prescription Drugs

- Aspirin or nonaspirin pain reliever
- Anti-diarrhea medication
- Antacid (for stomach upset)
- Syrup of Ipecac (use to induce vomiting if advised by the Poison Control Center)
- Laxative
- Activated charcoal (use if advised by the Poison Control Center)

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Tools and Supplies

- Mess kits, or paper cups, plates, and plastic utensils*

- Emergency preparedness manual*
- Battery-operated radio and extra batteries*
- Flashlight and extra batteries*
- Cash or traveler's checks, change*
- Non-electric can opener, utility knife*
- Fire extinguisher: small canister ABC type
- Tube tent
- Pliers
- Tape
- Compass
- Matches in a waterproof container
- Aluminum foil
- Plastic storage containers
- Signal flare
- Paper, pencil
- Needles, thread
- Medicine dropper
- Shut-off wrench, to turn off household gas and water
- Whistle
- Plastic sheeting
- Map of the area (for locating shelters)

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Sanitation

- Toilet paper, towelettes*
- Soap, liquid detergent*
- Feminine supplies*
- Personal hygiene items*
- Plastic garbage bags, ties (for personal sanitation uses)
- Plastic bucket with tight lid
- Disinfectant
- Household chlorine bleach

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Clothing and Bedding

*Include at least one complete change of clothing and footwear per person.

- Sturdy shoes or work boots*
- Rain gear*
- Blankets or sleeping bags*
- Hat and gloves
- Thermal underwear
- Sunglasses

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Special Items

- Remember family members with special requirements, such as infants and elderly or disabled persons

Solar water pasteurization

Solar cooks know how easy it is to heat foods in a solar cooker to temperatures well above 60°C (140°F). Knowing this, Dr. Bob Metcalf and a graduate student of his in the early 1980s, David Ciochetti, studied solar water pasteurization for the latter's master's thesis. They found that when contaminated water was heated in a black jar in a solar box cooker, both bacteria and rotaviruses -- the main cause of severe diarrhea in children -- were inactivated by 60°C (140°F). In the paper published this work (Applied and Environmental Microbiology, Vol. 47:223-228, 1984) it was concluded that if contaminated water were heated to 65°C (149°F), all pathogenic microbes would be inactivated. This includes the hepatitis A virus, which has a 90 percent reduction after two minutes at 60°C (140°F).

Another student, Negar Safapour, found that contaminated water could be pasteurized in a black metal or glass container in a CooKit (Solar Cookers International's simple solar cooker) without using the clear plastic bag that is required for cooking. In our experiments it took about three minutes for each 1°C increase from 55°C to 65°C when heating 2 liters of water, and four to five minutes for each 1°C increase when heating 4 liters. Thus, water is at lethal temperatures for a number of minutes as it is solar heated to 65°C (149°F), and it remains in the lethal zone for many more minutes as the water slowly cools back down to 55°C (131°F).

Solar Cookers International's WAPI shown in the solid wax state (left) and liquid wax state (right)

Since thermometers are not accessible to many people around the world, there is a need for a simple device that indicates when water has reached pasteurization temperatures. Fred Barrett, who was with the United States Department of Agriculture when Dr. Metcalf worked with him on a solar box cooker project in Sierra Leone in 1989, came up with the idea of using vegetable wax, with a melting point near 70°C (158°F), as an indicator. He built several models based on the idea of wax inside a plastic cylinder, and successfully used them to verify pasteurization conditions of contaminated water. In 1992, Dale Andreatta -- a Ph.D. candidate in mechanical engineering at the University of California, Berkeley at the time -- created the Water pasteurization indicator (WAPI) in its current form. The WAPI is a clear plastic tube partially filled with a soybean wax that melts at about 70°C (158°F). With the solid wax at the top end of the tube, the WAPI is placed in the bottom of a black container of water that is solar heated. If the wax melts and falls to the bottom of the tube, it ensures that water pasteurization conditions have been reached. The WAPI has a stainless steel washer around it to keep it at the bottom of the container, which is the coolest location when solar heating water. Since top water temperatures are often 2-5°C hotter than bottom water temperatures, lower WAPI placement helps to further insure that pasteurization conditions have been achieved.

Meatu resident Boniphace Luhende demonstrates solar water pasteurization using a CooKit and WAPI

During numerous trips to developing countries, Dr. Metcalf has had the opportunity to conduct numerous solar water pasteurization experiments. In Meatu district, Shinyanga region, Tanzania, water most often comes from open holes dug in the sand of dry riverbeds, and it is invariably contaminated. Indeed, the water that was provided in Dr. Metcalf's guesthouse was heavily contaminated. Bacteriological tests of the water during solar pasteurization repeatedly showed indicator bacteria (key bacteria whose presence indicates fecal contamination) becoming inactivated at temperatures just below 60°C (140°F). During all of Dr. Metcalf's fieldwork, he has heated his own drinking water in a solar cooker using a WAPI as a temperature indicator and he has had no intestinal problems.

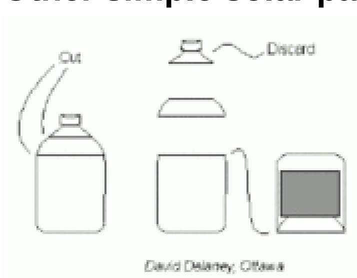
[edit]

Pasteurizing water in a solar cooker

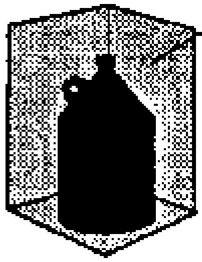
A standard solar cooker can be used to pasteurize water by simply replacing the food to be cooked with the water to be heated.

[edit]

Other simple solar pasteurization devices



A pasteurizer made from a large plastic jug



[edit]

SODIS- purifying water in the Sun

SODIS experiments using common plastic bottles were mostly successful, but small amounts of E. coli survived.
An alternative solar method of inactivating microbes in contaminated water -- exposing transparent bottles of water, placed horizontally on a flat surface, to direct sunshine for five to six hours -- was first reported in 1980 by Aftim Acra et al. at the American University of Beirut in Lebanon. UNICEF published a booklet describing this method in 1984. This procedure has recently been named SODIS (short for "solar disinfection") by the Swiss Institute for Environmental Science and Technology. The institute recommends painting half of the bottle black, or placing the clear bottle on a dark metal surface, to enhance heating and increase microbe inactivation (see www.sodis.ch). The World Health Organization (WHO) has endorsed the SODIS procedure.

The SODIS procedure will inactivate bacteria on sunny days. However, it does have some limitations. The SODIS method cannot be used for turbid water or for milk, since turbidity and non-clear liquids reduce solar radiation intensity. Also, Dr. Metcalf and his students have found that viruses are more resistant to direct sunshine than are bacteria. Research conducted by Negar Safapour and myself, using a bacterial virus, supports this. (See paper in Applied and Environmental Microbiology Vol. 65, #2, pp859-861, 1999; available online at: http://aem.asm.org) Another student, Yen Cao Verhoeven, studied the effects of the SODIS method on rotaviruses, with similar results. Her findings were presented as a poster at the American Society for Microbiology annual meeting in May 2000. Furthermore, the SODIS method suffers because it has no certain end-point. How does one know if the pathogens have been completely inactivated if there is only partial sunshine, or the water is moderately turbid? It's a guess.

In the summer of 2002 Christine Polinelli, from the Australian Department of Health, joined Dr. Metcalf in Meatu district to test CooKit water pasteurization, and the SODIS method, with the naturally contaminated water delivered to our guesthouse. This water had between 10-100 E. coli bacteria per milliliter. (The WHO considers water to be heavily contaminated if it has one E. coli per milliliter.) Water heated in a two-liter black metal container in a CooKit was free of E. coli within two hours, when temperatures reached 60°C. Water from the same source was given the SODIS treatment in the 1.5-liter blue-tinted plastic bottles available in Tanzania. Although we obtained over 90 percent inactivation of E. coli in 5-6 hours, viable E. coli were still sometimes present in one milliliter and ten milliliter samples. The moderate turbidity of the river water may have contributed somewhat to protecting E. coli.

[edit]

External links

- Water Disinfection by Solar Radiation

[edit]

Sari cloth filtering

In Bangladesh, cholera is a threat, particularly around the spring and summer monsoons. Some of the cholera bacteria attach to much larger -- but still microscopic -- plants and animals, which could possibly be filtered out of water. This has led to the recommendation to filter water through 8-10 folds of sari cloth (see National Geographic, February, 2002, p. 20). In Meatu district, Dr. Metcalf and Ms. Polinelli tested eight different cloths, folded eight and twelve times. As they expected, for all eight cloths, the E. coli bacteria in the filtrate was equal to the concentration before filtering. Unattached bacteria, and likely viruses, which are a fraction of the size of bacteria, go through folded cloth like air molecules go through a screen!

Dr. Metcalf has always considered the gold standard of microbe inactivation procedures to be: Will the person recommending a specific procedure actually drink heavily contaminated water which has been treated by the particular method? Dr. Metcalf will, and has many times, with solar water pasteurization using a CooKit and a WAPI. Certainly the folded sari method is dangerous. The SODIS method is effective at reducing viable bacteria. However, its ability to inactivate viruses, particularly the dangerous rotavirus, is less certain. And there is no inexpensive, easy device that indicates when SODIS-processed water is safe to drink.

Most of the people that Dr. Metcalf has talked to about solar water pasteurization oven the past 20 years are astonished to learn that water does not have to be boiled to make it safe microbiologically. The fact that the WHO, the Center for Disease Control (CDC), and the Peace Corps routinely recommend boiling suspect water -- sometimes for as long as ten minutes -- reinforces the myth that water needs to be heated drastically more than milk to kill pathogens. One reason for boil orders, Dave Ciochetti and Dr. Metcalf speculated 20 years ago, is that without a thermometer, it is not possible to judge the temperature of heated water. What the world needed was the WAPI, which [SCI now manufactures]. The SODIS method includes recommendations to boost water temperatures to 55°C (131°F) if possible, which greatly increases killing of bacteria. What is not well known is that the alternative to direct sunshine to pasteurize water is not boiling, but modest temperatures in the 60°C range, which are easily obtained using simple solar cookers. When it becomes common knowledge that 60-65°C (140-149°F) will guarantee all pathogens are killed, and boiling isn't needed, the CooKit and WAPI approach should become much more prominent. (Note that solar water pasteurization requires a container other than plastic, which starts to melt near 60°C.)

Another major reason to promote the CooKit/WAPI method of solar water pasteurization is that in most of the places where water is unsafe, people also use fuel wood for cooking, as they do in Meatu district. Women have to spend hours collecting scarce firewood every two or three days, and then spend more hours tending a smoky fire. The SODIS method doesn't inform 2.5 billion people who depend on traditional fuels that with sunshine, there is an alternative to fire.

In advocating for the spread of solar cooking, the many thousands of solar cooks who read the Solar Cooker Review might find that solar water pasteurization will open doors that the cooking function alone hasn't been able to open. That has happened the last two years in Tanzania, and this past July in Nairobi, Kenya, when Christine and I worked with SCI's eastern Africa staff to hold a three-day presentation and workshop on water testing and solar water pasteurization. We look forward to expanding these efforts in the future.

[edit]

Frequently-asked questions

[edit]

How is pasteurization accomplished?

Traditional fuels can be used to pasteurize water, but on sunny days solar energy can be used as well. Simple solar cookers can pasteurize water for a family at a rate of about one liter per hour. Solar Cookers International's reusable water pasteurization indicator (WAPI) can be used to determine when water heated by solar or conventional means has been heated to a high enough temperature to make it safe.

[edit]

Don’t you need to boil water for 20 minutes to sterilize it and make it safe to drink?

No, it is only necessary to heat water to 65° C to pasteurize it.

[edit]

What is the difference between sterilization and pasteurization?

Sterilization kills all of the organisms in the water, while pasteurization kills only those organisms that can cause harm to humans.

[edit]

What common disease organisms are killed by pasteurizing water?

Guardia, cryptosporidium, endameba, the eggs of worms, cholera, shigella, salmonella bacteria and those that cause typhoid, the enterotoxogenic strains of E. Coli, Hepatitis A, and also rotavirus which is a major cause of disease in children are all killed or inactivated at 65°C.

[edit]

How can water be tested in the field?

At Dadaab Refugee Camp, Kenya, villagers check the WAPI

The best indicator of human or animal fecal contamination of water is the bacterium Escherichia coli, which is always present in human feces, at a level of about one hundred million E. coli per gram. The presence of E. coli in water indicates recent fecal pollution and a public health threat. Water containing one E. coli per milliliter is considered heavily contaminated. In order to do world-class microbiology in developing countries where there is no lab, since 2000 SCI has used two complementary tests extensively.

The first test is a presence/absence test using Colilert, the most widely used test in the water industry (IDEXX Laboratories, Westbrook, Maine). SCI uses the Colilert MPN tube, which is inoculated with 10 ml of water, and incubated at body temperature for 10-24 hours. If the liquid in the tube turns yellow, and fluoresces blue when illuminated with a battery-operated, hand-held ultraviolet light, the presence of E. coli in the water sample is confirmed. If the tube remains clear, or is yellow but does not fluoresce blue under UV light, it indicates that there were no E. coli cells in the 10 ml sample, and there is a low risk of disease from the water.

Heat from your own body can be used as a incubator in the field.

The second test is a quantitative test using the E. coli count, Petrifilm (3M Microbiology Products, St. Paul, Minnesota), which is used extensively in the food industry. One milliliter of the water sample is added to the Petrifilm, which is incubated at body temperature for 10-24 hours. If E. coli is present in the water sample, it will develop into a blue colony surrounded by gas bubbles. By counting the number of blue colonies with gas, the number of E. coli in a milliter can be determined. One E. coli colony on a Petrifilm indicates heavily contaminated water and a high risk of disease, 10 or more E. coli on a Petrifilm indicates grossly contaminated water and a very high risk of disease. [edit]

Is there a kit available that contains everything needed for water testing in the field?

Yes. Dr. Bob Metcalf, a microbiology professor at California State University at Sacramento has prepared such a kit. Dr. Metcalf can be contacted at rmetcalf@csus.edu.

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Filtering and Purifying Water

Depending on where you're stranded in the world, locating water needs to be your No#1 priority. Without it, you can't survive anymore than a few days or a week, especially in a hot desert or tropical climate.

So what do you do if you're dying of thirst and come across some water that you're not sure is safe to drink? Well, it's entirely up to you and depends on how desperate you are for water. But if you've been wandering around for days without any water and you're starting to feel weak, delirious, and downright desperate for something to drink. You got a choice, you can either die from dehydration or risk dying from unsafe/contaminated water.

Now personally, if I was wondering around for days without any water and suddenly came across some, provided it wasn't discolored or have a strange odor… I'd drink it. Why? I'd rather risk drinking unsafe water and hope it would give me enough strength to travel/continue on just little bit further and longer than to give up and die right there on the spot from dehydration. After all, whether you feel ill after drinking some suspected contaminated water or not, if it gives you the strength to place one-foot-in-front-of-the-other and move on, your chances of surviving and being rescued before it actually overcomes you with severe illness is greater then giving up and lying down somewhere and dying, don't ya think? Sure it is!

No doubt you probably prefer to have some clean, safe, purified, water to drink, right? Sure, everybody would, but sometimes it's just not possible to find, ya know? And although there are many ways in how to find, improvise and acquire

water, the following are the most "commonly overlooked" techniques that require none or very little filtering and "no purifying." And the only things you need are some "clear" plastic trash bags, an empty bottle, and a couple of handkerchiefs, and the more you have - the more water you'll be able to produce. Note: Always pack a few of these in your survival kit, except a bottle, of course.

Because a tree holds an enormous amount of water, if you place a clear plastic bag over a "leafy green" branch you'll force it to cough up some of the water through condensation. But it's important to make sure the bag is tightly sealed around the branch or it won't produce any water at all.

And no matter where you go today, plastic and glass bottles can be found littered almost everywhere, even in some of the most remote and isolated places of the world. Really! (Well maybe not everywhere…) And if you take a "green leafy" branch and place it inside a bottle and seal it close, by the end of a hot sunny day it'll produce as much as 1/3 cup of water. And so the more bottles and or plastic bags you use - the more water you can produce. Figure it out, bubba!

And of course, the best time to acquire clean water is when

it rains, and the fastest and easiest way to gather it is by laying out sheets of plastic cut from trash bags. But if you don't have anything to carry the water in, then it's probably better to just roll up the sides of a trash bag and allow mother nature to slowly fill it.

And lastly, in the early mornings and some- times late at night, if you tie a couple of handkerchiefs or rags around your ankles and or to the end of a stick and walk through some tall grass you'll be able to soak up quite a bit of moisture, then all you gotta do is wring it out. Yep, a crude, slow method… but works!

Now let's talk about how to filter and purify water...

When it comes to filtering and purifying water for consumption, you can't screw around and take shortcuts. You either do it right or you're gonna get terribly ill, or worse yet, die from improperly treated water if you can't get to a medical facility in time.

So what's the difference between filtering and purifying water?

Filtering is the removal all "visual" particles and matter from the water such as dirt, leaves, critters, etc, so it can be properly purified and then safely consumed.

Purifying is the removal of all "invisible" bacteria, germs and other harmful elements from the water so it can be safely consumed.

You got it? In other words, "before you can consume untreated water, you've got to purify it, and before you can purify it, you've got to first filter it." (Untreated Water + Filter + Purify = Safe To Drink)

Got it? Good! Now let me show you a few ways in how to make a water filter, and believe it or not, my techniques are much more simpler than what other survival sites and books teach ya. And if you don't think so after I show you, feel free to send me a nasty e-mail, (rangerbooks@hotmail.com).

This first one is called a "Film Container Water Filter." And yep, as you can guess by the name, it's made out of a 35mm plastic film container, which you'll also need 2 x plastic water bottle caps and either some disposable coffee filters, cotton, or a piece of white cloth.

Once you've acquired these items, take a razor blade or a very sharp knife and carefully make a circular hole in the bottom of the plastic film container, not too small and not too big. Then take one of the plastic water bottle caps and either with an electric drill, a hot nail or a very pointed knife, make a bunch of holes in it and place it inside the film container. Then take either some disposable coffee filters, cotton, or a piece of white clothe and place it also inside the film container and you're now ready to start filtering water.

Now I'll bet you're wondering, "What's the second bottle cap for?" Right? Well it's for squeezing out the last few drops of water left inside the filter and for covering the hole (after you have remove the other bottle cap) from the bottom of the film container so you can keep it clean whenever you're not using it.

When should you replace the coffee filters, cotton or white cloth? When (a) the filter becomes blocked, (b) the filtered water is dripping very, very slowly, (c) the filtered water doesn't look very clear.

Did you like this water filter tip? Well here's another one you can make with a plastic water bottle, and two different types too, a "simple" and an "elaborate" water bottle filter.

Why would you want to make an elaborate water filter?

Well, maybe not all your water will come from a very good source such as a moving creek, stream, or lake, but instead from a stagnant and smelly pond, puddle, or swamp. And not only is it very important to filter this kind of water, but to rid it of any foul odor or bad taste too, which is why it's good to know how to make one of these filters.

And to make one, all you need is an empty plastic water bottle and three white socks. Then all you gotta do is cut the bottle in half, roll tightly up each sock, turn the top half of the bottle upside down and …

a) Place the first sock inside the bottle and on top of it place some "pure black" pieces of charcoal/well burnt wood from a fire, making sure it contains absolutely "no white ashes" whatsoever, NONE.

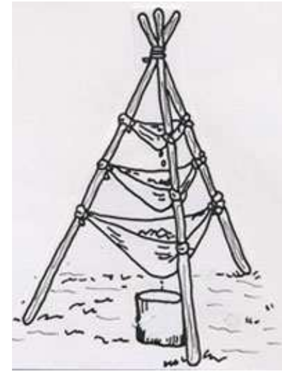
b) Place the second sock inside the bottle and on top of it place some green moss or grass, making sure it doesn't have any roots or dirt attached to it, NONE.

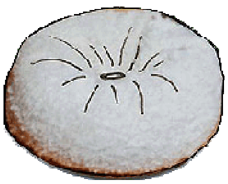
c) Place the third sock inside the bottle and because it's the main filter, place nothing on top of it. Though these other socks below it will filter the water too, their main job is to remove any foul odor or taste from the water.

US Army Ranger - Rick's Filter System

Other Survival Books Filter System

1st. Sock	"Nothing"	1st. Hanky
2nd. Sock	"Grass/Moss"	2nd. Hanky
3rd. Sock	"Burnt wood/charcoal"	3rd. Hanky





As you can see the most important part of this filter system is the socks, they should be rolled up very tight, and when placed inside the plastic water bottle they should fit "snug & tight" too.

WARNING: When pouring untreated water through this filter system, make sure you look closely at the filtered water to insure it looks clear, and if it doesn't, then run the water back through it again. And if necessary, again and again and again until it looks filtered and clear.

Ok, this was my "elaborate" filter system for nasty water, now here's my "simple" filter system for somewhat clear and odorless water. And all you need for this system is an empty plastic water bottle, 1 x clean "white" sock and then look closely at this next picture to see how easy it is to make.

No matter which one of these filter systems you make and use, always try to use a "white" sock, cloth, cotton, or coffee filter so you can see when it's dirty and needs to be replaced or clean. Makes sense, don't ya think? Sure does!

Now let's talk about how to purify water, and boy, are there a lot of expensive water purification gadgets on the market today, but only if you're "rich & wealthy" can you afford to buy them. And if you're not, or you're a tightwad like me, you can always boil it, bleach it, or tab it.

TO BOIL IT – You'll need a fire and a metal pot or tin can, and once you have this, pour the "filtered water" inside the pot/can, place it over the fire and then sit back and wait until it starts to boil.

Sound simple enough to do? It is if you know the difference between "simmering" and "boiling."

<u>Simmering</u> is when the water releases "visual vapors" because it's getting hot, but there's no sound coming from the pot/can. <u>Boiling</u> is when the water releases "visual vapors," you "hear a sound" coming from the pot/can and when you look inside you can see "bubbles popping" to the surface of the water.

Now once it begins to boil, it takes ten minutes before it's considered purified, free of germs, bacteria, and other harmful elements and safe to drink. And don't worry about over boiling, it's better to let it boil for more than ten minutes than less than ten minutes to make sure all those harmful micro-organisms and other nasty critters are all dead. And then once you've done this, all ya gotta do now is sit back and wait until the water cools before you can drink it.

TO BLEACH IT – You'll need some plastic drinking straws, silicone, a piece of cardboard and Clorox "Regular" Bleach. WARNING: Use strictly Clorox "<u>Regular</u>" Bleach and NOT the scented, lime, or other type or it WILL BE harmful to your health.

Then take a drinking straw, cut it into 1" inch long pieces, place a few drops of silicone on the cardboard and then stand the straws straight up in it and wait until they're completely dry.

When the silicone is dry, grab another straw and dip one end in the Clorox Bleach and place your finger over the other end to trap the liquid inside. Then very carefully lift it out and over the top of the short straws and allow only four (4) drops to drip inside each straw and seal them close (without touching the bleach inside) with silicone.

Why only four (4) drops of Clorox Bleach?

According to the manufacturer, it takes four (4) drops of Clorox "Regular" Bleach and thirty minutes to purify 1 x quart/liter of "clear water" for safe consumption. And if the water doesn't have a slight bleach odor to it after waiting 30 minutes, repeat the process. To confirm this dosage, call the Clorox Bleach toll-free "consumer hotline" at 1-800-292-2200.

Once the silicone is dry, you can then remove the straws from the cardboard and place them inside your survival kit until you need to use'em. But if you don't use'em for a long time, because I really don't know how long the liquid will stay good in the straws. Then I suggest you open one every 3-6 months to see if it still has a strong bleach odor, and if it doesn't, or the liquid looks strange…replace'em.

TO TAB IT - You'll need to buy a bottle of water purification tablets from a military/outdoor supply store, sometimes referred to as "iodine tablets" too.

Now the only thing I don't like about these tablets, is according to health officials, once the seal of the bottle is broken you gotta use'em all up within 6-12 months or you gotta throw'em away.

Why? Well once the seal of the bottle is broken and the tablets come in contact with the air, they begin to lose their potency to purify water. Not right away, but over a period of about a year, depending on how often you keep opening up the bottle and exposing'em to the air.

How do you use'em? Well it depends on which type you buy, so the best advice I can give is to tell you to read & follow the instruction on the side of the bottle if you don't want to get ill. And if you don't want to carry the entire bottle around with you, then just do what I do. I put a few tablets inside some short drinking straws and seal'em close with silicone, the same way I showed you how to do it with the Clorox Bleach. Works for me!

NOTE: Avoid picking up the tablets with your bare fingers, because due to your natural skin moisture/oils it causes the tablets to change color and quickly deteriorate, use a pair of tweezers to place them inside the straws.

LINKS

FEM (PDF)

http://www.redcross.org/images/pdfs/preparedness/A5055.pdf

http://www.fema.gov/plan/prepare/water

http://www.providentliving.org/content/display/0,11666,7534-1-4065-1,00.html
http://www.wwrf.org/waterterrorism.htm

Food, Air, Water and Terrorism: Assessing the Risk -
U.S. Medicine Institute for Health

http://www.epa.gov/safewater/faq/pdfs/fs_emergency-disinfection-drinkingwater-2006.pdf (see good pictures)

http://www.grannysstore.com/Wilderness_Survival/water_purification.htm