

Water_Copendium_1995.txt

This is composed of many reports -- use search for key word to find your subject of interest.

From jmpk 1995

Subject: Re: Sweetwater filters

desotell wrote:

>
> I am in the market for a water filter and I am considering the Sweetwater
> brand. They are pretty new on the market, so not a lot has been written
> about them. If you own one or know of anything would you drop me a line.
>
> Thanks
> James
> desotell
>

You missed a rather long discussion on filters a month or so ago. The general conclusion seemed to be that the Sweetwater was one of the better choices. It filters everything needed and with an additional charcoal cartridge added to the input or output line you even can get rid of the non-filterable bad guys. For the money it rated very high.

I personally own one and trust it completely.

Jim
Scoutmaster Troop 361, Federal Way Wa

From neoflyt
Subject: Re: Sweetwater filters

Date: 12 Apr 1995 11:58:19 -0400

I have a Sweetwater that I product-tested for a magazine article and think its great. I wouldn't pay more for another unless I was doing a lot of travel overseas and wanted virus protection. And, I believe, they've got an iodine attachment either out or coming out that should take care of that issue.

Index:

- a. (Title?)
[Comparison of filters, boiling and iodine]

Filters: First Need, Katadyn,
Boiling,
Iodine: PolarPure, Potable-Aqua

Bill Tuthill
1993

Based on "Medicine for Mountaineering", owner's manuals and
personal experience of author

- b. GIARDIASIS
Memo from Center from Disease Control
Dennis D. Juranek
Chief, Epidemiology Activity
Parasitic Diseases Branch
Division of Parasitic Diseases
Centers for Disease Control
1990

- c. Back-country water treatment to prevent giardiasis.
American Journal of Public Health
December 1989, Vol 79, No 12, pp 1633-1637.
Copyright 1989 AJPH 0090-0036/89\$1.50 [used without permission]
Filters: First Need, H2OK, Katadyn, Pocket Purifier, Water Purifier
Chemicals: Polar Pure, Coghlan's Emergency Germicidal Drinking
Water Tablets, Potable Aqua, 2% iodine,
Sierra Water Purifier, Halazone, commercial liquid bleach
Jerry E. Ongerth, PhD, PE,
Ron L. Johnson,
Steven C Macdonald, MPH,
Floyd Frost, PhD,
Henry H. Stibbs, PhD
- d. REI Water Filter Chart (2 similar articles)
Comparison of specs: pore size, weight, capacity, filter life,
cost/gallon, price, replacement cost,
elements
Filters: Katadyn, MSR, PUR, First Need, Basic Designs, Timber Line
199x?

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Unpurified drinking water may contain four things that pose health risks: protozoan parasites (e.g. giardia), toxic bacteria, harmful viruses, and poisonous chemicals. Of the methods available in the field, only boiling and iodine are entirely effective against the first three, and only charcoal filtration is effective against the fourth.

Because boiling and iodination take time, some folks prefer water filters, despite their weight. The Pur Explorer is recommended for large groups,

and the Pur Scout for small groups. As of this writing, Pur filters are the only ones on the market that combine a filter (for giardia) with an iodine resin matrix (for bacteria and viruses). The Explorer (\$130) is self-cleaning and very fast, while the Scout (\$60) must be taken apart for cleaning, and is only half as fast.

The MSR filter (\$140) is also recommended, if viruses are not a concern. So far viruses are not a problem in most wilderness areas of the US, but they are a problem in the Himalayas and elsewhere. MSR filters are very convenient, since they can be screwed onto the top of your water bottle. The MSR's .1 micron final filter is small enough to remove bacteria, but if you travel abroad (to Nepal for example), you risk viral infections such as Hepatitis A and C, among others.

The Katadyn water filter is expensive (over \$240), and really has little to recommend it over the Pur or MSR filters. It must be taken apart for cleaning, like the Pur Scout. Its ceramic filter is subject to cracking if it freezes when wet. Perhaps its sole advantage is that you can scrub it almost forever, until the ceramic wears out, so it is favored by desert river runners. The Katadyn is effective at removing smaller bacteria such as E. coli, but its .2 micron filter is not effective against viruses.

The First Need water filter is cheap (\$40), but is not recommended, since some people have reported E. coli infections after using it. Its .4 micron filter pores are smaller than giardia cysts at 3.5 microns, but larger than some bacteria, such as E. coli at .3 to .9 microns.

Optional charcoal filters are available for the Pur filters. For a limited time, they may help remove some poisonous chemicals, so they may be of use in agricultural areas. However, the charcoal also removes residual iodine, which may be needed to finish killing off high concentrations of waterborne bacteria and viruses. So use these charcoal filters sparingly.

Some folks don't like carrying filters, and still don't mind boiling their

Water_Copendium_1995.txt

water. To be entirely safe, water should be boiled at least five minutes. Giardia is killed in less than a minute at 176 F (80 C), well under the boiling point. Bacteria and viruses last longer, but are probably killed in less than five minutes at 190 F (88 C). Some types of virus may last longer; nobody knows for sure. At 10,000 feet water boils at 194 F (90 C); above this altitude boil water about an extra minute for each 1000 feet. Note that it's safe to make pasta using untreated water.

If you have neither the time, nor the fuel, nor the inclination to boil, iodine is equally effective. After 15 minutes (30 minutes for cold water), a sufficient dose of iodine kills all bacteria and viruses. Some protozoa take longer to kill; studies have shown giardia lasting for several hours. Shaking your water bottle may help, but it's always best to wait longer.

One readily-available choice is Potable-Aqua tablets. Dissolve one tablet per liter of water (two tablets for cloudy water) and wait. The problem with iodine tablets is that they degrade upon contact with moisture, so keep that bottle dry, and discard it upon returning home. Another choice is a bottle of PolarPure (elemental iodine). Add the number of capfulls recommended by the thermometer on the bottle. For travel in wet or humid areas, PolarPure is a better choice than Potable-Aqua.

Avoid halazone and Clorox, because chlorine is volatile, slow to disinfect, and works differently against protozoa and viruses at various pH levels. It also reacts with organic compounds to form carcinogenic chloramines. Iodine is not highly toxic, and in fact is an essential ingredient of human nutrition. However, continuous ingestion of large doses may cause health problems, particularly for people with thyroid problems.

The accepted concentration for iodine disinfection is 8 milligrams per liter, but this is mostly to get rid of protozoan parasites. A good way to reduce overall iodine consumption and minimize that iodine flavor is to filter first, then use a low concentration of iodine to get rid of bacteria and viruses. For this, a concentration of .5 mg/L is deemed

adequate, so one capful of PolarPure or one Potable-Aqua tablet should disinfect around 16 liters of lightly filtered water. Various inexpensive ceramic filters with 1 micron pores are fine for removing protozoa.

Giardia has become a well-known, almost fashionable, outdoor hazard. Many people who experience gastro-intestinal problems after drinking bad water think they have contracted giardia. In many cases they have contracted something else. Since the only FDA-approved treatment for giardia (Flagyl) is very nasty, it's wise to make sure you really have giardia before treatment. Most low-grade bacterial infections go away on their own, and Flagyl is ineffective against viral infections. One alternative to Flagyl is quinacrine. In many parts of the world (Asia for example) Tinidazole is also available, and is preferable to Flagyl since it is less toxic and quicker acting.

[This information based on "Medicine for Mountaineering", various research articles, owner's pamphlets, and personal experience.]

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Addendum, info packet from manufacturer of Pur filters

"Three identical [Pur Traveller water filters] were evaluated for their ability to inactivate/remove Klebsiella terrigena, poliovirus type1, rotavirus SA-11, and Giardia lamblia cysts. The units were operated according to the manufacturer's instructions until the designed lifetime of 100 gallons (378 liters) passed through. The units were challenged with [the micro-organisms mentioned above] after a passage of 0, 50, 75 and 100 gallons. At the 75% lifetime challenge, 'worst case' water quality of 1500 mg/l dissolved solids, 10 mg/l organic matter, 4 degrees C, with a turbidity of 30 NTU and a pH of 9 was used. For the 100% lifetime test the worst case water quality at pH 5 was used. The units were also tested after

stagnation for 48 hours at the 50%, 75%, and 100% [stages].

"At 0 and 50% lifetime test points, > 99.9999% of the bacteria, > 99.9% of the Giardia cysts, and > 99.99% of the test viruses were removed. With worst case water two passages of the test water through the units was required to achieve these same removals. These units would comply with criteria guidelines suggested by the US EPA...

"One passage of the pH 9 worst case water was not sufficient to remove the Klebsiella terrigena and poliovirus type1 to the required reduction. However, the required reduction [was] achieved by passage of the test water through the units a second time... Holding the water for 5 to 10 minutes after it had passed through the units also resulted in a further reduction of test bacteria and viruses."

Klebsiella terrigena is a bacteria that causes "stomach flu", as can rotavirus SA-11. Here is the residual iodine after treatment:

	cup1	cup2	cup3	
0%	.7	.7	.7	(ppm)
50%	.6	.5	.6	
75%	.6	.6	.7	
100%	.7	.6	.8	

This indicates that the filter still had plenty of life at 100 gallons. It also indicates that there is enough residual iodine to kill off all viruses and bacteria overnight (ppm = mg/L).

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OCR'ed memo from the Centers from Disease Control:

GIARDIASIS

GIARDIASIS: By Dennis D. Juranek, Chief, Epidemiology Activity
Parasitic Diseases Branch
Division of Parasitic Diseases
Centers for Disease Control

Transmission and Control

Introduction

During the past fifteen years giardiasis has been recognized as one of the most frequently occurring waterborne diseases in the United States (1). *Giardia lamblia* have been discovered in the United States in places as far apart as Estes Park, Colorado (near the Continental Divide); Missoula, Montana; Wilkes-Barre, Scranton, and Hazleton, Pennsylvania; and Pittsfield and Lawrence, Massachusetts just to name a few. In light of recent large outbreaks of waterborne giardiasis, it seem timely to present reliable information on the way in which giardiasis is acquired, treated, and prevented.

Giardiasis: Prevalence and Symptoms

Giardiasis is a disease caused by a one-celled parasite with the scientific name *Giardia lamblia*. The disease is characterized by intestinal symptoms that usually last one week or more and may be accompanied by one or more of the following: diarrhea, abdominal cramps, bloating, flatulence, fatigue, and weight loss (see Table 1). Although vomiting and fever are listed in Table 1 as relatively frequent symptoms, they have been uncommonly reported by people involved in waterborne outbreaks of giardiasis in the United States. Table 1 also suggests that 13 percent of patients with giardiasis may have blood in their stool. *Giardia*, however, rarely causes intestinal bleeding. Therefore, blood in the stool of a patient with giardiasis almost always indicates the

presence of a second disease.

While most *Giardia* infections persist only for one or two months, some people undergo a more chronic phase, which can follow the acute phase or may become manifest without an antecedent acute illness. The chronic phase is characterized by loose stools, and increased abdominal gassiness with cramping, flatulence and burping. Fever is not common, but malaise, fatigue, and depression may ensue (2). For a small number of people, the persistence of infection is associated with the development of marked malabsorption and weight loss (3). Similarly, lactose (milk) intolerance can be a problem for some people. This can develop coincidentally with the infection or be aggravated by it, causing an increase in intestinal symptoms after ingestion of milk products.

Some people may have several of these symptoms without evidence of diarrhea or have only sporadic episodes of diarrhea every 3 or 4 days. Still others may not have any symptoms at all. Therefore, the problem may not be whether you are infected with the parasite or not, but how harmoniously you both can live together, or how to get rid of the parasite (either spontaneously or by treatment) when the harmony does not exist or is lost.

Medical Treatment

Three drugs are available in the United States to treat giardiasis: quinacrine (Atabrine*), metronidazole (Flagyl*), and furazolidone (Furoxone*). All are prescription drugs. In a recent review of drug trials in which the efficacies of these drugs were compared, quinacrine produced a cure in 93% of 129 patients, metronidazole cured 92% of 219, and furazolidone cured 84% of 150 patients (4). Quinacrine is generally the least expensive of the anti-*Giardia* medications but it often causes vomiting in children younger than 5 years old. Although the treatment of giardiasis is not an FDA-approved indication for metronidazole, the drug is commonly used for this purpose. Furazolidone is the least effective of the three drugs, but is the only anti-*Giardia* medication that comes as a liquid preparation, which makes it easier to

deliver the exact dose to small children and makes it the most convenient dosage form for children who have difficulty taking pills. Cases of chronic giardiasis refractory to repeated courses of therapy have been noted, one of which responded to combined quinacrine and metronidazole treatment (5).

(*) Use of trade names is for purposes of identification only.

Etiology and Epidemiology

Giardiasis occurs worldwide. In the United States, Giardia is the parasite most commonly identified in stool specimens submitted to state laboratories for parasitologic examination. From 1977 through 1979, approximately 4% of 1 million stool specimens submitted to state laboratories were positive for Giardia (6). Other surveys have demonstrated Giardia prevalence rates ranging from 1 to 20% depending on the location and ages of persons studied. Giardiasis ranks among the top 20 infectious diseases that cause the greatest morbidity in Africa, Asia, and Latin America (7); it has been estimated that about 2 million infections occur per year in these regions (8).

People who are at highest risk for acquiring a Giardia infection in the United States may be placed into five major categories:

- 1) People in cities whose drinking water originates from streams or rivers and whose water treatment process does not include filtration, or filtration is ineffective because of malfunctioning equipment.
- 2) Hikers/campers/outdoorspeople.
- 3) International travelers
- 4) Children who attend day-care centers, day-care center staff, and parents and siblings of children infected in day-care centers.
- 5) Homosexual men.

People in categories 1, 2, and 3 have in common the same general source of infections, i.e., they acquire Giardia from fecally contaminated drinking

water. The city resident usually becomes infected because the municipal water treatment process does not include a filter that is necessary to physically remove the parasite from the water. The number of people in the United States at risk (i.e., the number who receive municipal drinking water from unfiltered surface water) is estimated to be 20 million. International travelers may also acquire the parasite from improperly treated municipal waters in cities or villages in other parts of the world, particularly in developing countries. In Eurasia, only travelers to Leningrad appear to be at increased risk. In prospective studies, 88% of U.S. and 35% of Finnish travelers to Leningrad who had negative stool tests for Giardia on departure to the Soviet Union developed symptoms of giardiasis and had positive tests for Giardia after they returned home (10,11). With the exception of visitors to Leningrad, however, Giardia has not been implicated as a major cause of traveler's diarrhea. The parasite has been detected in fewer than 2% of travelers who develop diarrhea. Hikers and campers risk infection every time they drink untreated raw water from a stream or river.

Persons in categories 4 and 5 become exposed through more direct contact with feces of an infected person, e.g., exposure to soiled diapers of an infected child (day-care center-associated cases), or through direct or indirect anal-oral sexual practices in the case of homosexual men.

Although community waterborne outbreaks of giardiasis have received the greatest publicity in the United States during the past decade, about half of the Giardia cases discussed with staff of the Centers for Disease Control in the past 2 to 3 years have a day-care center exposure as the most likely source of infection. Numerous outbreaks of Giardia in day-care centers have been reported in recent years. Infection rates for children in day-care center outbreaks range from 21 to 44% in the United States and from 8 to 27% in Canada (12,13,14,15,16,17). The highest infection rates are usually observed in children who wear diapers (1 to 3 years of age). In one study of 18 randomly selected day care centers in Atlanta (CDC unpublished data), 10% of diapered children were found infected. Transmission from this age group to older children, day-care staff, and household contacts is also common. About

20% of parents caring for an infected child will come infected.

It is important that local health officials and managers of water utility companies realize that sources of Giardia infection other than municipal drinking water exist. Armed with this knowledge, they are less likely to make a quick (and sometimes wrong) assumption that a cluster of recently diagnosed cases in a city is related to municipal drinking water. Of course, drinking water must not be ruled out as a source of infection when a larger than expected number of cases are recognized in a community, but the possibility that the cases are associated with a day-care center outbreak, drinking untreated stream water, or international travel should also be entertained.

Parasite Biology

To understand the finer aspects of Giardia transmission and the strategies for control, one must become familiar with several aspects of the parasite's biology. Two forms of the parasite exist: a trophozoite and a cyst, both of which are much larger than bacteria (see Figure 1). Trophozoites live in the upper small intestine where they attach to the intestinal wall by means of a disc-shaped suction pad on their ventral surface. Trophozoites actively feed and reproduce at this location. At some time during the trophozoite's life, it releases its hold on the bowel wall and floats in the fecal stream through the intestine. As it makes this journey, it undergoes a morphologic transformation into an egglike structure called a cyst. The cyst, which is about 6 to 9 micrometers in diameter x 8 to 12 micrometers (1/100 millimeter) in length, has a thick exterior wall that protects the parasite against the harsh elements that it will encounter outside the body. This cyst form of the parasite is infectious for other people or animals. Most people become infected either directly by hand-to-mouth transfer of cysts from the feces of an infected individual, or indirectly by drinking feces-contaminated water. Less common modes of transmission included ingestion of fecally contaminated food and hand-to-mouth transfer of cysts after touching a fecally contaminated surface. After the cyst is swallowed, the trophozoite is liberated through

the action of stomach acid and digestive enzymes and becomes established in the small intestine.

Although infection after the ingestion of only one Giardia cyst is theoretically possible, the minimum number of cysts shown to infect a human under experimental conditions is ten (18). Trophozoites divide by binary fission about every 12 hours. What this means in practical terms that if a person swallowed only a single cyst, reproduction at this rate would result in more than 1 million parasites 10 days later, and 1 billion parasites by day 15.

The exact mechanism by which Giardia causes illness is not yet well understood, but is not necessarily related to the number of organisms present. Nearly all of the symptoms, however, are related to dysfunction of the gastrointestinal tract. The parasite rarely invades other parts of the body, such as the gall bladder or pancreatic ducts. Intestinal infection does not result in permanent damage.

Transmission

Data reported to the CDC indicate that Giardia is the most frequently identified cause of diarrheal outbreaks associated with drinking water in the United States. The remainder of this article will be devoted to waterborne transmission of Giardia. Waterborne epidemics of giardiasis are a relatively frequent occurrence. In 1983, for example, Giardia was identified as the cause of diarrhea in 68% of waterborne outbreaks in which the causal agent was identified (19). From 1965 to 1982, more than 50 waterborne outbreaks were reported (20). In 1984, about 250,000 people in Pennsylvania were advised to boil drinking water for 6 months because of Giardia-contaminated water. Many of the municipal waterborne outbreaks of Giardia have been subjected to intense study to determine their cause. Several general conclusions can be made from data obtained in those studies. Waterborne transmission of Giardia in the United States usually occurs in mountainous regions where community drinking water is obtained from clear running streams, is chlorinated but is not filtered before distribution. Although mountain streams appear to be

clean, fecal contamination upstream by human residents or visitors, as well as by Giardia-infected animals such as beavers, has been well documented. It is worth emphasizing that water obtained from deep wells is an unlikely source of Giardia because of the natural filtration of water as it percolates through the soil to reach underground cisterns. Well-water sources that pose the greatest risk of fecal contamination are those that are poorly constructed or improperly located. A few outbreaks have occurred in towns that included filtration in the water treatment process, but the filtration was not effective in removing Giardia cysts because of defects in filter construction, poor maintenance of the filter media, or inadequate pretreatment of the water before it was filtered. Occasional outbreaks have also occurred because of accidental cross-connections between water and sewerage systems.

One can conclude from these data that two major ingredients are necessary for waterborne outbreak. First, there must be Giardia cysts in untreated source water and, second, the water purification process must either fail to kill or fail to remove Giardia cysts from the water.

Although beavers are often blamed for contaminating water with Giardia cysts, it seems unlikely that they are responsible for introducing the parasite into new areas. It is far more likely that they are also victims: Giardia cysts may be carried in untreated human sewage discharged into the water by small-town sewage disposal plants or originate from cabin toilets that drain directly into streams and rivers. Backpackers, campers, and sports enthusiasts may also deposit Giardia-contaminated feces in the environment that are subsequently washed into streams by rain. In support of this concept is a growing amount of data that indicate a higher Giardia infection rate in beavers living downstream from U.S. National Forest campgrounds compared with a near zero rate of infection in beavers living in more remote areas.

Although beavers may be unwitting victims in the Giardia story, they still play an important part in the transmission scheme, because they can (and probably do) serve as amplifying hosts. An amplifying host is one that is easy to infect, serves as a good habitat for the parasite to reproduce, and,

in the case of Giardia, returns millions of cysts to the water for every one ingested. Beavers are especially important in this regard because they tend to defecate in or very near the water, which ensures that most of the Giardia cysts excreted are returned to the water

The contribution of other animals to waterborne outbreaks of Giardia is less clear. Muskrats (another semiaquatic animal) have been found in several parts of the United States to have high infection rates (30 to 40%) (21). Recent studies have shown that muskrats can be infected with Giardia cysts obtained from humans and beavers. Occasional Giardia infections have been reported in coyotes, deer, elk, cattle, dogs, and cats, but not in horses and sheep, encountered in mountainous regions of the United States. Naturally occurring Giardia infections have not been found in most other wild animals (bear, nutria, rabbit, squirrel, badger, marmot, skunk, ferret, porcupine, mink, raccoon, river otter, bobcat, lynx, moose, bighorn sheep) (22).

Removal from Municipal Water Supplies

During the past 10 years, scientific knowledge about what is required to kill or remove Giardia cysts from a contaminated water supply has increased considerably. For example, it is known that cysts can survive in cold water (4 deg C) for at least 2 months and that they are killed instantaneously by boiling water (100 deg C) (23,24). It is not known how long the cysts will remain viable at other water temperatures (e.g., at 0 deg C or in a canteen at 15-20 deg C), nor is it known how long the parasite will survive on various environment surfaces, e.g., under a pine tree, in the sun, on a diaper-changing table, or in carpets in a day-care center.

The effect of chemical disinfection, such as chlorine, on the viability of Giardia cysts is an even more complex issue. It is clear from the number of waterborne outbreaks of Giardia that have occurred in communities where chlorine was employed as a disinfectant that the amount of chlorine used routinely for municipal water treatment is not effective against Giardia cysts. These observations have been confirmed in the laboratory under

experimental conditions (25,26,27). This does not mean, however, that chlorine does not work at all. It does work under certain favorable conditions. Without getting too technical, one can gain some appreciation of the problem by understanding a few of the variables that influence the efficacy of chlorine as a disinfectant.

- 1) Water pH: at pH values above 7.5, the disinfectant capability of chlorine is greatly reduced.
- 2) Water temperature: the warmer the water, the higher the efficacy. Thus, chlorine does not work well in ice-cold water from mountain streams.
- 3) Organic content of the water: mud, decayed vegetation, or other suspended organic debris in water chemically combines with chlorine making it unavailable as a disinfectant.
- 4) Chlorine contact time: the longer Giardia cysts are exposed to chlorine, the more likely it is that the chemical will kill them.
- 5) Chlorine concentration: the higher the chlorine concentration, the more likely chlorine will kill Giardia cysts. Most water treatment facilities try to add enough chlorine to give a free (unbound) chlorine residual at the customer tap of 0.5 mg per liter of water.

The five variables above are so closely interrelated that an unfavorable occurrence in one can often be compensated for by improving another. For example, if chlorine efficacy is expected to be low because water is obtained from an icy stream, either the chlorine contact time or chlorine concentration, or both could be increased. In the case of Giardia-contaminated water, it might be possible to produce safe drinking water with a chlorine concentration of 1 mg per liter and a contact time as short as 10 minutes if all the other variables were optimal (i.e., pH of 7.0, water temperature of 25 deg C, and a total organic content of the water close to zero). On the other hand, if all of these variables were unfavorable (i.e., pH of 7.9, water temperature of 5 deg C, and high organic content), chlorine concentrations in excess of 8 mg per liter with several hours of contact time may not be consistently effective. Because water conditions and water

treatment plant operations (especially those related to water retention time and, therefore, to chlorine contact time) vary considerably in different parts of the United States, neither the U.S. Environmental Protection Agency nor the CDC has been able to identify a chlorine concentration that would be safe yet effective against Giardia cysts under all water conditions. Therefore, the use of chlorine as a preventive measure against waterborne giardiasis generally has been used under outbreak conditions when the amount of chlorine and contact time have been tailored to fit specific water conditions and the existing operational design of the water utility.

In an outbreak, for example, the local health department and water utility may issue an advisory to boil water, may increase the chlorine residual at the consumer's tap from 0.5 mg per liter to 1 or 2 mg per liter, and, if the physical layout and operation of the water treatment facility permit, increase the chlorine contact time. These are emergency procedures intended to reduce the risk of transmission until a filtration device can be installed or repaired or until an alternative source of safe water, such as a well, can be made operational.

The long-term solution to the problem of municipal waterborne outbreaks of giardiasis will involve improvements in and more widespread use of filters in the municipal water treatment process. The sand filters most commonly used in municipal water treatment today cost millions of dollars to install, which makes them unattractive for many small communities. Moreover, the pore sizes in these filters are not sufficiently small to remove a Giardia (6 to 9 micrometers x 8 to 12 micrometers). For the sand filter to remove Giardia cysts from the water effectively, the water must receive some additional treatment before it reaches the filter. In addition, the flow of water through the filter bed must be carefully regulated.

An ideal prefilter treatment for muddy water would include sedimentation (a holding pond where the large suspended particles are allowed to settle out by the action of gravity) followed by flocculation or coagulation (the addition of chemicals such as alum or ammonium to cause microscopic particles to clump

together). The large particles resulting from the flocculation/coagulation process, including Giardia cysts bound to other microparticulates, are easily removed by the sand filter. Chlorine is then added to kill the bacteria and viruses that may escape the filtration process. If the water comes from a relatively clear source, chlorine may be added to the water before it reaches the filter. The point here is that successful operation of a complete water treatment facility is a complex process that requires considerable training. Troubleshooting breakdowns or recognizing potential problems in the system before they occur often requires the skills of an engineer. Unfortunately, most small water utilities that have a water treatment facility that includes filtration cannot afford the services of a full-time engineer. Filter operation or maintenance problems in such systems may not be detected until a Giardia outbreak is recognized in the community. The bottom line is that although, in reference to municipal systems, water filtration is the best that water treatment technology has to offer against waterborne giardiasis, it is not infallible. For municipal water filtration facilities to work properly, they must be properly constructed, operated, and maintained.

Water Disinfection in the Out-of-Doors

Whenever possible, persons in the out-of-doors should carry drinking water of known purity with them. When this is not practical, and water from streams, lakes, ponds, and other outdoor sources must be used, time should be taken to disinfect the water before drinking it.

Boiling

Boiling water is one of the simplest and most effective ways to purify water. Boiling for 1 minute is adequate to kill Giardia as well as most other bacterial or viral pathogens likely to be acquired from drinking polluted water.

Chemical Disinfection

Water_Copendium_1995.txt

Disinfection of water with chlorine or iodine is considered less reliable than boiling for killing Giardia. However, it is recognized that boiling drinking water is not practical under many circumstances. Therefore, when one cannot boil drinking water, chemical disinfectants such as iodine or chlorine should be used. This will provide some protection against Giardia and will destroy most bacteria and viruses that cause illness. Iodine or chlorine concentrations of 8 mg/liter (8ppm) with a minimum contact time of 30 minutes are recommended. If the water is cold (less than 10 deg C or 50 deg F) we suggest a minimum contact time of 60 minutes. If you have a choice of disinfectants, use iodine. Iodine's disinfectant activity is less likely to be reduced by unfavorable water conditions, such as dissolved organic material in water or by water with a high pH, than chlorine.

Below are instructions for disinfecting water using household tincture of iodine or chlorine bleach. If water is visibly dirty, it should first be strained through a clean cloth into a container to remove any sediment or floating matter. Then the water should be treated with chemicals as follows:

IODINE

Tincture of iodine from the medicine chest or first aid kit can be used to treat water. Mix thoroughly by stirring or shaking water in container and let stand for 30 minutes.

Tincture of Iodine	Drops* to be Added per Quart or Liter	
	Clear Water	Cold or Cloudy Water**
2%	5	10

* 1 drop = 0.05ml

** Very turbid or very cold water may require prolonged contact time; let stand up to several hours or even overnight.

CHLORINE

Liquid chlorine bleach used for washing clothes usually has 4% to 6% available chlorine. The label should be read to find the percentage of chlorine in the solution and the treatment schedule below should be followed.

Available Chlorine	Drops* to be Added per Quart or Liter	
	Clear Water	Cold or Cloudy Water**
1%	10	20
4% to 6%	2	4
7% to 10%	1	2
Unknown	10	20

* 1 drop = 0.05ml

** Very turbid or very cold water may require prolonged contact time; let stand up to several hours or even overnight.

Mix thoroughly by stirring or shaking water in container and let stand for 30 minutes. A slight chlorine odor should be detectable in the water; if not, repeat the dosage and let stand for an additional 15 minutes before using.

Filters

Newcomers in the battle against waterborne giardiasis include a variety of portable filters for field or individual use as well as some household filters. Manufacturers' data accompanying these filters indicate that some can remove particles the size of a Giardia cyst or smaller and may be capable of providing a source of safe drinking water for an individual or family during a waterborne outbreak. Such devices, if carefully selected, might also be useful in preventing giardiasis in international travelers, backpackers, campers, sportsmen, or persons who live or work in areas where water is known

to be contaminated.

Unfortunately, there are yet few published reports in the scientific literature detailing both the methods used and the results of tests employed to evaluate the efficacy of these filters against Giardia. Until more published experimental data become available, there are a few common sense things that a consumer should look for when selecting a portable or household filter. The first thing to consider is the filter media. Filters relying solely on ordinary or silver-impregnated carbon or charcoal should be avoided, because they are not intended to prevent, destroy, or repel micro-organisms. Their principal use is to remove undesirable chemicals, odors, and very large particles such as rust or dirt.

Some filters rely on chemicals such as iodide-impregnated resins to kill Giardia. While properly designed and manufactured iodide-impregnated resin filters have been shown to kill many species of bacteria and virus present in human feces, their efficacy against Giardia cysts is less well-established. The principle under which these filters operate is similar to that achieved by adding the chemical disinfectant iodine to water, except that the micro-organisms in the water pass over the iodide-impregnated disinfectant as the water flows through the filter.

While the disinfectant activity of iodide is not as readily affected as chlorine by water pH or organic content, iodide disinfectant activity is markedly reduced by cold water temperatures. Experiments on Giardia indicate that many of the cysts in cold water (4 deg C) remain viable after passage through filters containing tri-iodide or penta-iodide disinfectants (28). As indicated earlier, longer contact times (compared to those required to kill bacteria) are required when using chemical filters to process cold water for Giardia protection. Presently available chemical filters also are not recommended for muddy or very turbid water. Additionally, filters relying solely on chemical action usually give no indication to the user when disinfectant activity has been depleted.

The so-called microstrainer types of filters are true filters. Manufacturer data accompanying these filters indicate that some have a sufficiently small pore size to physically restrict the passage of some micro-organisms through the filter. The types of filter media employed in microstraining filters include orlon, ceramic, and proprietary materials. Theoretically, a filter having an absolute pore size of less than 6 micrometers might be able to prevent Giardia cysts of 8 to 10 micrometers in diameter from passing. However, when used as a water sampling device during community outbreaks, portable filters in the 1- to 3- micrometer range more effectively removed Giardia cysts from raw water than filters with larger pore sizes. For effective removal of bacterial or viral organisms which cause disease in humans, microstraining filters with pore sizes of less than 1 micrometer are advisable. However, the smaller the pores, the more quickly the filters will tend to clog. To obtain maximum filter life, and as a matter of reasonable precaution, the cleanest available water source should always be used. Keep in mind, however, that even sparkling, clear mountain streams can be heavily contaminated.

Secondly, because infectious organisms can be concentrated on the filter element/media, it is important to consider whether the filter element can be cleaned or replaced without posing a significant health hazard to the user. Properly engineered portable filters should also minimize the possibility of contaminating the "clean water side" of the filter with contaminated water during replacement or cleaning of the filter element. This is especially important for filters used in the field where they are often rinsed or "cleaned" in a stream or river that may be contaminated.

Ongerth (29) recently evaluated four filters (First Need, H20K, Katadyn, the Pockett Purifier) for their ability to remove Giardia cysts from water. Only the First Need and Katadyn filters removed 100% of the cysts.

Conclusion

In conclusion, during the past fifteen years, giardiasis has been recognized

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as one of the most frequently occurring waterborne diseases in the United States. The most common sources of water contamination include improperly treated municipal sewage, infected animals, and indiscriminate defecation by outdoorsmen. Chlorine concentrations in the 0.1 mg per liter to 0.5 mg per liter range are largely ineffective against Giardia at the contact times commonly employed by municipal water utilities. The long-term solution to the problem of municipal waterborne outbreaks of giardiasis will involve appropriate pretreatment combined with improvements in and more widespread use of filters in the municipal water treatment process. While both micrometer- and submicrometer-rated filters are being employed on a limited scale for personal or household use, further evaluation of the efficacy of filters distributed by different manufacturers is needed to enable individuals and public health personnel to distinguish those that are safe and effective from those that are not.

TABLE I

	Percentage	Number of Patients
Symptoms		
Diarrhea*	84	516
Malaise	80	56
Weakness	72	324
Abdominal cramps	63	412
Weight loss (0.5 - 11 kg)	63	412
Greasy, foul smelling stools	59	412
Nausea	57	444
Headaches	53	92
Anorexia	49	156
Abdominal bloating	45	380
Flatulence	41	388
Constipation	25	88
Vomiting	24	488

Fever	22	32
Physical finding		
Abdomen tender to palpitation	66	92
Laboratory findings		
Blood		
Anemia	15	124
Leukocytosis	9	32
Stool		
Increased mucus	56	32
Increased neutral fats	50	32
Blood	13	156

* Index symptom; may be biased (upward)

TABLE 1 - Based on data from Fifty diseases: Fifty Diagnoses, by M.G. Periroth and D.J. Weiland. Year Book Medical Publishers, Inc., Chicago, 1981, pp. 158-159. Reprinted by special arrangement with Year Book Publishers, Inc.

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Back-country water treatment to prevent giardiasis.

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Abstract

This study was conducted to provide current information on the effectiveness of water treatment chemicals and filters for control of Giardia cysts in areas where treated water is not available. Four filters and seven chemical treatments were evaluated for both clear and turbid water at 10C. Three contact disinfection devices were also tested for cyst inactivation. Filters were tested with 1-liter volumes of water seeded with 3×10^4 cysts of *G. lamblia* produced in gerbils inoculated with in vitro cultured trophozoites; the entire volume of filtrate was examined for cyst passage. Chemical treatments were evaluated at concentrations specified by the manufacturer and for contact times that might be expected of hikers (30 minutes) and campers (eight hours, i.e., overnight). Two of the four filter devices tested were 100 percent effective for Giardia cyst removal. Of the other two filters, one was 90 percent effective and the other considerably less effective. Among the seven disinfection treatments, the iodine-based chemicals were all significantly more effective than the chlorine-based chemicals. None of the chemical treatments achieved 99.9 percent cyst inactivation with only 30-minute contact. After an eight-hour contact each of the iodine but none of the chlorine preparations achieved at least 99.9 percent cyst inactivation. None of the contact disinfection devices provided appreciable cyst inactivation. Heating water to at least 70C for 10 minutes was an acceptable alternative treatment.

Introduction

Giardia lamblia is the most commonly identified human intestinal parasite in the United States. Giardiasis is commonly transmitted between humans, especially among small children. It is also transmitted in water, particularly in the mountainous regions of the U.S. Since 1965, over 80 waterborne outbreaks of

giardiasis have occurred in community water systems, affecting more than 20,000 persons (1). Giardiasis in hikers and campers has also been documented (2,3); indeed, it is commonly considered a backpackers' illness. Giardia cysts in concentrations as high as four per gallon have been detected in untreated surface water in northeastern and western states (4).

Concern over waterborne transmission of Giardia has led to development of a variety of chemical disinfectants and portable filters for individual use in the backcountry. Although some information on such methods has been reported (2,5,6), there is no comprehensive guide to their reliability in actually removing or inactivating Giardia cysts. We tested four commercially available portable filters and one contact disinfection device for their ability to remove Giardia cysts from water. We also evaluated the cysticidal effectiveness of seven chemical disinfectants and three contact disinfection devices.

Methods

Cysts of *G. lamblia* were prepared for use in both the filtration and disinfection tests by propagation in gerbils inoculated with trophozoites from sterile culture. Trophozoites were of two isolates: one from a beaver (Be-4 isolate from Alberta) and one from a human (H-2 CSU isolate from Colorado). Cysts were concentrated from crushed, filtered gerbil feces by flotation on zinc sulfate (sp. gr. 1.18), cleaned, and stored in distilled water at 4C for up to 10 days before use. Similarly, *G. muris* cysts of an isolate originally obtained from hamsters (7) were purified from feces of infected athymic (nu/nu) mice and stored before use. Cyst concentrations were determined with a Coulter Counter (Model ZBI, Coulter Electronics, Hialeah, FL) and a haemocytometer. Except where noted, cysts were added to water samples in concentrations of about 3×10^4 /ml. Cyst viability was assayed by fluorogenic staining (8) and in vitro excystation (7). In the former method, live cysts are distinguished by two fluorescing dyes. One dye is fluorescein diacetate (FDA), which when absorbed by cysts produces a fluorescent green only in live cysts; the second dye, either

propidium iodide (PI) or ethidium bromide (EB), is excluded efficiently by live cysts but absorbed by dead cysts, resulting in red fluorescence.

Filter testing

The following backpacker-type water filters were purchased from local retailers: First Need Water Purification Device (First Need), General Ecology Inc., Lionville, PA; H2OK Portable Drinking Water Treatment Unit Model No. 6 (H2OK), Better Living Laboratories Inc., Memphis, TN; Katadyn Pocket Filter (Katadyn), Katadyn Products Inc., Wallisellen, Switzerland; and Pocket Purifier, Calco Ltd, Rosemont, IL. Also noted in this category is the Water Tech Water Purifier (Water Purifier), Water Technologies Corp., Ann Arbor, MI. Although it is not advertised as a filter and was not specifically tested for Giardia cyst removal, we report qualitative observations made during disinfection testing (see below) because its configuration and mode of operation suggest that particle removal may occur. Physical and operating information provided in the filter packaging is summarized in Appendix A. Each device was tested when it was new. Devices that removed all cysts when new were retested after a period of use approximating several months for a regular weekend user.

Each filter was prepared for testing by filtering four liters of tap water to purge loose carbon particles or debris. The cyst removal performance of each filter was determined by filtering one liter of spring water, turbidity of 0.1 NTU, to which formalin-fixed *G. lamblia* cysts had been added. The entire filtrate volume was passed through a 25-mm dia., 5-um pore size, polycarbonate membrane (Nuclepore, Pleasanton, CA). stained with EB (100 ug/ml), and mounted under a cover slip. Cysts were counted at x250 magnification with the aid of epifluorescence microscopy. A representative portion of each filter was examined to quantify cyst recovery as described previously (9). The area examined was inversely proportional to the number of cysts found and ranged from 3.5 percent of seeded positive control filters to 25 percent (one quadrant) of filters with cyst densities less than one per field. Total numbers of cysts present were estimated by extrapolation in direct proportion to the area examined. In extensive work on recovery of Giardia cysts using the procedures

described above, cyst retention on the 5-um polycarbonate membrane in a single filtration step has routinely averaged 80 to 90 percent (Ongerth JE: unpublished). Accordingly, the ability to identify high levels of cyst removal, which would result in passage of very few or no cysts, is excellent. This ability is unaffected by the factors that contribute to lack of precision in counting large numbers of cysts on filters; such inaccuracies usually occur when only small representative subareas are examined and the total numbers are estimated by extrapolation. A seeded positive control and an unseeded negative control were processed with each batch of filter evaluations. The cyst removal performance evaluation was replicated three times for each filter device, with results expressed as the arithmetic average and corresponding standard deviation.

Contact Disinfection Testing

The Water Purifier is described in packaging information as a contact disinfection device. Likewise, the H20K and Pocket Purifier devices are described as providing disinfection as well as removing cysts by filtration. These devices were therefore tested for their effect on cyst viability in addition to filtration efficiency. A single 500-ml sample for each device was seeded with approximately 2.5×10^4 cysts and passed through the device. Filtrate was collected and filtered as described above to recover cysts. The viability of cysts was then assessed by FDA and EB staining as described below.

Disinfectant Testing

The cysticidal effects of seven commercially available and commonly used disinfectant preparations were tested with identical procedures. Four of the products were iodine based: Polar Pure Water Disinfectant (Polar Pure), Polar Equipment, Saratoga, CA; Coghlan's Emergency Germicidal Drinking Water Tablets (CEGDWT). Coghlan's Ltd, Winnipeg, Canada; Potable Aqua Drinking Water Germicidal Tablets (Potable Aqua), Wisconsin Pharmacal Inc., Jackson, WI; and 2 percent iodine prepared from I2 reagent grade (Baker, Phillipsburg, NJ). The remaining three products were chlorine-based: Sierra Water Purifier (Sierra), 4

Water_Copendium_1995.txt

in 1 Water Co., Santa Fe, NM; Halazone, Abbott Laboratories, North Chicago, IL; and commercial liquid bleach (5.25 percent sodium hypochlorite). Disinfectant solutions were characterized by pH and total halogen concentration (Appendix B), the latter being determined colorimetrically using the DPD method.

Two water sources were used, one to reflect clear high-mountain conditions, the other to reflect downstream, more turbid conditions. Water sources were characterized by pH, turbidity, and free chlorine demand (Appendix C). The upstream source was from a small, spring-fed tributary to the Snoqualmie River near North Bend, Washington. Samples were taken from the stream approximately 50 yards downstream from the spring. The downstream source was the discharge from Lake Washington in Seattle, Washington. Samples were taken in midstream at the entrance to Portage Bay, adjacent to the University of Washington campus. Water samples were prepared for testing by adding disinfectant, according to manufacturers' instructions, to one liter of water in stoppered glass bottles (Appendix B).

Cysticidal properties of the chemical treatments were determined as follows.

- 1) Water was put in 50-ml disposable plastic centrifuge tubes and placed in a 10°C incubator.
- 2) *G. lamblia* cysts were added to each test sample at time zero.
- 3) Tubes were vortex-mixed, sampled, and returned to the incubator.
- 4) At each sampling time, i.e., time 0, 30 minutes and 8 hours, a 10-ml sample was withdrawn; a portion was used for measuring disinfectant concentration, and in the remainder the disinfectant was quenched with 0.1-mM sodium thiosulphate.
- 5) Cysts in the quenched sample portion were exposed to aqueous solutions of the viability indicators, FDA (25 ug/ml) and EH (100 ug/ml), filtered on to a 13-mm dia. 5-um pore-size filter membrane, and rinsed with distilled water (10 ml).

6) Filters were mounted on glass slides, sealed under coverslips and examined by epifluorescence microscopy at x250 magnification (Model 16, Carl Zeiss, Inc., Thornwood, NY) to enumerate proportions of red and green fluorescing cysts indicating dead and live status, respectively. The viability baseline of the cysts was established by running a control sample of untreated water seeded with cysts through each test, using procedures identical to those for disinfectant-treated samples. Data are presented in terms of percent survival relative to the controls (Figure 2). The effectiveness of each disinfectant for killing cysts in both upstream and downstream water was determined in triplicate, with results expressed as the arithmetic average and corresponding standard deviation.

The Water Tech Water Purifier, a contact disinfectant, was also tested as a chemical disinfectant. The test water was 100 ml of spring-source water seeded with *Giardia* cysts. The treated water was filtered, stained, and examined for cyst viability as described in steps 5 and 6 above. Three replicates were assayed.

Heat Inactivation

Inactivation of *G. lamblia* and *G. muris* cysts by heating was established as follows. Cysts were added to distilled water in 15-ml glass test tubes. The seeded tubes were incubated for 10 minutes at temperatures ranging from 10C to 70C. Afterwards, cyst suspensions were cooled immediately by swirling in 10C water for one minute. Cyst viability was determined either by excystation or by staining. If by the latter, FDA and EB were added to the samples, the tubes were vortex-mixed, and a 1-ml aliquot was filtered through a 13-mm dia. 5-um pore-size filter membrane. Filters were rinsed, mounted, and examined as described above to enumerate the live and dead cysts.

Results

Filter Device Tests

The four filters differed significantly in their ability to remove Giardia cysts (Figure 1). The number of cysts recovered from water having passed through the filter devices ranged from zero to greater than 10^4 in individual tests. The performance of individual devices was consistent as indicated by the standard deviations for each of the three replicate test sets (Figure 1). The percentage of cysts removed by the devices, corresponding to 100 minus the percent of cysts recovered from the filtrate, was 100 percent for the First Need and Katadyn filters and approximately 90 percent for the H20K filter. The concentration of cysts in the Pocket Purifier effluent was not statistically different from the seed concentration.

The First Need and Katadyn filters were then subjected to a period of moderate use and then retested. The volume of water processed during the simulated use period was not the same for the two filters owing to differences in their operation. The difference in volume had no apparent effect on performance of the two filters. A total of 88 liters of tap water (turbidity of 0.3 NTU) was filtered with the First Need. During the process it was back-flushed, as recommended in package instructions, because the filtration rate decreased after 50, 71, and 75 liters had been filtered. After 88 liters had been processed, the filtration rate was about 25 percent lower than when the filter was new, and it was retested in that condition. The Katadyn filter was subjected to use by filtering one liter of tap water four times a day for five days. At the end of each day, the filter was cleaned according to package instructions by disassembling, brushing the filter element, and allowing it to air-dry overnight before reassembly. After the respective periods of use, these two filters were tested in triplicate for efficiency of cyst removal. Performance of these filters was the same, 100 percent cyst removal, when they were retested.

Cyst Inactivation

Contact Disinfection Devices - The effect of each of the contact disinfection devices on *G. lamblia* cyst viability was limited. The Water Purifier

inactivated about 15 percent of the cysts added in 100 ml of upstream (low turbidity) water; the H2OK filter inactivated about 5 percent of the cyst challenge, and the Pocket Purifier inactivated about 2 percent of the cyst challenge.

Chemical Disinfectants - The effectiveness of seven disinfecting chemical preparations ranged from only a few percent to greater than 99.9 percent, depending on the chemical and its concentration, the contact time, and the disinfectant demand of the water (Figure 2). None of the disinfectants was more than 90 percent effective after a contact time of 30 minutes. After eight-hour contact, the four iodine-based disinfectants, each caused a greater than 99.9 percent reduction in viable cysts. The chlorine-based disinfectants were clearly less effective than the iodine-based ones at both contact times.

Heating in Water - Experiments conducted with cysts of *G. lamblia* and of *G. muris* indicated that the two species have virtually the same sensitivity to inactivation by heating. Cysts at both species were completely inactivated by heating to 70C for 10 minutes. Heating to 50C and 60C for 10 minutes produced 95 and 98 percent inactivation, respectively (Figure 3).

Discussion

To remove *Giardia* cysts from water, one must use a filter with sufficiently small pores to trap the cysts and sufficiently large capacity to produce a useful volume of treated water before backwashing or replacement is necessary. Although a number of manufacturers advertise that their filters remove *Giardia* cysts, the only previously published account of filter performance was for the Katadyn unit (6). Our filter evaluation study showed that only the First Need and the Katadyn filters removed cysts with at least 99.9 percent effectiveness. Under the same test conditions, the H2OK filter was approximately 90 percent effective and the Pocket Purifier was less than 50 percent effective for cyst removal. The analysis of viability for the cysts collected in the effluent of

the Water Purifier, H2OK, and Pocket Purifier indicates that passage through the device did not significantly reduce the percentage of viable cysts.

The current study showed that none of the chemical treatments could inactivate more than 90 percent of cysts with 30 minutes of contact time at 10C. At both 30 minutes and eight hours of contact time, the iodine-based disinfectants inactivated a higher fraction of cysts than did the chlorine-based products. All methods inactivated a lower percentage of cysts in cloudy or turbid water than in clear water. All disinfectants performed better with eight hours of contact time than with 30 minutes. Only the iodine-based compounds inactivated 99 to 99.9 percent of cysts, within eight hours of contact time for both turbid and clear water. As observed by Jarroll, et al (5), the 2 percent tincture of iodine was less effective than the other iodine preparations with 30 minutes of contact time, but it was as effective as the others at eight hours. Comparison of our results with those of Jarroll, et al (5), is complicated by differences between test conditions used. However, our results generally indicate more stringent requirements for effective inactivation of Giardia cysts. Differences between cyst populations used in the two studies could account for the observed differences, even though both were *G. lamblia*. Cysts produced in our trophozoite - gerbil system had consistently high intrinsic viability (>80 percent), excysted efficiently when fresh (80 to 90 percent), and have appeared more resistant to halogen disinfectants than reported previously (Ongerth J.E.: unpublished).

The results of heat inactivation in our study correspond to previous reports indicating that heating to between 60C and 70C kills Giardia cysts efficiently. In addition, our data illustrate the correspondence between the fluorogenic staining and in vitro excystation procedures for assessing cyst viability. When applied to cysts of the same condition. Staining indicates a slightly higher proportion of viable cysts than does excystation. Overall, however, the two procedures provide comparable information.

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Figure 1 - Effectiveness of Four Portable Water Filters for Removal of Giardia Cysts from One-Liter Volumes of Water Each containing approximately 3×10^4 Cysts (dotted line). [A bar chart showing the positive and negative controls and results from the filters, on a log scale. The First Need and Katadyn results and the negative control were all zero. The Pocket Purifier and the positive control were approximately the same - i.e. the Pocket Purifier did not remove cysts at all. The H2OK results were somewhat below the positive control, actually -- due to the log scale -- indicating 90% removal.]

Figure 2 - Effect of Time and Disinfectant Concentration of Seven Chemical Disinfectants on Survival of *G. lamblia* Cysts in Turbid and in Clear Water. [A rather striking bar chart comparing chemical treatments under varying conditions. The chlorine compounds were basically ineffective, with no significant effect at 30 minutes; at 8 hours the Sierra was still totally ineffective, the bleach killed about half the cysts, and the Halazone killed 70-90% of the cysts (better in clear water). The iodine compounds were poor at 30 minutes in turbid water (half killed), only a little better at 30 minutes in clear water (70-90% killed, with Potable Aqua the best), but completely effective (100% killed) after 8 hours.]

Figure 3 - Inactivation of Giardia Cysts as a Function of Temperature (10-minute exposures) as Indicated by Ethidium Bromide Staining and by in vitro Excystation. [A line chart showing cyst survival at different temperatures. Four combinations of Giardia species, source, and laboratory technique are shown, but all show approximately the same results. 40C kills no cysts; 50C kills a lot of cysts, 60C kills most cysts, 70C kills all cysts.]

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References to commercial products shall not be construed to represent or imply the approval or endorsement by project investigators or sponsors.

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 Appendix A: Water Filter characteristics Listed by Manufacturers on Packaging or Instruction Insert

[Manufacturer column omitted. See text for this information.]

Name	Filter Type	Operating Mode	Operating Rate	Useful Life	Restrictions /Limitations
First Need	0.4 um microscreen plus adsorber	hand pump	1 pt/min	up to 800 pints	A
H20K	6 um mesh, 3 in. activated carbon w/Ag	gravity	1 qt/min	2000 gal	A, B
Katadyn Pocket Filter	0.2 um ceramic, Ag-impregnated	hand pump	1 qt/min	many years	A
Pocket Purifier	10 um (nominal), halogenated resin (38% I), Ag-impregnated carbon	mouth suction	-	-	A
Water Purifier (a)	Polystyrene resin bed (46% I2 as I5)	gravity	-	100 gal	A, C

A - Does not desalinate; not for saltwater or brackish water.

B - Pretreat with I2 for bacterially contaminated water.

C - Not for use with muddy water.

(a) Not described as a filter by package information.

Appendix B: Characteristics of Disinfectant Preparations

[Manufacturer column omitted. See text for this information.]

Name	Active Chemical	Recommended Application	Total Halogen Concentration (a), (mg/liter)	pH (b)
Polar Pure	Crystalline iodine, 99.5%	1-7 capfuls per quart depending on temperature	2.4 (1 cap/quart)	6.1
CEGDWT	Tetraglycine hydro-periodate 16.7% (6.68% titrable iodine)	1 tablet per liter or quart	4.5 (1 tab/quart)	5.6
Potable Aqua	Tetraglycine hydro-periodate 16.7% (6.68% titrable iodine)	1 tablet per liter or quart	5.3 (1 tab/quart)	5.6
2% Iodine	Iodine	0.4 ml per liter	4.5	6.5
Sierra	Calcium hypochlorite & hydrogen peroxide	100 crystals (50 mg) Ca(OCl) ₂ + 6 drops H ₂ O ₂ per gallon	11.6	6.7
Halazone	p-dichloro-sulfamoyl	5 tablets per quart	7.5	6.7

benzoic acid, 2.87%

Chlorine	sodium hypo-chlorite, 5 ml per gallon	3.9	7.1
bleach	5.25%		

- (a) As prepared according to package instructions.
- (b) In water treated according to package instructions.

Appendix C: Characteristics of Disinfectant Test Water

Source	pH	Turbidity (NTU)	Chlorine Demand (a) (mg.liter)
Spring-fed	6.8	0.09	0.3
Lake Washington	7.1	0.75 - 0.80	0.7

- (a) 30 minutes, free chlorine demand (5).

The authors

Address reprint requests to Jerry E. Ongerth, PhD, PE, Assistant professor, Department of Environmental Health, SB-75, University of Washington, School of Public Health and Community Medicine, Seattle, WA 98195. Dr. Stibbs is with the Department of Pathobiology, also at the School, and Mr. Macdonald is with the Department of Medical Education, School of Medicine, both at the University of Washington; Mr. Johnson is with the Department of Biological Chemistry, Johns Hopkins School of Medicine, Baltimore; Dr. Frost is with the Office of Environmental Programs, Department of Social and Health Sciences, Olympia, WA. This paper, submitted to the Journal January 12, 1989, was revised and accepted

for publication June 22, 1989.

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AU XIAO LH; HERD RP
TI EPIDEMIOLOGY OF EQUINE CRYPTOSPORIDIUM AND GIARDIA INFECTIONS
SO EQUINE VETERINARY JOURNAL. V0026 N1. JAN 1994. pp. 14-17.

AB Prevalence and infection patterns of Cryptosporidium and Giardia infections in horses were studied by a direct immunofluorescence staining method. Faecal examinations of 222 horses of different age groups revealed Cryptosporidium infection rates of 15-31% in 66 foals surveyed in central Ohio, southern Ohio and central Kentucky, USA. Only 1 of 39 weanlings, 0 of 46 yearlings, and 0 of 71 mares were positive. Giardia infection was found in all age groups, although the infection rates for foals were higher (17-35%). Chronological study of infection in 35 foals showed that foals started to excrete Cryptosporidium oocysts between 4 and 19 weeks and Giardia cysts between 2 and 22 weeks of age. The cumulative infection rates of Cryptosporidium and Giardia in foals were each 71%. Some foals were concurrently infected with both parasites and excretion of oocysts or cysts was intermittent and long-lasting. The longest duration of excretion was 14 weeks for Cryptosporidium and 16 weeks for Giardia. Excretion of Cryptosporidium oocysts stopped before weaning, while excretion of Giardia cysts continued thereafter. Infected foals were considered the major source of Cryptosporidium infection in foals, whereas infected mares were deemed the major source of Giardia infection in foals. The high infection rate of Giardia in nursing mares suggested a periparturient relaxation of immunity. The results indicated that Cryptosporidium and Giardia infections are common in horses.

AD Reprint: OHIO STATE UNIV,DEPT VET PREVENT MED,1900 COFFEY
RD/COLUMBUS//OH/43210.

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REI Water Filter Chart

REI Water Filters Comparison Chart:

	Katadyne	MSR	PUR	First Need
Minimum Pore Size	.2 absolute	.1 absolute	1.0 nominal	.4 absolute
Weight	23 oz.	19 oz.	21 oz.	14 oz.
Number of Filter Elements	2	4	2	1
Types of Elements	Screen, Ceramic	Foam, Screen Carbon, Paper Membrane	Glass Fibre, Iodine resin	Charcoal
Cost Per Gallon	\$.25	\$.28	\$.24	\$.37
Appr. Filter Life (in Gallons)	1000	500	500	100
Approximate Filtering Time (in Quarts)	120 seconds	90 seconds	60 seconds	90 seconds
Cost of		Two Parts		

Water_Copendium_1995.txt

Replacement Filter	\$89.00	\$20.00 & \$30.00	\$40.00	\$24.00
Price	\$225.00	\$140.00	\$130.00	\$37.00

For room reasons I left off two filters. Its specs are in order:

Basic Designs

1.0 absolute, 12 oz., 2, Granular active carbin & ceramic, \$.07, 1000, 60 MINUTES!, \$40.00, \$60.00.

Timber Line:

2.0 absolute, 6 oz., 1, Spun Polypro, \$.30, 100, 70 Seconds, \$??, \$30.00.

The filtering times are probably based on a new unit. Some units are easy to clean, one can't be properly, and one can be cleaned on the fly.

Lower prices can be found elsewhere than REI. REI charges list mostly.

Also note some units are easier to use (and clean) than others.

	Katadyn	MSR	PUR	1stNeed	line	Designs	
min pore size	.2	.1	1 + I	.4	2	1	
dry weight	23 oz	19 oz	21 oz	14 oz	6 oz	12 oz	
seconds/qt	120	90	60	90	70	grav-	(when new)
seconds/qt	120	180	60	180	140	ity	(after usage)
filter life	1000	500	500	100	100	1000	(in gallons)
cost/gallon	\$.25	\$.28	\$.24	\$.37	\$.30	\$.07	
retail price	\$225	\$140	\$130	\$ 38	\$ 30	\$ 65	
replacement	\$ 89	\$ 50	\$ 40	\$ 24	n/a	\$ 40	(filter cost)
# elements	2	4	3	1	1	2	
elements	screen ceramic	foam screen carbon	screen glassfiber iodine	carbon	polypro	carbon ceramic	

paper

Notes: 1st Need, Timberline, and Basic Designs require iodine to treat bacteria and viruses. Katadyn and MSR require iodine to treat viruses. Only PUR requires no additional iodine. With carbon elements, only MSR, 1st Need, and Basic Designs remove harmful chemicals.

TABLE OF CONTENTS of this chain:

- 9/ Water Filter wisdom < * THIS PANEL * >
- 10/ Volunteer Work
- 11/ Snake bite
- 12/ Netiquette
- 13/ Questions on conditions and travel
- 14/ Dedication to Aldo Leopold
- 15/ Leopold's lot.
- 16/ Morbid backcountry/memorial
- 17/ Information about bears
- 18/ Poison ivy, frequently ask, under question
- 19/ Lyme disease, frequently ask, under question
- 20/ "Telling questions" backcountry Turing test
- 21/ AMS
- 22/ Words from Foreman and Hayduke
- 23/ A bit of song (like camp songs)
- 24/ What is natural?
- 25/ A romantic notion of high-tech employment
- 26/ Other news groups of related interest, networking
- 27/ Films/cinema references
- 28/ References (written)
- 1/ DISCLAIMER
- 2/ Ethics
- 3/ Learning I
- 4/ learning II (lists, "Ten Essentials," Chouinard comments)
- 5/ Summary of past topics

- 6/ Non-wisdom: fire-arms topic circular discussion
- 7/ Phone / address lists
- 8/ Fletcher's Law of Inverse Appreciation / advice and Rachel Carson

From: alanmalk
Subject: Review-Katadyn Mini Filter

Equipment Review - Katadyn Minifilter

Specifications: weight 8.2 oz., filters to 0.2 microns, pump force 13 lbs., output 0.5 liters per minute, cost \$150.
Specifications taken w/o permission from REI catalog.

Personal observations: My wife and I used the Katadyn Minifilter on a 4 day backpack trip to Colorado. Most of the trip was just below tree line. It did not rain during this period. As the primary pumper, let me say I possess reasonable upper body strength. (Prior to the trip I built a wood fence using hand tools and a hand post hole digger.)

The first time I used the filter I tossed the intake screen into a fast moving, clear trout stream. The intake settled onto what I thought was a clean rock, and I began pumping. After dozens of strokes without pumping a drop I speculated that the filter was defective. After disassembly and inspection I concluded the metal intake screen had clogged and the ceramic element had a thick "gunk" coating. My "clean" rock was covered with a thin layer of brown algae which plugged the system on the first stroke.

Disassembly was quick, requiring a half turn of the outlet spout. The cleaning tool is actually a metal file which scrapes off a layer of ceramic, exposing a fresh surface. The instructions claim 100 cleanings are possible. A measuring device (included) determines when the remaining ceramic material is worn away. The plugged metal screen was cleaned with a finger nail. Reassembly was equally quick but no effort was made to keep unfiltered water from contaminating the "clean area".

Water_Copendium_1995.txt

For the next attempt, I filled a 2 quart pot and dropped in the intake hose. Contaminated water from the first dozen strokes was discarded. Pumping one quart required an average of 150 strokes. Relative effort was high, requiring a "death grip" on the filter body to aim the stream of filtered water into the canteen. Average time to filter a quart was 5 minutes. Averages were computed over the

4 day period, during which time 3 additional cleanings were necessary while filtering 6 to 8 quarts per day.

Other observations: The intake screen jumped 2 inches on each stroke and tended to "walk" out of the pot. A clothes pin would have been handy here. Of greater concern was the single drop of unfiltered water leaking from around the pump shaft after every 10 to 20 strokes. Holding the pump at the wrong angle would allow this water to drip into the canteen. As a precaution I added Polar Pure iodine at half strength and doubled the waiting period. Finally comment - it took my wife about 10 minutes to pump a quart, including rest periods.

Conclusion. The Katadyn Minifilter is acceptable only if:

A - Filtration is the preferred method of water treatment.

B - Weight and small size is critical.

C - Intended use is by one or two people, max.

Cleaning is necessary after pumping 6 quarts of water with no visible particulates (except for 10 inch trout), bringing the estimated cost to \$0.25 per quart. Compare this to less than a penny per quart for Polar Pure. Pumping effort will work up a sweat and preventing unfiltered water from contaminating filtered water is problematic. The unit is mechanically rugged and will probably survive greater abuse than - for example - the First Need. Access to critical parts is very good.

Reviewer - Alan Malkiel

Contact Disinfection Testing

The Water Purifier is described in packaging information as a contact disinfection device. Likewise, the H2OK and Pocket Purifier devices are described as providing disinfection as well as removing cysts by filtration. These devices were therefore tested for their effect on cyst viability in addition to filtration efficiency. A single 500-ml sample for each device was seeded with approximately 2.5×10^4 cysts and passed through the device. Filtrate was collected and filtered as described above to recover cysts. The viability of cysts was then assessed by FDA and EB staining as described below.

Disinfectant Testing

The cysticidal effects of seven commercially available and commonly used disinfectant preparations were tested with identical procedures. Four of the products were iodine based: Polar Pure Water Disinfectant (Polar Pure), Polar Equipment, Saratoga, CA; Coghlan's Emergency Germicidal Drinking Water Tablets (CEGDWT). Coghlan's Ltd, Winnipeg, Canada; Potable Aqua Drinking Water Germicidal Tablets (Potable Aqua), Wisconsin Pharmacal Inc., Jackson, WI; and 2 percent iodine prepared from I2 reagent grade (Baker, Phillipsburg, NJ). The remaining three products were chlorine-based: Sierra Water Purifier (Sierra), 4 in 1 Water Co., Santa Fe, NM; Halazone, Abbott Laboratories, North Chicago, IL; and commercial liquid bleach (5.25 percent sodium hypochlorite). Disinfectant solutions were characterized by pH and total halogen concentration (Appendix B), the latter being determined colorimetrically using the DPD method.

Two water sources were used, one to reflect clear high-mountain conditions, the other to reflect downstream, more turbid conditions. Water sources were characterized by pH, turbidity, and free chlorine demand (Appendix C). The upstream source was from a small, spring-fed tributary to the Snoqualmie River near North Bend, Washington. Samples were taken from the stream approximately 50 yards downstream from the spring. The downstream source was the discharge

from Lake Washington in Seattle, Washington. Samples were taken in midstream at the entrance to Portage Bay, adjacent to the University of Washington campus. Water samples were prepared for testing by adding disinfectant, according to manufacturers' instructions, to one liter of water in stoppered glass bottles (Appendix B).

Cysticidal properties of the chemical treatments were determined as follows.

- 1) Water was put in 50-ml disposable plastic centrifuge tubes and placed in a 10C incubator.
- 2) *G. lamblia* cysts were added to each test sample at time zero.
- 3) Tubes were vortex-mixed, sampled, and returned to the incubator.
- 4) At each sampling time, i.e., time 0, 30 minutes and 8 hours, a 10-ml sample was withdrawn; a portion was used for measuring disinfectant concentration, and in the remainder the disinfectant was quenched with 0.1-mM sodium thiosulphate.
- 5) Cysts in the quenched sample portion were exposed to aqueous solutions of the viability indicators, FDA (25 ug/ml) and EH (100 ug/ml), filtered on to a 13-mm dia. 5-um pore-size filter membrane, and rinsed with distilled water (10 ml).
- 6) Filters were mounted on glass slides, sealed under coverslips and examined by epifluorescence microscopy at x250 magnification (Model 16, Carl Zeiss, Inc., Thornwood, NY) to enumerate proportions of red and green fluorescing cysts indicating dead and live status, respectively. The viability baseline of the cysts was established by running a control sample of untreated water seeded with cysts through each test, using procedures identical to those for disinfectant-treated samples. Data are presented in terms of percent survival relative to the controls (Figure 2). The effectiveness of each disinfectant for killing cysts in both upstream and downstream water was determined in triplicate, with results expressed as the arithmetic average and corresponding standard deviation.

The Water Tech Water Purifier, a contact disinfectant, was also tested as a chemical disinfectant. The test water was 100 ml of spring-source water seeded with Giardia cysts. The treated water was filtered, stained, and examined for cyst viability as described in steps 5 and 6 above. Three replicates were assayed.

Heat Inactivation

Inactivation of *G. lamblia* and *G. muris* cysts by heating was established as follows. Cysts were added to distilled water in 15-ml glass test tubes. The seeded tubes were incubated for 10 minutes at temperatures ranging from 10C to 70C. Afterwards, cyst suspensions were cooled immediately by swirling in 10C water for one minute. Cyst viability was determined either by excystation or by staining. If by the latter, FDA and EB were added to the samples, the tubes were vortex-mixed, and a 1-ml aliquot was filtered through a 13-mm dia. 5-um pore-size filter membrane. Filters were rinsed, mounted, and examined as described above to enumerate the live and dead cysts.

Results

Filter Device Tests

The four filters differed significantly in their ability to remove Giardia cysts (Figure 1). The number of cysts recovered from water having passed through the filter devices ranged from zero to greater than 10^4 in individual tests. The performance of individual devices was consistent as indicated by the standard deviations for each of the three replicate test sets (Figure 1). The percentage of cysts removed by the devices, corresponding to 100 minus the percent of cysts recovered from the filtrate, was 100 percent for the First Need and Katadyn filters and approximately 90 percent for the H2OK filter. The concentration of cysts in the Pocket Purifier effluent was not statistically different from the

seed concentration.

The First Need and Katadyn filters were then subjected to a period of moderate use and then retested. The volume of water processed during the simulated use period was not the same for the two filters owing to differences in their operation. The difference in volume had no apparent effect on performance of the two filters. A total of 88 liters of tap water (turbidity of 0.3 NTU) was filtered with the First Need. During the process it was back-flushed, as recommended in package instructions, because the filtration rate decreased after 50, 71, and 75 liters had been filtered. After 88 liters had been processed, the filtration rate was about 25 percent lower than when the filter was new, and it was retested in that condition. The Katadyn filter was subjected to use by filtering one liter of tap water four times a day for five days. At the end of each day, the filter was cleaned according to package instructions by disassembling, brushing the filter element, and allowing it to air-dry overnight before reassembly. After the respective periods of use, these two filters were tested in triplicate for efficiency of cyst removal. Performance of these filters was the same, 100 percent cyst removal, when they were retested.

Cyst Inactivation

Contact Disinfection Devices - The effect of each of the contact disinfection devices on *G. lamblia* cyst viability was limited. The Water Purifier inactivated about 15 percent of the cysts added in 100 ml of upstream (low turbidity) water; the H20K filter inactivated about 5 percent of the cyst challenge, and the Pocket Purifier inactivated about 2 percent of the cyst challenge.

Chemical Disinfectants - The effectiveness of seven disinfecting chemical preparations ranged from only a few percent to greater than 99.9 percent, depending on the chemical and its concentration, the contact time, and the disinfectant demand of the water (Figure 2). None of the disinfectants was more than 90 percent effective after a contact time of 30 minutes. After eight-hour contact, the four iodine-based disinfectants, each caused a greater than 99.9

percent reduction in viable cysts. The chlorine-based disinfectants were clearly less effective than the iodine-based ones at both contact times.

Heating in Water - Experiments conducted with cysts of *G. lamblia* and of *G. muris* indicated that the two species have virtually the same sensitivity to inactivation by heating. Cysts at both species were completely inactivated by heating to 70C for 10 minutes. Heating to 50C and 60C for 10 minutes produced 95 and 98 percent inactivation, respectively (Figure 3).

Discussion

To remove *Giardia* cysts from water, one must use a filter with sufficiently small pores to trap the cysts and sufficiently large capacity to produce a useful volume of treated water before backwashing or replacement is necessary. Although a number of manufacturers advertise that their filters remove *Giardia* cysts, the only previously published account of filter performance was for the Katadyn unit (6). Our filter evaluation study showed that only the First Need and the Katadyn filters removed cysts with at least 99.9 percent effectiveness. Under the same test conditions, the H20K filter was approximately 90 percent effective and the Pocket Purifier was less than 50 percent effective for cyst removal. The analysis of viability for the cysts collected in the effluent of the Water Purifier, H20K, and Pocket Purifier indicates that passage through the device did not significantly reduce the percentage of viable cysts.

The current study showed that none of the chemical treatments could inactivate more than 90 percent of cysts with 30 minutes of contact time at 10C. At both 30 minutes and eight hours of contact time, the iodine-based disinfectants inactivated a higher fraction of cysts than did the chlorine-based products. All methods inactivated a lower percentage of cysts in cloudy or turbid water than in clear water. All disinfectants performed better with eight hours of contact time than with 30 minutes. Only the iodine-based compounds inactivated 99 to 99.9 percent of cysts, within eight hours of contact time for both turbid

and clear water. As observed by Jarroll, et al (5), the 2 percent tincture of iodine was less effective than the other iodine preparations with 30 minutes of contact time, but it was as effective as the others at eight hours. Comparison of our results with those of Jarroll, et al (5), is complicated by differences between test conditions used. However, our results generally indicate more stringent requirements for effective inactivation of Giardia cysts. Differences between cyst populations used in the two studies could account for the observed differences, even though both were *G. lamblia*. Cysts produced in our trophozoite - gerbil system had consistently high intrinsic viability (>80 percent), excysted efficiently when fresh (80 to 90 percent), and have appeared more resistant to halogen disinfectants than reported previously (Ongerth J.E.: unpublished).

The results of heat inactivation in our study correspond to previous reports indicating that heating to between 60C and 70C kills Giardia cysts efficiently. In addition, our data illustrate the correspondence between the fluorogenic staining and in vitro excystation procedures for assessing cyst viability. When applied to cysts of the same condition. Staining indicates a slightly higher proportion of viable cysts than does excystation. Overall, however, the two procedures provide comparable information.

Figure 1 - Effectiveness of Four Portable Water Filters for Removal of Giardia Cysts from One-Liter Volumes of Water Each containing approximately 3×10^4 Cysts (dotted line). [A bar chart showing the positive and negative controls and results from the filters, on a log scale. The First Need and Katadyn results and the negative control were all zero. The Pocket Purifier and the positive control were approximately the same - i.e. the Pocket Purifier did not remove cysts at all. The H20K results were somewhat below the positive control, actually -- due to the log scale -- indicating 90% removal.]

Figure 2 - Effect of Time and Disinfectant Concentration of Seven Chemical Disinfectants on Survival of *G. lamblia* Cysts in Turbid and in Clear Water. [A

rather striking bar chart comparing chemical treatments under varying conditions. The chlorine compounds were basically ineffective, with no significant effect at 30 minutes; at 8 hours the Sierra was still totally ineffective, the bleach killed about half the cysts, and the Halazone killed 70-90% of the cysts (better in clear water). The iodine compounds were poor at 30 minutes in turbid water (half killed), only a little better at 30 minutes in clear water (70-90% killed, with Potable Aqua the best), but completely effective (100% killed) after 8 hours.]

Figure 3 - Inactivation of Giardia Cysts as a Function of Temperature (10-minute exposures) as Indicated by Ethidium Bromide Staining and by in vitro Excystation. [A line chart showing cyst survival at different temperatures. Four combinations of Giardia species, source, and laboratory technique are shown, but all show approximately the same results. 40C kills no cysts; 50C kills a lot of cysts, 60C kills most cysts, 70C kills all cysts.]

Acknowledgements

References to commercial products shall not be construed to represent or imply the approval or endorsement by project investigators or sponsors.

Grant support was provided in part by the REI Environment Committee which assumes no responsibility for the content of research reported in this manuscript.

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Water_Copendium_1995.txt

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Appendix A: Water Filter characteristics Listed by Manufacturers on Packaging or

Instruction Insert

[Manufacturer column omitted. See text for this information.]

Name	Filter Type	Operating Mode	Operating Rate	Useful Life	Restrictions /Limitations
First Need	0.4 um microscreen plus adsorber	hand pump	1 pt/min	up to 800 pints	A
H20K	6 um mesh, 3 in. activated carbon w/Ag	gravity	1 qt/min	2000 gal	A, B
Katadyn Pocket Filter	0.2 um ceramic, Ag-impregnated	hand pump	1 qt/min	many years	A
Pocket Purifier	10 um (nominal), halogenated resin (38% I), Ag-impregnated carbon	mouth suction	-	-	A
Water Purifier (a)	Polystyrene resin bed (46% I2 as I5)	gravity	-	100 gal	A, C

A - Does not desalinate; not for saltwater or brackish water.

B - Pretreat with I2 for bacterially contaminated water.

C - Not for use with muddy water.

(a) Not described as a filter by package information.

Appendix B: Characteristics of Disinfectant Preparations

[Manufacturer column omitted. See text for this information.]

Water_Copendium_1995.txt

Name	Active Chemical	Recommended Application	Total Halogen Concentration (a), (mg/liter)	pH (b)
Polar Pure	Crystalline iodine, 99.5%	1-7 capfuls per quart depending on temperature	2.4 (1 cap/quart)	6.1
CEGDWT	Tetraglycine hydro-periodate 16.7% (6.68% titrable iodine)	1 tablet per liter or quart	4.5 (1 tab/quart)	5.6
Potable Aqua	Tetraglycine hydro-periodate 16.7% (6.68% titrable iodine)	1 tablet per liter or quart	5.3 (1 tab/quart)	5.6
2% Iodine	Iodine	0.4 ml per liter	4.5	6.5
Sierra	Calcium hypochlorite & hydrogen peroxide	100 crystals (50 mg) Ca(OCl)2 + 6 drops H2O2 per gallon	11.6	6.7
Halazone	p-dichloro-sulfamoyl benzoic acid, 2.87%	5 tablets per quart	7.5	6.7
Chlorine bleach	sodium hypo-chlorite, 5.25%	5 ml per gallon	3.9	7.1

(a) As prepared according to package instructions.

(b) In water treated according to package instructions.

Appendix C: Characteristics of Disinfectant Test Water

Water_Copendium_1995.txt

Source	pH	Turbidity (NTU)	Chlorine Demand (a) (mg.liter)
Spring-fed	6.8	0.09	0.3
Lake Washington	7.1	0.75 - 0.80	0.7

(a) 30 minutes, free chlorine demand (5).

The authors

Address reprint requests to Jerry E. Ongerth, PhD, PE, Assistant professor, Department of Environmental Health, SB-75, University of Washington, School of Public Health and Community Medicine, Seattle, WA 98195. Dr. Stibbs is with the Department of Pathobiology, also at the School, and Mr. Macdonald is with the Department of Medical Education, School of Medicine, both at the University of Washington; Mr. Johnson is with the Department of Biological Chemistry, Johns Hopkins School of Medicine, Baltimore; Dr. Frost is with the Office of Environmental Programs, Department of Social and Health Sciences, Olympia, WA. This paper, submitted to the Journal January 12, 1289, was revised and accepted for publication June 22, 1989.

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REI Water Filter Chart

REI Water Filters Comparison Chart:

	Katadyne	MSR	PUR	First Need
Minimum Pore Size	.2 absolute	.1 absolute	1.0 nominal	.4 absolute

Water_Copendium_1995.txt

Weight	23 oz.	19 oz.	21 oz.	14 oz.
Number of Filter Elements	2	4	2	1
Types of Elements	Screen, Ceramic	Foam, Screen Carbon, Paper Membrane	Glass Fibre, Iodine resin	Charcoal
Cost Per Gallon	\$.25	\$.28	\$.24	\$.37
Appr. Filter Life (in Gallons)	1000	500	500	100
Approximate Filtering Time (in Quarts)	120 seconds	90 seconds	60 seconds	90 seconds
Cost of Replacement Filter	\$89.00	Two Parts \$20.00 & \$30.00	\$40.00	\$24.00
Price	\$225.00	\$140.00	\$130.00	\$37.00

For room reasons I left off two filters. Its specs are in order:
 Basic Designs
 1.0 absolute, 12 oz., 2, Granular active carbin & ceramic, \$.07,
 1000, 60 MINUTES!, \$40.00, \$60.00.

Water_Copendium_1995.txt

Timber Line:

2.0 absolute, 6 oz., 1, Spun Polypro, \$.30,
100, 70 Seconds, \$??, \$30.00.

The filtering times are probably based on a new unit. Some units are easy to clean, one can't be properly, and one can be cleaned on the fly.

Lower prices can be found elsewhere than REI. REI charges list mostly.

Also note some units are easier to use (and clean) than others.

	Katadyn	MSR	PUR	1stNeed	line	Designs	
min pore size	.2	.1	1 + I	.4	2	1	
dry weight	23 oz	19 oz	21 oz	14 oz	6 oz	12 oz	
seconds/qt	120	90	60	90	70	grav-	(when new)
seconds/qt	120	180	60	180	140	ity	(after usage)
filter life	1000	500	500	100	100	1000	(in gallons)
cost/gallon	\$.25	\$.28	\$.24	\$.37	\$.30	\$.07	
retail price	\$225	\$140	\$130	\$ 38	\$ 30	\$ 65	
replacement	\$ 89	\$ 50	\$ 40	\$ 24	n/a	\$ 40	(filter cost)
# elements	2	4	3	1	1	2	
elements	screen ceramic	foam screen carbon paper	screen glassfiber iodine	carbon	polypro	carbon ceramic	

Notes: 1st Need, Timberline, and Basic Designs require iodine to treat bacteria and viruses. Katadyn and MSR require iodine to treat viruses. Only PUR requires no additional iodine. With carbon elements, only MSR, 1st Need, and Basic Designs remove harmful chemicals.

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- 1/ DISCLAIMER
- 2/ Ethics
- 3/ Learning I
- 4/ learning II (lists, "Ten Essentials," Chouinard comments)
- 5/ Summary of past topics
- 6/ Non-wisdom: fire-arms topic circular discussion
- 7/ Phone / address lists
- 8/ Fletcher's Law of Inverse Appreciation / advice and Rachel Carson

From: alanmalk

Subject: Review-Katadyn Mini Filter

Equipment Review - Katadyn Minifilter

Specifications: weight 8.2 oz., filters to 0.2 microns, pump force 13 lbs.,

Water_Copendium_1995.txt

output 0.5 liters per minute, cost \$150.
Specifications taken w/o permission from REI catalog.

Personal observations: My wife and I used the Katadyn Minifilter on a 4 day backpack trip to Colorado. Most of the trip was just below tree line. It did not rain during this period. As the primary pumper, let me say I possess reasonable upper body strength. (Prior to the trip I built a wood fence using hand tools and a hand post hole digger.)

The first time I used the filter I tossed the intake screen into a fast moving, clear trout stream. The intake settled onto what I thought was a clean rock, and I began pumping. After dozens of strokes without pumping a drop I speculated that the filter was defective. After disassembly and inspection I concluded the metal intake screen had clogged and the ceramic element had a thick "gunk" coating. My "clean" rock was covered with a thin layer of brown algae which plugged the system on the first stroke.

Disassembly was quick, requiring a half turn of the outlet spout. The cleaning tool is actually a metal file which scrapes off a layer of ceramic, exposing a fresh surface. The instructions claim 100 cleanings are possible. A measuring device (included) determines when the remaining ceramic material is worn away. The plugged metal screen was cleaned with a finger nail. Reassembly was equally quick but no effort was made to keep unfiltered water from contaminating the "clean area".

For the next attempt, I filled a 2 quart pot and dropped in the intake hose. Contaminated water from the first dozen strokes was discarded. Pumping one quart required an average of 150 strokes. Relative effort was high, requiring a "death grip" on the filter body to aim the stream of filtered water into the canteen. Average time to filter a quart was 5 minutes. Averages were computed over the

4 day period, during which time 3 additional cleanings were necessary while filtering 6 to 8 quarts per day.

Water_Copendium_1995.txt

Other observations: The intake screen jumped 2 inches on each stroke and tended to "walk" out of the pot. A clothes pin would have been handy here. Of greater concern was the single drop of unfiltered water leaking from around the pump shaft after every 10 to 20 strokes. Holding the pump at the wrong angle would allow this water to drip into the canteen. As a precaution I added Polar Pure iodine at half strength and doubled the waiting period. Finally comment - it took my wife about 10 minutes to pump a quart, including rest periods.

Conclusion. The Katadyn Minifilter is acceptable only if:

A - Filtration is the preferred method of water treatment.

B - Weight and small size is critical.

C - Intended use is by one or two people, max.

Cleaning is necessary after pumping 6 quarts of water with no visible particulates (except for 10 inch trout), bringing the estimated cost to \$0.25 per quart. Compare this to less than a penny per quart for Polar Pure. Pumping effort will work up a sweat and preventing unfiltered water from contaminating filtered water is problematic. The unit is mechanically rugged and will probably survive greater abuse than - for example - the First Need. Access to critical parts is very good.

Reviewer - Alan Malkiel

Subject: Re: Water Storage - Liter bottles?

Date: 28 Mar 1995 06:39:52 -0800

In article <19950327215323IZZYS9L writes:

>I hit upon the idea of using 2-liter soda bottles for water storage.

>However, I've wondered how stable the plastic is,

Very stable. The carbonic acid in soda is rather corrosive so these containers must be stable to stand up against it. They are excellent for long term storage.

>and what I should treat the water with to make it last longer.

First, start with good pure water. If it comes from a municipal system in the US it will already have most junk removed and the pH adjusted to the point that chlorine will be an effective disinfectant. Under these conditions about a drop of chlorine bleach per 2 liter bottle will keep it safe for drinking.

If you obtain your water from an unknown source use iodine for disinfection. The best way to do this is to use PolarPure (registered trademark) or the equivalent and follow the directions.

Alternatively you can just keep the water in **absolute** darkness. All the nasties need a source of energy to grow, that source being either already existing organic matter or light. In the absence of light once all organic matter is consumed the microbes will all die of starvation. However if any light reaches the water some of the little critters will grow by photosynthesis and make food for others so you can get a bioculture growing, possibly including some disease causing organisms.

Boiling of course is a good disinfection technique, but it does nothing to prevent future microbe growth except that it reduces initial stocks. If you can bring your water to boiling temperature inside a sealed container and keep it sealed it should stay safe. One way to do this is to use ordinary home canning techniques and just "can" your water in Mason jars. I don't think I would trust soda bottles for this.

Water_Copendium_1995.txt

Subject: Re: Water Storage - Liter bottles?

Date: 28 Mar 1995 18:28:15 -0800

In article <1995Mar28.135250 wrote:

>In article <31973 writes:

>> In article <19950327215323IZZYS9L writes:

>>

>>>and what I should treat the water with to make it last longer.

>>

>> First, start with good pure water. If it comes from a municipal
>> system in the US it will already have most junk removed and the pH
>> adjusted to the point that chlorine will be an effective
>> disinfectant. Under these conditions about a drop of chlorine
>> bleach per 2 liter bottle will keep it safe for drinking.

>>

>

>I've seen this suggestion before and wonder why the need to add the
>chlorine. Didn't the municipal sysytem already treat it with chlorine?

I think it just knocks down the nasties. Doesn't kill them all. When the chlorine fades, guess who comes back? :) You are supposed to rotate your stored water after six months, but I imagine that as long as you put chlorine in for storage, and some more before you use it, you wouldn't have too many problems. Its your life though... :) After the big January earthquake here, I had bottles of water that were a bit more than a year old. I purified them and drank them without any side effects (other than an imagination that was insisting I was committing suicide... :) :)). I rotate them now, with the thought that, in an emergency, I really didn't need more to worry about... Oh, by the way, it *does* help to have a filter that can at least take out the chlorine (like a Brita jug). It doesn't do anything about nasties in the water, but it sure makes the water taste better. Chlorine is nasty...

Water_Copendium_1995.txt

James

From richard

>>Subject: Water Storage - Liter bottles?

>>Date: Mon, 27 Mar 1995 21:53

>>I hit upon the idea of using 2-liter soda bottles for water storage.

>>However, I've wondered how stable the plastic is, and what I should

>>treat the water with to make it last longer.

>>Anybody with storage advice?

>>TC

>I just fill them and keep them under the sink - and rotate the water every six
>months or so. YMMV

Adding a teaspoon of 6% food grade hydrogen peroxide might also prove useful.
It's available through The Family News (800) 284-6261. They have a catalog/
newsletter most should find interesting.

Hydrogen peroxide is a very effective antibiotic, antifungal, and antiviral
agent. I personally consider it MUCH better than the various chlorine-based
chemicals currently being used in our water supply. Bubbling ozone gas
(assuming you have a machine to generate it) is also good. It can be done
just before sealing the bottle and/or just before drinking.

Many people with livestock find that adding hydrogen peroxide to their
animals' water supply (50-100 ppm) give good results (helps keep animals

disease free). In a survival situation, healthy livestock can be very valuable.

From sheff 1995

Subject: Re: Water Storage - Liter bottles?

> In a previous posting, Paul writes:

>>> I hit upon the idea of using 2-liter soda bottles for water storage.
>>> However, I've wondered how stable the plastic is, and what I should treat
>>> the water with to make it last longer.
>>>
>>> Anybody with storage advice?
>>>
>>> TC

> I try to keep on hand a 3 day supply of water (two 2 liter bottles per
> person per day, I also count my dog as a person), so for 5 people that would
> be 30 bottles. We always get more bottles, so we pitch the oldest every now
> and then. We also dump them all every 3 months and refill them. The 3 month
> old water does not taste bad or even too flat, so I'm pretty sure its still
> ok.

> For larger capacity storage, you could use food grade plastic barrels and
> pipe them into your cold water line and from there to the hot water heater,
> that way you would create a reserve of continually freshened water (somebody
> else's idea, I can't take credit for it).

So one would just cut a couple holes in the top and cement some cpvc pipe to

Water_Copendium_1995.txt

the barrels and hook that into the existing lines? Cool. Another side effect of this would be that if there was an existing heat source near the barrels, the water heater wouldn't have to heat the water as much.

> -- Joseph

From Ben 1995

Subject: Re: Water Storage - Liter bottles?

Date: 29 Mar 1995 07:14:32 GMT

> IZZYS9 writes:

> I hit upon the idea of using 2-liter soda bottles for water storage.

IMHO this is a good idea for -part- of a water reserve program. The plastic pop bottles are designed to be durable and to not let anything leech through the plastic to destroy the taste. Four drops of pure chlorine bleach will keep the water for at least five years if kept in a cool dark location. In the average conditions it will take two bottles per person per day.

A good book with this and much more info on the subject of surviving hard times is---

"Preparing for Emergencies"
by James McKeever
Omega Publications
P.O. Box 4130

Medford, Oregon 97501

From jtz 1995

Subject: Re: Water Storage - Liter bottles?

Date: Thu, 30 Mar 95 05:43:20 GM

IZZYS9 wrote:

>I hit upon the idea of using 2-liter soda bottles for water storage.

...

>Anybody with storage advice?

I've tried that route. It's a genuine pain in the tuckus. You wind up carting a zillion bottles back and forth. There's a better way: You can get large polyethylene barrels that are DOT spec for foods (including water), with liquid tight seals. Light tight, too. A supplier by the name of National Bag (800-247-6000) carries them, among others. Look for "open head drum" in sizes from 8 gal to 55 gal, last catalog priced the 55 gal drum at \$76.40.

The trick is keeping the water fresh. Hooking the drum(s) up to your water supply, like at the hot water tank, is one approach, but that implies building a system designed to be constantly pressurized. A simpler approach is to use the drum for gardening water, or hydroponics water, whatever. This forces you to keep adding new water to the supply, thereby keeping it fresh. Depends on how much work you're willing to go through to set up the water storage system in the first place.

Of course, if you're storing water in a bunker or other bug-out location, then you may want to add iodine as mentioned in this forum for long term storage. The drums are light tight, though, so there won't be much growth

Water_Copendium_1995.txt

going on inside. Don't try to store a year's worth of water; make sure you have a stable source of water available, then have a good set of water filters on hand, enough to filter one to five years worth of water.

From sheff

Subject: Re: Water Storage - Liter bottles?

Date: Thu, 30 Mar 1995 15:01:56 GMT

>>>> "John" == John writes:
In article <jtz. writes:

> I've tried that route. It's a genuine pain in the tuckus. You wind up
> carting a zillion bottles back and forth. There's a better way: You can get
> large polyethylene barrels that are DOT spec for foods (including water),
> with liquid tight seals. Light tight, too. A supplier by the name of
> National Bag (800-247-6000) carries them, among others. Look for "open head
> drum" in sizes from 8 gal to 55 gal, last catalog priced the 55 gal drum at
> \$76.40.

Emergency Essentials in Utah (800-999-1863) has food grade 25-55 gal drums. The 55 gal drum is about \$56. They carry lots of other stuff too. Ranging from 72-hr kits, camping supplies, books, water filters, dehydrated food, MREs, etc.

> - John

> "Who was arrested in the 'gold' wave [of 1929]? All those who, at one time
> or another, fifteen years before, had a private 'business,' had been
> involved in retail trade, had earned wages at a craft, and _could_have_,

- > according to the GPU's deductions, hoarded gold." -- Aleksandr
- > Solzhenitsyn: The Gulag Archipelago.

=====
Drinking Water for Extended Cruises
=====

Any water that is brought aboard for such purposes as drinking, cooking, or even that used for brushing your teeth, should have some type of purifying compound added before it is used. There are commercially prepared tablets and powders meant for this purpose, or you can use regular household bleach which contains a 5% solution of hypochlorite, or chlorine.

The formula for adding chlorine bleach to water to make it drinkable for long periods of time is:

- 8-10 drops per gallon
- or:
- 1 teaspoonful per 10 gallons

These amounts are for clear water, and if cloudy or discolored, double this. Always allow water to stand about 30 minutes after being purified before using it.

If you have no products with which to treat your water, then you may boil small amounts prior to use. Bring the water to a rolling boil and boil hard for at least five minutes. When it has cooled, pour the water back and forth between two containers to aerate it and give it a "fresher" taste.

While cruising, rain water can be a good supplement to your supplies.

Water_Copendium_1995.txt

Take along some gear meant especially for rain catching, or you might be able to improvise from things that are suitable that you happen to have on board. Rainwater is a fine supplement to your water supply, and can be used for drinking, cooking, washing, and other Purposes. It is important to take the same precautions with this water as you would with any other and add some type of purifying agent so that it is usable for as long as your supply lasts. It might be a good idea to store any water such as this in a separate container, that is not in your permanent tanks.

For emergency purposes, you should have among your survival equipment (see section on SURVIVAL ESSENTIALS) a few solar stills. Hopefully, these will never have to be used, but if the need arises to distill sea water in order to survive you will be able to provide a very minimum amount of fresh water for drinking with the use of these stills. Ideally, you should include one solar still for each crew member.

In calculating your original water supply for the cruise, figure first your longest passage and then add a few days. Then allot one gallon of water per person for each day at sea. You can use this formula:

$$\text{CREW} \times \text{DAYS} = \text{WATER SUPPLY}$$

This will provide what is considered a very minimum amount of water for your daily needs.

The following description of "Hard" water was used as part of presentation to a company describing the benefits of treating their incoming water from a well, used to clean parts prior to painting and plating.

Water Supply

What is considered normally good, mineral laden, drinking water is not always good process water. All ground water supplies contain a certain amount of dissolved minerals. In those areas where the ground water is predominantly limestone, rain water dissolves significant amounts of calcium and magnesium carbonate. This is caused by the fact that the rain water starts out relatively pure, and on it's way through the air, dissolves large quantities of carbon dioxide from the air. Carbon dioxide gas, when dissolved in water forms carbonic acid and causes the rain water to be slightly acidic (did you ever hear of putting a rusty nail in Coca-Cola?). This "acidity" is then neutralized as the rain filters through the limestone changing the water from slightly "acidic" to slightly "alkaline". Because most waters are not completely alkaline, they contain a mixture of carbonates and partially neutralized carbonic acid known as bicarbonates.

Over the years , these particular dissolved minerals have become known by the trouble they cause. Calcium and magnesium, because they retard the action of soaps and detergents, got the name "hardness". They leave their evidence in wasted cleaners, soap film and insoluble sludge. Carbonates and bicarbonate, because they are the opposite of acids, got the name "alkalinity". When found with calcium and magnesium, alkalinity forms a tightly adherent sludge called "hardness scale" that is found in most pipes, water heaters, untreated boilers, cooling towers and industrial washers.

The most common form of treatment is softening, where "soft" sodium carbonates are exchanged for the "hard" calcium and magnesium carbonates. This however does not reduce the total amount of material that is dissolved in the water. An alternate method, known as "dealkalization", takes the process one step further where "soft" hydrogen carbonates are exchanged for the "hard" calcium and magnesium carbonates. The hydrogen carbonates, also

known as carbonic acid, (carbon dioxide dissolved in water) are then removed from the water by passing through an air stripper. The resulting water is substantially reduced in both hardness and alkalinity. The water is then close in comparison to typical fresh lake, brook or rain water.

This process is about half the capital cost of D.I. (deionized) water and substantially less expensive to operate. It provides many production benefits by improving chemical ability to clean, thereby decreasing chemical consumption and cost. It would significantly reduce sludging and scaling in all stages of the washer.

Dave

The problems associated with water are acquisition, purification, and transportation OR get, good, and go.

FACTS

1 gallon of water weighs 8 1/3 pounds and is 231 cu. in. about 6 1/8" cube
1 liter of water weighs 1 kilogram and is 1 cubic decimeter

ACQUISITION

DEW
STREAM OR POOL
GROUND WATER (DIGGING)

PURIFICATION All water is good to drink, it is the extras that can kill you

-BIOLOGICAL HAZARDS

PHYSICAL REMOVAL

ULTRAFILTER

CONDENSATION
KILLING ORGANISMS
BOILING
CHEMICAL

-ORGANIC HAZARDS
FILTER CARBON
DISTILLATION *IF* 212 degrees isn't the boiling point of the hazard

-INORGANIC HAZARDS -WILD WEST ADAGE, IF SLIME CAN DRINK IT SO CAN YOU
pH AND FILTERING
ACTIVATED CARBON

ELECTROLYTES

PRETREATMENT All water purification will work better and allow your equipment to last longer if you get rid of as much mechanical solids as possible.

Cheap paper filters
shirt, socks, pants, screen, Kearney bucket

Absorbtion = incorporate
adsorbtion = block/stick

Once you have your water, you need to purify it to make sure that it is not contaminated with material that will cause sickness or death. The most common contaminants are

BIOLOGICAL - SOMETHING THAT IS ALIVE AND HARMFUL

E. Colii - Infectious disease specialist said, If shit were red, we'd be living in a rose colored world.

ORGANIC TOXIN - SOMETHING THAT CAME FROM A LIVING CREATURE AND IS HARMFUL

Venom, vitamin A, cyanide, micotoxins, etc.

INORGANIC TOXIC - SOME ELEMENT OR COMPOUND THAT IS TOXIC

Beryllium, cadmium, lead, arsenic, methyl mercury, lead, etc.

The most common methods of water purification are boiling, adding disinfectants, and various types of filtering.

Most biological hazards consist of naturally occurring bacteria and other organisms.

BIOLOGICAL HAZARDS

* METHODS

KILL ORGANISM - toxin that can kill all forms of life.

MECHANICALLY REMOVE ORGANISM

K BOILING. Boiling water for one minute will kill all bacteria. However, since additional various organisms that are harmful and commonly found in water are not bacteria, 15 to 20 minutes of boiling is needed to kill these other organisms to give you sterile water.

M DISTILLATION. Distillation is the most reliable method for obtaining pure water as the resulting water is sterile, soft, neutral in pH and removes all other contaminants as well. If the distiller does not have some sort of system that preheats the water to remove various gases, the various gases can be collected in the distillate if all boiled off contaminants are not purged by running steam through the condenser at the beginning of the batch.

K DISINFECTANTS. The most common disinfectant is chlorine. Chlorine is a poisonous gas and hazardous to handle. Two safer forms of chlorine are common household bleach which is a 5.25% solution of sodium hypochlorite, and dry pool chlorine ("burn out" or "shock treatment") which is 65% calcium hypochlorite. Dry pool chlorine can be used to make a solution that is the same concentration as household bleach, 24.5 grams (about 10 Tablespoons) of powder in 1 gallon of water. This mixing MUST be done in a very well ventilated area and stored in an air tight enclosure since it gives off enough chlorine gas to cause problems. Please note that many bleaches state, "not for human consumption." If the listed ingredients contains anything other than sodium hypochlorite, avoid it. If it contains ONLY sodium hypochlorite, it is okay. For water purification use hypochlorite solution in the following mixes

Volume	clear water 1:5,000	cloudy water 1:2,500
1 Quart	2 drops	4 drops
1 Gallon	8 drops	16 drops
5 gallons	1/2 tsp.	1 tsp.

Allow at least 30 minutes for the chlorine to kill all microorganisms.

Tuberculosis organisms are the only organism that is resistant to chlorine.

Use a 1 to 10 solution for cleaning instruments and surfaces. Do NOT use hypochlorite solutions for irrigating wounds (as was done in WW1) as the hypochlorite dissolves blood clots.

Iodine is extremely toxic. One source of iodine are the solid crystals.

How to use iodine to sterilize water. Put 4-8 grams of iodine crystals in a 1 oz. glass jar (must have glass or bakelite stopper otherwise the iodine will react with the plastic or metal stopper and destroy it.) Actually 0.1 gram is adequate for the job, but using a larger amount of iodine creates a saturated solution much quicker.

Put in 1 oz. (1 tablespoon or 3 teaspoons) of water (at least room temperature, body temperature preferred).

Close stopper and shake for several minutes. You now have a saturated solution. A saturated solution is when as much solid has dissolved in a liquid as it can.

Carefully pour off 10ml (10cc, 2 teaspoons) of the saturated solution. REMEMBER, the iodine crystals are VERY TOXIC! The reason that adding more water than needed is suggested is so that you need not tip the bottle over too far thus spilling some crystals.

Add the 10ml (2 teaspoons) of saturated solution to 1 liter (1.06 quart) of water.

Let stand at least 15 minutes at 77 degrees F. or higher. Make sure all of the interior surface including lid get treated.

Another form of iodine is the familiar tincture of iodine which is 2% iodine and 2% sodium iodide in alcohol. Use 3-5 drops of tincture per quart of clear water and 10 drops of tincture in cloudy water. Please remember, very old tincture or tincture that has been left unstoppered may have lost some of its alcohol due to evaporation and would have an excessive concentration of iodine.

Water_Copendium_1995.txt

NOTE: Iodine is not very soluble in water, but VERY soluble in alcohol

Betadines are not suitable for water purification. Betadine scrub should be only used for cleaning intact skin as it is very toxic to tissues. Betadine solution when diluted 1:100 (3 drops per ounce of water) is suitable for cleaning wounds.

M FILTERING. Only extremely sophisticated filters are precise enough to remove micro organisms. One device that is able to do this is the Katadyn family of water filters from Switzerland. It consists of a core of ceramic material whose holes are so small that no living organism can pass through. There are available synthetic woven filters for use in industry that are able filter out micro-organisms. Example, Coors beer is pasteurized by the micro filtration process.

Another type of filter is the 800 PSI reverse osmosis style filter, the Survivor-06 from Phoenix Systems \$525 will remove salt for 2 pints per hour.

ORGANIC TOXINS

Many of these will be broken down by heat during the boiling of water or boiled away if they evaporate below 212 degrees.

NOTE on distillation. If you have a sophisticated still and put in the water, seal the still, and start the still - any toxin that boils below 212 degrees is going to pass right through on the first minute of distillation

INORGANIC HAZARDS

Toxic substances like arsenic, various heavy metals, aluminum, salt etc. are a less common hazard. They can be found however in water near mining sites and in areas that have alkaline lakes. A lack of normal plant growth around a water source or unusually colored algae are frequently signs of abnormal pH or unusual contamination.

Many of these toxins are only water soluble if the water has an unusual pH factor. That is these factors can only be in solution in the water if the water is fairly acidic (low pH) or fairly alkaline (high pH). Totally neutral pH is 7 and most water sources will be between 5 and 8 in pH. If you have the papers to measure pH and add lyes or acids to the water to bring the pH within

a normal range, the metal may go out of solution and become a solid, but in particles that are so small that they stay suspended in the water. Letting the water set overnight will allow the particles to drop to the bottem, but since they are so small pouring the water from the container might be enough to put them back in suspension again. A better method would be to filter the neutralized water. A microfiltration filter could be used for this, but even common laboratory filter papers would remove most of the precipitated solids, even though common filter paper is not fine enough to filter out biological hazards. Many inorganics are highly reactive and are adsorbed by dirt or activated carbon filters.

Some inorganic hazards like asbestos fibers are mechanically hazardous, any filtration method will remove this items. If no filters are available, just letting the water stand still for several hours or overnight will help reduce contamination. Siphoning water off of the top of standing water is the best way to remove the water as pouring the container will kick up the sediment again.

A NOTE ON LABORATORY FILTER PAPERS

These filters should be used to prefilter any water that you are going to treat. They aren't suitable for an entire process, but their removal of larger contaminants improves performance of disinfectants and extends the working life of microfiltration units. Filter papers come in various speeds. The faster the speed of the paper, the less that is filtered out. Filter papers are very inexpensive, lightweight and compact. For maximum effect you can prefilter water through a fast filter and then put that water through a slow filter.

ORGANIC HAZARDS

These substances can be removed via activated carbon filters. An item to note about activated carbon filters: water or moisture in the carbon filters is a breeding ground for biological organisms. Many filters are doped with silver compounds to prevent or retard organism growth.

Note never pour hot water through activated carbon. Also, powdered activated carbon is more likely to release its toxin content.

Hartz Mountain 191 grams ~6 oz \$2 dusty in cardboard box
VRP 300 grams ~10 oz \$10 (three month supply) very low dust, in sealed plastic bottle

SOIL FILTERS

The book NUCLEAR WAR SURVIVAL SKILLS, in addition to having good information on water storage and transporation, has an excellent design for a water filter based on a bucket, gravel, towels and clayey soil (4" down). page 71-74

This device will buffer the pH (assuming normal soil) and adsorb 99% of radioactivity. It produces 6 quarts of water/hour initially and 2 quarts an hour after several hours of use. I you get 1 quart/ 10 minutes you need to repack the soil. Buy shaving off 1/2" of the 6-7" soil stack every time the filter clogs, you can get 50 quarts out before a complete soil change is needed.

ELECTROLYTES

Nutshell	single dose	storage ratios for 300 quarts
Lite salt	1 teaspoon	5 - 11 oz. tubes of Morton Lite Salt
Baking soda	1/3 teaspoon	one pound box
sugar	10 teespoons	25 pound sack
water	1 quart	

Subj: ELECTROLYTE AND FLUID REPLACEMENT

For those that do not subscribe to the FIGHTING CHANCE newsletter P.O.Box 1279, Cave Junction,Oregon 97523 \$60/12 issues/year or haven't purchased the Medical Preparation video tape by Dr. Jane Orient (president of Doctors for Disaster Preparedness) \$29.50 from same address, here is a good little life saver that you might be interested in.

One teaspoon of "Lite Salt"(by Morton, 1/2 iodized potassium chloride, 1/2 sodium chloride in a blue cylinder), 1/3 teaspoon of baking soda (sodium bicarbonate), 10 teaspoons of table sugar (sucrose), and one quart of water. That happens to be a life saving fluid replacement and partial electrolyte expiedent replacement. At least it is expiedent if you have had the foresight to purchase the above three items BEFORE an emergency happens while it is readily available and very cheap. Many people die in times of emergency because of fluid losses. This can be from burns, vomiting, or diarrhea. The body needs water and certian water souluable chemicals to function. If either

Water_Copendium_1995.txt

or both of these drop below a certain level, you die. There are many non-fatal diseases like cholera that become fatal due to lack of simple things like proper fluid replacement. If you have ever had a bad case of diarrhea and start to have pain in your muscles or joints, congratulations, you have had the early warning symptoms of a potassium deficiency.

Bananas are very high in potassium.

For ease of purchasing the items for Dr. Orient's formula, Morton Lite Salt comes in a 11 oz. light blue cylinder. Baking soda a 1 or 4 pound box. Sugar 5, 10, or 25 pound sack. To make approximately 300 quarts of the solution you need 5 - 11 oz. units of Morton's Lite salt, 1 - 1 pound box of baking soda, and 25 pounds of sugar.

FIGHTING CHANCE is a great publication for those that are installing blast/fallout shelters. It also is the place that tells you where to buy ventilators for \$20 that other places charge \$245.00 and in this month they tell you where to purchase 12-120 volt AC/DC PM motor generators for \$12 that other survival stores sell for \$100-275.

TOXIN STORAGE IN THE BODY

Most in fat cells, rapid fat burning without adequate water can cause kidney damage

HOW MUCH WATER IS ENOUGH? enough to keep your urine a normal color and smell

One exercise fitness center recommends

1/2 oz water per 1 pound body weight (sedentary) (me ~ 3 quarts)

3/4 oz water per 1 pound body weight (athletic) (me ~ 4 quarts)

In the desert under heavy labor you might go through 2-5 gallons
Sweating = losing water + losing electrolytes

No activity in a cool cave 1 quart a day might be all you need short term with no bathing or food preparation needs.

TRANSPORTATION

Page 67 of NWSS plastic trash sack inside pillowcase or burlap sack.

Canteens, plastic, steel, aluminum (al + halide based tablets can produce toxins)

Water bags of aluminized mylar and boxes

Polycarbonate jugs

Folding bags with handles

From : Daniel 06 Oct 92 07:31:00

To : Michael

Subj : Solar Water Distillation

--> Quoting Michael to All <==

MK> Does anyone have information on how to Distill water by Solar

MK> Methods, or where to purchase such equipment?

MK> Information on How to Make/Maintain a Well would also be helpful.

MK>

MK> Thanks in advance for any replies!

MK>

MK> Mike

Probably the best way is to set up a solar distiller. You build a 4' by 8' frame, make it water proof. But some black cloth on the inside and let your 'dirty' water drip down this cloth. Put glass on the top of the box and make a little trough to rest at the bottom of the glass (the box is inclined to face the sun). The water will evaporate off the cloth, condense on the glass and run down to the trough where you can hook up a small hose to take the water out of the box. (Make sure the trough only catches water from the glass).

Look up some articles on solar distillers for alcohol to get some more ideas.

Water_Copendium_1995.txt

The simplest is to dig a hole in the ground. Pour water into it and place a tin can into the middle of the hole. Put a piece of plastic over the hole and weigh it down with rocks on the outside. Place a single rock in the middle of the plastic to create an 'inverted cone'. The water will evaporate and condense on the plastic and then it will run down to the 'point', where it will drip into the can.

SP> I've heard that chlorine can contribute to harsh flavours in the
SP> final product, Do you think that controlling the concentration of
SP> chlorine in my water will make much difference? (I can occasionally
SP> smell it when I turn on the tap)

If you can smell chlorine when you turn on the tap water, its concentration is high enough to affect the taste of your beer. Get a simple activated charcoal filter for that tap, and most of the chlorine will be removed.

Book Name: The Outdoor Life EMERGENCY Survival Guide
Author: Byrn Dalrymple This is Chapter 3, beginning on Page 14

Where to Find Water

IN ANY CLIMATE where severe cold does not drain energy, you can live for many days without a single bite of food. The length of time depends to some extent upon how much physical energy must be expended. Starving to death is not as dangerous as finding yourself without water. Charts have been compiled showing average life expectancy without water.

Temperature is crucial here. Even in the desert, where you may encounter extreme high temperatures to well above 100 degrees, a man who remains quiet in shade can go without water a short time. Expectancy would be

from two to three days. At moderate summer temperatures in woodland latitudes, say from 50 to 75 degrees, death might not occur for ten days, but before that a man would become too sick to help himself.

Water is the most important factor in survival, regardless of where you are. It is estimated that at 110-degree temperature,, an inactive person lives for 5 days if he has available 2 quarts of water per day, a total of 10 quarts. At about 75 degrees he has a chance of quadrupling his life expectancy on the same 10 quarts. But these are bare minimums and this is also a substantial quantity of water. At a moderate temperature a person even mildly active needs an average of 2 quarts of water per day. That's 3/ gallons per week. Strenuous exercise, such as hiking, will run the need higher.

Water Supply

Obviously no one can carry that much water, except by horse or motorized transport. In any desert trip, you should know where water sources are and carry as much water as possible. If a vehicle is used, a copious supply should be stored for emergency. Then, if a breakdown occurs you should stay with the vehicle to conserve energy.

Fortunately, over the major share of the land mass of this continent where emergencies may occur, water supply is not a great problem. The large forest tracts, the vast Canadian bush all have many lakes and streams. But having pure water may be a problem. Even high-country rivulets may be polluted, for example, by a dead animal lying in them. The old idea that water swiftly becomes pure as it runs a few yards in sunlight over a streambed is nonsense.

Happily, on trails in many State and National Forests water has been tested at springs or other sources and signs designate whether or not it is fit for drinking. But in an emergency you cannot count on finding one of those. Thus it is best to purify all water. once a partner of mine

got off his horse, drank deeply from a clear stream, and looked up to find a dead deer a few yards above in the creek. Especially in lower elevations, or in desert country where water may stand, purification is a must.

Purifying Water

Halazone tablets were mentioned earlier. Directions for use are given on the bottle. Iodine is also a purifier, with 2 to 4 drops per quart sufficient. Tablets used by the Armed Forces for water purification are available, too. There are other purifiers, such as chlorine, but those noted are easiest to carry and handiest for treating small amounts of water.

However, situations may arise where no chemical purification is possible-you have failed to go prepared, or have lost or used up the chemicals. Boiling water is the simple old wilderness standby. Many sources suggest boiling hard for at least five minutes. I'd suggest not being too eager. No harm is done by boiling twice as long, and even more to assure purity. Remember that altitude makes a big difference in how long it takes to bring water to a boil, and how hard it will boil with a given amount of fire.

Although water is seldom difficult to find in snow country, injury may make it necessary to stay put, or available water may be distant, and so snow must be used. If snow is plentiful, dig away the top layer, and use that underneath. It will be cleaner and more compact. A substantial amount of snow is required to melt down into a couple of quarts of water. If fuel for your fire is any problem, never fill a container brim full of packed snow and then begin to melt it. Melt a small amount and keep adding small amounts to the water formed. Melting will be faster this way. The same method applies if you must use ice. Chip it into small pieces.

Don't drink snow or ice water without boiling it. Each might be contaminated. Play it safe. It is imperative to stay well. Although boiled water will seem tasteless, some aeration occurs by pouring back and forth from one container to another. If you have foil, a second container can be fashioned from it. But emergencies are not comfort tours, and you may have only a single container. Drink the water flat and forget it.

A winter-camping, snowshoeing addict friend of mine carries a coil of small-diameter plastic tube for drinking from high-country streams when snow is deep. Granted, he takes in water that might be polluted, but under the snow mass that completely covers small creeks at high altitude the chance is slim. He uses the drinking tube because it is often very difficult to get down steep banks to the tiny open waterholes. Never eat snow or ice as a source of water unless it is absolutely necessary, and then only slowly. It may be polluted, and it chills your stomach.

Mountains and Forests

In the mountains of the North and in forests such as those of New England, southern Canada and the upper Great Lakes region finding water is seldom any problem. If you have a map, as you should, you can easily locate water, unless you are lost. If so, canyons, valleys, gorges, any "downhill country" all lead to water almost without fail. The water table in mountain valleys or in heavily forested northern regions is generally not far below the ground surface. If you do not immediately find lake or flowing stream, it is a good idea to know where water is most likely to occur and most easily acquired.

At the foot of any steep, broken rock wall where definite cracks exist in the rocks, running out to points, there are likely to be springs or seepages. Porous and soft rocks allow water to leach out easily. Hard rocks, such as granite, turn seepage along crevices. If you locate a mountain or north-country streambed that is dry but has bluffs and rock

terraces rising above it, don't assume no water is present. Check the rock strata carefully. If there are hard folds above, then a layer of limestone or even sand or clay, look for green vegetation growing along the base of this layer. The entire layer may be filled with water. A small trench dug into the edge of such strata, right along where the green vegetation grows, may attract a quick seepage of water that offers an ample supply.

Dry mountain or northern-forest streambeds that show gravel can be deceptive, too. On occasion when you lie down and press your ear against such a gravel stretch you hear a trickle underneath. However, this is a lucky exception and is by no means reliable. More often water is there and not heard. Dig a bit in a gravel bed, especially where the stream course is narrow. If you gravel continues on down a foot or more and is dry, better forget it. Remember that when you need water, energy spent digging deep holes is usually better spent seeking another source. However, if you strike sand beneath the layer of surface gravel, and it is damp, water may be nearby. Water sinks swiftly in gravel but not necessarily in sand. Damp sand may indicate that a foot or two down you will strike flowing water.

On my own property in the Texas hill country we have a creek that flows year-round. But in hot weather long stretches of it go underground. I've had people who I've taken down there sympathizing because my stream is dry. But a few rods on downstream there is a bubbling, gurgling flow bursting out of the gravel to flow over solid rock.

Often in mountain or forest country water can be found at unexpected locations. For example, an area of clay soil atop a high bluff is a fine water source. This is because clay soils retain water. In building earthen dams engineers often use clay for a core; it holds back the water. A damp spot atop a clay bluff may indicate a reservoir of water. Look closely at the edges of the clay area for sand, or any soil with lesser water-holding properties. A hole dug here, or even in the clay,

might fill with good water.

Vegetation Clues

Vegetation growing in specific places offers excellent clues to water, in forested and mountain regions and in arid areas. A good plan, particularly if you have a binocular, is to scan the entire surrounding region, checking out both land contours and vegetation clues. Even though a water course is unseen, a line of brush that can be identified as alder or willow invariably means water. Tamaracks and balsams grow in low, wet places, and in the North cedar is associated with stream courses or lake shores.

Large willow trees always mean water, and because their root system is shallow but spreading, they commonly indicate water close to the surface. You do not need to find a stream or lake or bubbling spring. A cedar or tamarack bog or alder swamp will offer pools of water, stained from leaves and decaying vegetation but not necessarily impure. Boiling will make it potable, even though some taste-especially in cedar and tamarack swamps- may remain.

Arid country

In severely canyon-cut, rocky country, scan very carefully the headers of short, sharp draws or canyons. These draws may be of solid rock, but with trees growing along the edges. You often find a flat place' where clay or muck has accumulated over many years on top of the rock, where heavy water-oriented grasses or sedges grow. This is true of my area of Texas, and it occurs almost anywhere throughout the continent where such canyon terrain exists. Heavy grasses indicate that water has been here over many, many years, perhaps only seasonally. However, a hole dug into the thin clay or muck below such grasses often emits a seep of water.

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In numerous arid locations a rocky bluff that overhangs an apparently dry streambed has ferns clinging to it at specific spots. This indicates porous rock and sure water. I have chipped out indentations in such porous overhangs and started a drop of clean, cool water on numerous occasions. This can be a lifesaver, with an almost unlimited supply of water to which a small clump of clinging ferns in an otherwise desert situation directed you.

Throughout vast expanses of arid country, across the plains and the desert, the cottonwood tree is a sure indicator of water. It is found along stream courses. Many will be dry or at least appear so. Look for large cottonwoods. An ancient one of large size indicates that a consistent source of water has been here for many years. Dozens of times a pool of water will be discovered in an otherwise dry wash near a cottonwood. Or, a bit of digging in the vicinity-try upstream first-will uncover seepage. Mesquites, however, growing along a wash usually mean little chance for water. Whitebrush thickets along a wash mean, in the Southwest, that water is near.

In any arid region, glassing or searching may turn up spots of outstanding green: at the base of a rock outcrop, in a low place along a wash, even part way up a rock terraced barren mountain. Especially lush patches of different vegetation are usually indicators of water. Getting to the water may not always be easy. Conversely, there may be a spring or small oasis lower down and wide open for your use. It is surprising how water plants-even cattails- colonize a small spot in desert surroundings where water is permanent. Undoubtedly seeds were transported by birds.

Bird and Animal Signs

Birds are very much worth watching. Flights of doves, common in U.S. deserts, all moving in the same direction toward evening or late afternoon mean a waterhole. Doves are extremely mobile, long-distance

flyers, and may be going to a hole too distant for you to reach that day. Nonetheless, take a bearing on them, and watch them closely. Watch for quail, too. Some desert quails may get along fairly well for long periods without water, other than that taken from vegetation. But any desert area that abounds in quail will have water within 100 to 300 yards of such a concentration. Quail stay bunched up resting in shade during the middle of the day, but go to water early and late. Be particularly alert in desert situations for such birds as blackbirds, or water-oriented birds such as a few ducks in flight. Blackbirds are not desert creatures but are occasionally found in arid terrain, invariably near water. Any bird flights, regardless of species, that take a definite tack, are worth checking. They must have a water supply at flight's end.

Watch animals, too. A well worn mule deer trail in desert mountains, one that goes downhill, may well be a trail leading to water. Such trails are often seen from high points at great distances when you scan with a binocular. Watch desert mule deer with special concentration just prior to and at dawn. They have a habit of drinking at dawn, then going up into the rimrocks to bed down in shady crevices for the day. Don't expect to find a huge spring as their water source. They are desert creatures, getting along on what is available. It may be only a rocky depression that holds rainwater.

Caves or hollowed out places in rock bluffs may contain water. But be cautious about entering caves, because of snakes and the chance of getting lost. If you note a cave or hole in a rock wall, even one you cannot reach, watch it closely at evening. If swarms of bats emerge, remember that they are mammals and must have water. They will usually head for water right away. Their course may give you a clue.

Desert Hints

Again let me caution against any vast amount of digging for water in

desert terrain. The amount of energy used up may be too much, or it may be expended to better advantage in other ways. For example, following a definite, time-worn dry stream course in a desert, not just a flood wash, not only may lead in due time to a larger, live stream, but it may also bring you to small pools among rocks or in gravel and sand, even in hot weather. Evaluate carefully "sure" indications of water. For instance, in such a dry streambed, the outside of a bend is the place to check most meticulously. If the bank is concave, and a depression exists, water has stood here. Sandy loam should at least be probed here. If it shows any damp-ness, on surface or a foot down, then digging is worth-while.

If you are outfitted with quality maps of the desert region where you are going, you should check beforehand all indications of springs and other water sources. Invariably they are shown on the maps. Then if you are not lost but have a breakdown on your hands, you can study your map and determine precisely where a water supply is located. Another type of arid-country water source nowadays is seldom mentioned. Finding it requires knowing where you are, and having its location or locations exactly pinpointed on your map. Over a number of years game management people have been building, often in remote desert expanses, what are known as "guzzlers." These are water traps, designed to catch, hold, and protect rainwater over long periods, for use by game birds and animals. Some have been built in desert bighorn sheep country, to make possible spread of range. Others are for desert quail and deer. They are designed so that these creatures can drink but cannot get into the water and thus pollute it. Contact game department personnel for locations of guzzlers in the "outback" when planning a trip as a good precaution. Mark them on your map.

Plant Sources

Vegetation is a water source in emergency. There is hardly a place where you have much difficulty finding water across the northern half of this

continent, but the arid areas are problem locations. Fortunately it is here that water-conserving plants, such as the cacti, grow most abundantly. The barrel cactus is always cited as a desert water source. It is a good one, too, but it does not grow in all desert locations. If you hack off the top of this cactus and slice and hack the pulp inside into pieces, a substantial amount of juice, mostly water, will accumulate. Prickly pear is the most common cactus and comes in great variety. The pads and fruit both contain large quantities of juice. The problem in handling cacti as a water source is the danger of getting scratches or cuts from spines, which quickly fester. Beware the fuzz in small clumps on prickly pear fruits or pads, or on any cactus. The various prickly pears and flat-pad cactus species are, incidentally, excellent food items as well as water sources.

With the exception of the coconut, beware of plant juices that are milky. Among desert plants, stalks of mescal, sotol, and Spanish bayonet all can be cut and drained of their juices for emergency water. In jungles or even some shaded desert locations, varied vines are found. When you are tapping any of these for water, reach up as high as you can to cut first. Then cut the section at the bottom. The juice drains downward when the two cuts are made, but the top one must be made first to keep sap from rising. Green coconuts contain milk easy to get to. But the chances of getting into a survival situation in green-coconut country on this continent are rare.

In fact, the water-from-plants idea has been highly over-popularized. Even "cactus water" is not the bubbling fountain it is sometimes pictured to be. I have camped among prickly pear, thousands of acres of it, during dry spells when you couldn't have coaxed a quart of water from fifty pounds of pads. They contract and grow "thin" during dry times. The common grapevine is one of the most overworked plants of all in popular survival literature. Large wild grapevines are an excellent source of juice to substitute for water. Cut a length and drain the water into a container or directly into your mouth. But wild grapes

seldom grow in severely arid expanses. In my travels over forty years I have never seen wild grapevines in any spot where I could not find water elsewhere within a short distance!

While it is important to know such sources of emergency liquids, or cordage, a false sense of security is possible. For example I read recently some advice about gathering wild grapevines to bind a raft together for a swift northern mountain stream in winter. There is just one drawback: at that latitude and in such terrain the chance of finding a wild grapevine is about as remote as finding a green coconut! Also liquid from vines- the wild grape is one- does not flow readily at all times. Summer produces best, winter not at all. In other words, know what is possible, but don't let cozy campfire chatter confuse the facts.

Seacoasts

It is conceivable (though not possible in many places on this continent) that you might be caught in an emergency along a seacoast. Along all Northern coasts there is little chance of being far from freshwater sources: streams which enter the bays or oceans, near-shore ponds and lakes, or inland swamps. But you might find yourself in sand dune country. It is possible, but again not surefire, that you will be able to get fresh water by digging in sand, not deeply, during low tide just at the highwater line on the sand. In theory, the first water to come into a hole here will be fresh. It is less dense (lighter) than salt water. Or, at times you can go back among dunes and dig and locate seeping fresh water the same way. But, too many people accept this as a system that is going to work, and it may not work at all. Fresh water must be present. It's that simple. If it isn't, you don't get any.

Some distance back from the shore, perhaps among dunes but in the lowest spot, so a kind of seepage basin is formed, chances are better that if you get water at all, it will be partly fresh. It may be brackish. But a small amount of salt is not harmful. Filtering through thicknesses of

cloth, or through sand, may help some. In no case should you drink saltwater. It can kill you, taken in any quantity.

Filtering Desert Water

Inland in deserts occasionally alkali water is all that can be located. It is hardly drinkable as is, but can be made so if not too severely alkaline. First filter it through sand. Do this by filling a cloth, even your shirt, with sand and pouring the water through it. But use sub-surface sand. Surface sand may be alkali-loaded already. Next boil it, but meanwhile place in the pot some charcoal or ash from wood previously charred in your fire. If you find desert waterholes, incidentally, with no vegetation at all growing around them, at least no vegetation which is alive, beware. This water probably is not drinkable, having leached out from the soil certain minerals that have literally poisoned it.

In deserts especially, conserving the liquids in your body is almost like finding water. Conserve energy during the heat, so you perspire as little as possible. Always keep well covered-head, arms, entire body-rather than removing your clothing. This may not be comfortable, but perspiration evaporates more slowly when you are clothed, and you avoid sunburn, which raises body temperature and hastens evaporation.

Ground Sources

In some instances dew is a source of water. In the desert, where temperature changes are wide between night and day, heavy dews may occur. A downed plane or a broken-down vehicle offers large surfaces on which dew can collect. Clean such surfaces as best you can. Prepare to mop up dew at dawn, squeezing out mop cloth into a container. A sheet of plastic, numerous smooth rocks laid out at night, a canvas ground cloth or tarp-all can be utilized as dew collectors. Dew may even be utilized from vegetation. But small surfaces unfortunately do not furnish much.

You must be up before dawn in order to collect as much as possible.

Plain mud can be a water source. Wallow absorbent material such as cloth in it, and squeeze out the saturation. Obviously this is impure liquid. It must be boiled. But a fair sized mudhole, mopped up, could save your life. Meanwhile, be ever watchful of the weather. At the least sign of rain, don't travel if you are in dire need of water. Begin immediately to arrange for catching all the rain water you can. Some ideas are as follows. Scoop a broad, shallow hole in the earth, lay your plastic sheet or tarp in it. Any small board or tree trunk or even a stick can work, in a heavy rain, as a "run-off" to direct water into any makeshift container. Make containers, in desperation, from broad leaves, or packed earth, or flat rocks.

If there is a dry wash near you that is narrow enough, you may be able before a hard rain to push sand and rocks into a makeshift dam that will hold back a flood of water long enough for you to get your share. Use every possible and available container, even to spreading your shirt, with sand spread atop it, inside a shallow depression. If a tree is near, tie a cloth around it and let a "tail" serve as a wick to drain water during a rain off into any type of container. Wring out the cloth periodically.

Palm trees are mentioned in all survival manuals. Many North Americans may be gulled into believing that they should keep an eye out for them. Palm trees are a clue to nearby, immediate, water, and to liquids from various types of palm-borne fruit. The trouble is that only far down in tropical North America are there palm trees worthy of mention in isolated situations that could possibly be helpful to persons who need them. In southern Mexico and Central America they are present. The sap from cut fronds or flower stalks might be helpful. But not within the continental United States and only in restricted areas far south of the border where these trees are indigenous. This popular fallacy instills confidence where it is not due. Palmettos, however, in the Southeastern

low country, can give up water when fronds or stems or hearts are cut. But chances of need in this region are so few that only the fundamental knowledge is necessary. Other water is readily available, as in the Ever-glades, one of the few remote areas in that region.

There are many ways to filter mud and other sediment out of water. In cactus country, slash pads (as of prickly pear) and pour muddy water on them in a lined hole or container. The gelatinous moisture within the pads gathers the mud or sediment. Let muddy water stand overnight to settle out mud. Filtering through cloth, grass, a cone-shaped contrivance made from tough sedge grasses or reeds, or through sand, will help. None of these operations is especially important, if you boil the water. Mud is not harmful as such. Settle it out, then skim off the water and boil to purify, assuming you have no chemical treatment.

Survival 'Still'

Among the most important water-gathering knowledge is how to build a "still" to force water from what appears to be dry ground. Over the past few years the still made with a plastic sheet has been used a good many times for gathering much needed water. This is an important reason for carrying the plastic in the first place. Some exertion is required. In moderate temperatures this won't matter. In high temperature of a desert locale, wait until dusk or predawn to do the work. To make a still, dig a hole at least one and one-half to two feet deep and a yard or a bit more across at the top. This depression should be bowl shaped. At the bottom, dead center, place a container, hopefully one with a reasonably wide mouth such as a boiling pot, or a container shaped from foil.

Now spread the plastic sheet across the top of the hole, and gently push down in the center so that it becomes a large cone with the apex directly over and within about three inches of the container. The sheet must now be tightly sealed around the rim of the depression by piling on

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earth dug from the hole, or rocks. When that is done, place a small weight such as a stone on the bottom, center, to keep the plastic snug and the inverted apex precisely above the container. This plastic cone, heated by the sun, will pull from the earth any moisture that is there. It is distilled onto the underside of the plastic and runs down to drip into the container. This is not absolutely infallible, however. There must first be moisture present.

Variations add to the amount of water. If cactus is plentiful, hack up chunks and line the entire bottom of the hole with pulp before spreading the plastic and sealing it. The cactus will be dehydrated and the resultant water distilled and dripped into the container. If you have a coil of small plastic tubing, mentioned a few paragraphs back, lay one end into the container and bring the tube up the side of the hole and from under the edge of the sheet. You are thus able to drink without disturbing your still. This can collect a quart of water a day and under optimum conditions more.

No doubt other water-gathering ideas can be concocted. However, using the foregoing as a guide, you will be basically prepared. As in every other survival endeavor, good sense, calm approaches and reasoning are of the utmost importance.

Big Dave

Microbiological Contaminants:

What are pathogens and where do they occur?

by Beth Cahape

On Tap Editor

On Tap Fall 1993

In part two of this series on microbiological contamination, we look at specific microbiological contaminants, and where contaminant outbreaks occur. We conclude with a brief look at *Cryptosporidium* and

the likely regulation of it and other pathogens in the future. This article was prepared with the assistance of Senior Microbiologist Paul Berger, Ph.D., who works in the U.S. Environmental Protection Agency's Office of Ground Water and Drinking Water.

Where do outbreaks occur?

There are many thousands of microbial species (living organisms) in water and in the intestines of humans. Only a few of these species present a risk to health. Harmful microorganisms that cause disease (meaning any type of illness) are called pathogens, and a large number of these come from human and animal wastes.

A 1991 study by Gunther F. Craun of the U.S. Environmental Protection Agency (EPA), examines, by decade, the number of reported waterborne disease outbreaks in the United States from 1920 to 1988.

While small community residents may feel that their chances of seeing waterborne outbreaks are greatly reduced simply because they have "city water," Craun's study shows that this is not necessarily the case. This report looks at contaminated private as well as public drinking water sources from 1981 to 1988, and a very large portion (79 percent) of those outbreaks took place at community and noncommunity water systems.

Operators and managers of small systems should especially take note that, of those outbreaks taking place at public water supplies since 1971, "most have occurred in small community and noncommunity water systems," reports Craun.

Isn't groundwater safe?

Many operators or managers of small groundwater systems feel that they can rely on the natural filtration of the subsoil to protect their source water from microbiological contamination. Here again, the conclusions of this EPA study might surprise small system personnel. The statistics show that in the 1980s nearly half (44 percent) of all reported waterborne outbreaks occurred in groundwater systems. Contaminated, untreated, or inadequately treated surface water actually

accounted for much less, at 26 percent. (It should be noted that this figure primarily represents large-sized water systems.) Half of the remaining 30 percent happened because of problems in distribution and storage facilities.

The Craun study should serve as a warning that, although over 90 percent of small water systems use groundwater as their source, this does not necessarily mean that they will have naturally filtered, pathogen-free water.

This is especially true, explains one environmental engineer, of groundwater taken from an aquifer in which the flow is through cracks, fissures, or large pore spaces (such as limestone). Surface water with potential pathogens—whether it be from a stream flow or precipitation runoff—can easily flow through these structures.

According to regulators at EPA's Office of Water, approximately one percent of all groundwater systems face these sorts of potential groundwater contamination problems, and their source water can be classified as "under the influence of surface water."

Large systems, more pathogens?

Large- and medium-sized water systems, (serving populations over 10,000), have a greater potential for microbial contamination because they handle greater volumes of water and serve more customers. Most of these systems also use surface water, where the presence of pathogens from sewage and other sources is much greater. However, these larger water systems typically have both the technologies and the trained staff to treat their water for pathogens.

Dr. Paul Berger, senior microbiologist with EPA's Office of Ground Water and Drinking Water, says, "systems using surface waters that are highly polluted have to pay special attention to removing pathogens. While serious outbreaks such as the one that occurred in Milwaukee can happen to any size system, this is especially the case for many large water systems.

"However," insists Berger, "it is small systems that might be at greater risk of contamination from waterborne pathogens." Berger

attributes this to the fact that small system operators don't have the expertise in water treatment and operation. Also, the required monitoring is infrequent and most small groundwater systems don't disinfect.

Specific microbial contaminants

"Waterborne pathogens that might be found in drinking water are normally in one of three categories: bacteria, viruses, or protozoa," says Berger. Each category of pathogen has unique characteristics and can present different treatment challenges.

Bacteria, for example, are a large group of single-celled organisms visible only under a microscope. "The vast majority are harmless and many are beneficial to humans and the environment," explains Berger. "In fact, life could not continue on earth without them.

"However," he continues, "a few of the bacterial species are the cause of disease in humans. When water containing these bacteria is consumed, it generally causes gastrointestinal symptoms such as diarrhea, cramps, nausea, and vomiting.

"When symptoms are severe," adds Berger, "they can lead to extreme dehydration and may, for the vulnerable, lead to other, more serious complications, and even death.

"The first approach to bacterial contamination," Berger says, "is to install disinfectant treatment and use it on a continuing basis. If this treatment is already in place, the operator should either flush the system periodically with water or start other control measures."

Additionally, water system operators or managers will need to investigate the source of the contamination and determine how they might protect their watershed in the future.

What about viruses?

Viruses are even smaller microscopic particles than bacteria, and are only able to multiply inside living cells. They can also cause infection in both animals and plants. There are probably thousands of different types of viruses, and hundreds have been identified. Some of the more

common diseases that airborne viruses can cause are mumps, measles, chicken pox, the common cold, and influenza. These particular viruses are not, however, carried in water.

An EPA document about drinking water microbes describes the symptoms from waterborne viruses as ranging from "minor stomach flu-like complaints to fatal liver conditions." A waterborne virus like Hepatitis A can cause liver failure, and is one of the most important microorganisms that water system personnel need to protect their community from, especially since "there are some deaths associated with this particular virus," says Berger.

Common waterborne viruses, explains one textbook on the subject, "can multiply in the human intestine and are excreted in feces. As a result, sewage and polluted water sources often contain viruses in high concentration."

In a recent water publication, microbiologist Terence McSweeney has suggested that most researchers feel that viruses can account for "at least 35 to 50 percent" of all those waterborne outbreaks where the pathogen could not be identified."

Typically viruses can be eliminated with the same sorts of disinfectants as those used on bacteria "unless," says Berger, "the source water is highly polluted with sewage waste."

What about Cryptosporidium?

The Cryptosporidium that contaminated Milwaukee's drinking water belongs to the third and final category of waterborne pathogens. This category is a group of one-celled animals called protozoa.

Another common protozoan is the parasite Giardia, which causes a severe intestinal ailment called giardiasis. In Craun's study, giardiasis accounted for 103 reported outbreaksÄresulting in a total of 25,834 illnessesÄin the years 1971-88. According to one EPA document, "From 1971 to 1985 . . . giardiasis was the most frequently diagnosed waterborne disease."

Like the disease cryptosporidiosis, more severe symptoms of giardiasis may include diarrhea, severe dehydration, weight loss, and

fatigue. A person infected with Giardia, says Berger, "may be ill with these symptoms for months, or even longer. With cryptosporidiosis, symptoms may be controlled in a much shorter time, but many experts feel that Cryptosporidium may be an important contributing factor in the death of AIDS patients."

Protozoa are also microscopic, and although they are usually single-celled organisms, they are more complex in structure and life cycle than bacteria or viruses. Both Cryptosporidium and Giardia have life cycles that produce cysts, which means that they have a protective shell around them. This cyst stage protects the protozoa when it is in the environment (i.e., outside of humans and other susceptible animals), and helps it be more resistant to disinfectants like chlorine.

While healthy people usually do not carry these organisms in their body, a microbiologist studying the Milwaukee outbreak explains that, "A sick person will produce 100 million cysts a day, expelling these through diarrhea and vomiting."

Protozoa in drinking water

"Giardia and Cryptosporidium contamination is associated primarily with surface water," explains Berger, "because soil usually acts as a pretty good filter for their removal." But even though most small systems are groundwater systems, these systems' operators and managers should not automatically assume they are safe from protozoa.

"If you do find them in groundwater," says Berger, "that's a good basis for suspecting that your groundwater is under the direct influence of surface water."

Giardia and Cryptosporidium may be more commonplace than we think, because the cause of many waterborne outbreaks cannot always be identified. One professional in the field has explained that, "while these protozoa may have been around for a long time, we have really only become aware of them within our water supplies in the past decade. There is still much to learn about the identification and treatment of these kinds of pathogens."

Problems testing for protozoa?

Currently, public water systems are not required to test for protozoa like Cryptosporidium or Giardia. "The main reason for this has been that laboratory analysis is difficult, expensive, and time-consuming," says Berger.

While specific tests for Crypto-sporidium are still problematic, it is a general rule that if no coliform bacteria are detected in filtered water that has not been disinfected, it is unlikely to have harmful protozoa in it either.

A Cryptosporidium rule?

Although monitoring for these protozoan contaminants is a difficult process, EPA is currently working on a data-gathering requirement, which would be the first step toward regulating, among others, the Cryptosporidium pathogen. This requirement would have large- and medium-sized systems do additional tests for other problem contaminants, such as Giardia and viruses.

"In order to properly control these pathogens," states Berger, "it is necessary to obtain source water data from many systems about the concentration of these pathogens." From this information, Berger says regulators will have a much better idea about treatment requirements. He explains that "the more polluted the water, the more treatment we know we will need.

"Hopefully," says Berger, "these proposed monitoring requirements will be published shortly in the Federal Register. There will, of course, be a period of public comment, and eventually a final rule by the second half of 1994."

Changing the SWTR

"The information we collect from the above requirement," adds Berger, "will be used to develop the 'Enhanced Surface Water Treatment Rule,' which will address Cryptosporidium and several other pathogens. As determined by the above-mentioned monitoring requirements, this enhanced rule will also deal with surface water systems that have poor quality

source waters.

"Especially emphasized will be those situations that present a risk to public health," he explains, "and which are not adequately addressed in the current Surface Water Treatment Rule.

"Small systems will not be affected by these new requirements anytime soon," concludes Berger. "But sometime in the future, EPA may require many small systems to install additional treatment."

In the next issue of On Tap, we will continue this series on microbiological contamination by examining requirements for small systems under current and future EPA regulations. Also examined will be an array of treatment techniques small systems might implement as protection against microbiological pathogens, including Giardia and Cryptosporidium.

Have We Become Too Casual About Microbial Contamination?

by Beth Cahape

NDWC Staff Writer

On Tap Summer 1993

Although Milwaukee's Cryptosporidium outbreak will undoubtedly be the drinking water story of the year, water system operators and managers need to be mindful of more than just this particular microbiological contaminant. This first in a series of articles examines the risk microbiological contaminants pose to the public health and the extent of their occurrence.

This article was prepared with the assistance of Senior Microbiologist Paul Berger, Ph.D., who works in the U.S. Environmental Protection Agency's Office of Ground Water and Drinking Water.

At a regional conference for small water system operators a few years ago, there was a general discussion of various U.S. Environmental Protection Agency (EPA) drinking water standards. When the talk turned to the requirements of the Total Coliform Rule, one operator rose from his seat and shared with the rest of the attendees a way to "get around

this requirement." Incredibly, the audience then listened to their colleague tell them how to alter their samples so that the test results—no matter how contaminated the sample might be—would be found "safe" when tested in a lab.

Undeniably, there are times when it may seem to be nearly impossible for a small water system to keep track of, and comply with, all the current and upcoming regulations for drinking water. But the information that operator shared reflected an attitude toward federal and state requirements that almost certainly would endanger the health of his community.

As informed system operators and managers know, microbiological contamination—also called microbial or microbe contamination—represents the most likely health threat a community's water system might encounter. While it should be noted that any tampering with samples can be readily detected by a suspicious regulator and a competent lab, uninformed or careless attitudes toward microbial contamination are still all too common.

Epidemics: Past and Present

Until the beginning of this century, Americans regularly suffered through a series of cholera and typhoid epidemics. With its terrible mortality rate, cholera easily became known as the most feared epidemic disease of the nineteenth century.

Both diseases, caused by sewage infiltrating drinking water, were ultimately controlled in this country with the discovery of chlorine as a disinfectant. Also instrumental in the control of waterborne disease (illness caused by drinking water) was a 1912 act passed by Congress that authorized the U.S. Public Health Service to oversee and protect the nation's public drinking water supplies.

According to one public health engineer, "The increase in the average life span is largely due to the near elimination of life-threatening waterborne disease by developments in the treatment of drinking water and sewage, not in the cure of disease once it has struck."

Indeed, we have seen the tragic results of neglecting careful water

treatment in South and Central America over the past three years. Traced to its January 1991 beginnings in Peru, the recent cholera epidemic has caused more than 5,000 deaths from the more than 500,000 reported cases in South and Central America.

"We should not allow ourselves to be complacent," adds the public health engineer. "We cannot overlook the fundamental importance of disease prevention by water system operators."

A Low Priority?

With the exception of a few very limited cholera outbreaks in communities along the Mexican border, we don't really have to be concerned about this terrible waterborne disease in this country anymore. But have we become complacent in our attitudes toward the treatment of microbiological contaminants?

It has been argued that a casual attitude toward regulation of microbes has been caused, in part, by EPA's own emphasis on chemical contaminants. In a recent editorial from *Waterworld Review*, editor Paul Hersch criticized this country's current drinking water priorities, saying that maximum contaminant levels (MCLs) are "set not by what matters, but what can be measured . . . the tight MCLs on many organics presumably are intended to prevent one death among 10,000 after 70 years' exposure. In contrast, the population regularly is exposed to waterborne biological affliction—some of it costing lives."

Detailing the final statistics from Milwaukee's *Cryptosporidium* outbreak this past April, Hersch says that ". . . the Milwaukee event may be notable for the numbers afflicted, but the scourge managed by *Cryptosporidium* is not a rare event."

More Serious than Chemicals?

There are many scientists in the drinking water field who believe that microbiological contamination may represent the most serious health threat to our drinking water. Paul Berger, a senior microbiologist with EPA's Office of Ground Water and Drinking Water, is one such scientist. "If you take a look at waterborne diseases," says Berger, "the great

majority are caused by microorganisms as opposed to chemicals. The data from all reported waterborne diseases from 1986 to '88 supports this. With the 25,846 people who actually got sick, only 103 were exposed to a chemical hazard," he says.

"While the vast majority of people suffering from waterborne diseases caused by microbes recover quickly, deaths do occur. Some data suggest that the number of deaths from microbes in water is much higher than that from cancers caused by chemicals in the water. There are people," explains Berger, "who say that the degree of harm (from waterborne disease) from both the exposure and illness is usually self limiting. They say that you get better soon, and that these contaminants are not like the chemicals that can cause cancer. This is true. But in some parts of our population—in every community—there are people who are at special risk."

Who's at Risk?

"Microorganisms," continues Berger, "can cause an acute effect with a single exposure. Usually the effect is just temporary, but for many of the aged, infants, and those with immunodeficiencies (weakened immune systems) like that caused by AIDS, these contaminants can be life-threatening. A healthy individual may not be affected, but these (high-risk) people are seriously affected.

"For example, in Missouri in 1989," says Berger, "four people died of E. coli. Even Hepatitis A, a viral infection that causes waterborne epidemics, has some mortality associated with it. And recent research on AIDS suggests that Cryptosporidium is associated in some manner with the death of AIDS patients."

However, people with weak immune systems represent more than the many thousands afflicted with AIDS. Those most vulnerable to microbial contamination can include individuals in the end stages of a number of serious illnesses, such as heart and kidney disease. Cancer patients undergoing radiation therapy, no matter how serious their conditions, are also vulnerable because their immune systems are weakened by this treatment.

"The elderly are vulnerable," adds Berger, "because their immune systems begin to weaken. In infants, the immune system is not mature enough to withstand an attack by disease-causing microorganisms."

Outbreaks Not Recognized

One of the problems with illnesses caused by waterborne microbiological contamination is that the vast majority of cases go unreported. The acute gastrointestinal symptoms (e.g., diarrhea and vomiting) that people typically get when they are exposed to these contaminants are very much like a case of influenza, or "stomach flu." Because of this, people usually don't seek medical treatment. Even when symptoms are more severe and an individual sees a physician, that physician generally has no immediate way to determine that his or her patient's condition is the result of drinking contaminated water.

"Most waterborne disease is not recognized as being waterborne," says Berger. "Unless a doctor suspects it is caused by this source, or unless doctors are alerted to the possibility by their public health department, it is likely to go unreported."

Berger cites the 1987 waterborne *Cryptosporidium* outbreak in Carrollton, Georgia, as an example: "Some 13,000 people became ill, and yet it would have gone completely unnoticed had it not been identified by a sharp nurse who began looking at the situation more closely. She was the one who put it together."

It's still not possible to say exactly how many outbreaks might actually be taking place, but some studies provide an idea. In Colorado, state health officials hired a consultant to look through their records for cases of waterborne disease outbreaks. After studying 18 months of state medical statistics, the consultant determined that there were more than three times as many cases occurring as had actually been reported. "In 1985, the Centers for Disease Control interviewed their various departments," adds Berger, "to get a better idea of the extent of diseases per year. They actually estimated 940,000 cases per year of waterborne disease due to drinking water. They also attribute

Water_Copendium_1995.txt

approximately 900 deaths per year to waterborne illness."

As this series continues, specific microbial contaminants, current and future EPA microbiological regulations, and how these regulations affect small systems will be examined.

From : Thomas Sun 01 May 94 23:00

Subj : Making Distilled H2o

Check out what Jim R wrote on 27 Apr 94 20:57:01:

JR> PLEASE do so... you have gotten me thinking. Is the reason you used
JR> vacuum
JR> distillation instead of heat distillation on ship efficiency or what?
JR> thanks..

Efficiency definitely adds into the equation in the Marine industry. Another reason for the low Pressure (READ: Vacuum) is reduced temperature. Now reduced temps do use less fuel but low temps also reduce scaling of the heat exchangers. The scale produced from the magnesium and calcium in the seawater is soft and easily removed if temperatures are kept below 215 degrees F. Therefore we introduce seawater into a chamber with 14 to 18 inches of Hg vacuum at 175 degrees F. Part of the seawater flashes to vapor and is collected in condensing units in the upper part of the chamber. The remaining seawater is drawn into a second chamber at 28.5 inches of Hg vacuum where more is flashed to vapor and condensed. The remaining seawater (called Brine at this point) is pumped over back to the sea. I am working on a diagram of the distillation unit. It is steam powered, but can operate at low pressures if a mechanical vacuum pump is utilized. More efficiency can be achieved by using steam jet air-ejectors for vacuum pumps, but they also require a 150# minimum of steam pressure.

I will send the diagram up to John Mudge when complete. Also will be

Water_Copendium_1995.txt

included the complete description and operating principles as taken from the US Naval Handbook. The commercial units are made by a company called AquaChem. The distillers are about 8'X6'X10' and make between 10,000 and 40,000 gallons in 24 hrs. The water is less than .001 PPM (Parts per million) from seawater. Imagine what you could do with water from a stream....

Redwing

From : Vic Mon 18 Apr 94 00:22

Subj : Making Distilled H2o

I have been gathering materials and equipment for our move to the wide open spaces (southern Iowa).

I use an electric distiller at home (Florida at the moment) and after about 3 or 4 gallons I must clean the crud out with vinegar.

It gets kinda expensive.

I've been trying to come up with a method to distill water without using electricity. I suppose a solar distiller would work but I had in mind one that would use an open fire, similar to perhaps a "moonshine" type distiller. I'm knocking around the idea of using a stainless steel pool filter canister. They're about 12" in diameter and 40" high and probably could hold 20 or so gallons of water. The top is sealed with six 3/8" bolts and wing nuts. The coiled copper tubing from the top (added) would be used as the condenser. Easily opened and cleaned.

Anyone think this might work or has anyone built something along these lines and been satisfied with the results?

EMERGENCY WATER
by Ken Larson

To the surprise of many, the need for water is much higher than for food. Many people have lived for 30 days with no food, but without water, after three or four days you are in serious trouble.

People tend to underestimate how much water is actually needed to perform normal, routine tasks of daily living.

Drinking water is the primary need, but you may need additional water for baths, cooking, flushing toilets, cleaning eating utensils, washing clothes and other chores.

Water availability is affected in natural and man made disasters. In every disaster, the majority of the general population is totally unprepared for even a small interruptions in normal utility and food distribution services. In most disasters, the victims expect and sometimes demand that "someone" provide needed protection, water, shelter and food.

There are myriad ways the water supply can be disrupted. The most common way is due to lack of electricity. With no electricity, there will be no water from water purification plants or your well--unless it is a non-electric well.

The second most common way is a water main rupture. Recently, more than 10,000 people in the southeastern United States were out of water for over two weeks due to such a rupture.

Wells can be contaminated by flooding, and well pumps can become damaged by flooding. Freezing weather also takes its toll on well and city water lines.

Local streams are never safe during disasters because raw sewerage and polluted surface water can enter the streams.

During a recent hurricane , the wind blew an excessive amount of leaves into the affected area's reservoirs. The water turned yellow for three weeks and acquired an objectionable taste due to the abnormal amount of leaves that were decomposing.

Container storage -- certain plastic containers such as

drywall buckets and plastic trash containers are not intended for food contact and may leach undesirable chemicals into stored water. These containers should be used for transporting water or for storage of water not used for consumption.

Although the 5 gallon drywall bucket is not good for storing drinking water, it is an excellent choice for transporting water and for storage of water not used for consumption.

Any container used for transportation or for storage needs a top. during transportation, the top reduces spillage. Tray transporting water in the car trunk in a bucket without a top and you will see how much sloshes out. During storage, the top keeps out dirt, dust, insects, etc.

The 5 gallon buckets used by restaurants for food products are excellent for storing drinking water. If no containers are available, plastic sheets or bags can be used to line porous containers for storing water in emergencies. A depression can ever be dug in the ground and lined with plastic to hold water temporarily.

In storing water for emergency uses, most authorities recommend a minimum of 2 gallons per person per day. This should include one half gallon for drinking and the balance for other uses. It is preferable not to ration water in a survival situation because this may have adverse affects on the health of people involved.

I store non-drinking water for dishwashing, toilets, washing clothes, etc. in 5 gallon plastic drywall buckets. My drinking water is stored in out bleach bottles and plastic milk jugs. I add 16 drops of liquid bleach (4-6 percent sodium hypochlorite) per gallon of clear water to protect it during storage form the growth of micro-organisms. I suggest storing an extra jug of bleach to purify any new water that is of questionable quality.

Be careful not to misidentify bleach bottles as containing drinking water if you also have bleach on hand. This is especially dangerous where children are involved. Always remove the bleach

label and replace it with the word "WATER" in large indelible letters on the jugs in which the water is stored.

The Utah State University Extension Service offers the following instructions for heat sterilization when using glass containers to store water: "fill clean fruit jars with water, leaving one inch of head space at the top of the jar. Place clean sterilized lids on the jar and process the water in a boiling water bath as fruit juice is processed. Quart jars should be processed 20 minutes. Two quart jars 25 minutes."

Whatever the container used, it is probably a good idea to date each container with a large magic marker or other marking instrument. I'm glad I did mark my first water storage jugs because I now have water that is 8 years old. Water is used on a first-in first-out basis. My water supplies have been used many times in the last 8 years.

Since I do own a generator, a power outage will shut down my well. No electricity, no electric well pump. On several other occasions, my well pump had maintenance problems and the stored water came in very handy while the pump was being repaired.

Don't store plastic containers near fuels, pesticides or similar materials. The vapors from these can penetrate the plastic and contaminate the water. Also, store water in the dark to protect the plastic from sunlight.

One problem commonly encountered in water storage is inventory control. You must be diligent in replacing the water you use and rotate your inventory at least every several years. Use the oldest inventory first. Any questionable water you have in storage can be used for non-drinking purposes.

The local county extension service will test your water for purity. This is a good idea when you have water supplies that have not been rotated for several years.

If you have enough advance notice of a coming water emergency or possible emergency, fill up extra empty milk cartons, jars, bathtubs, sinks, wading pools, trash cans and or any other

available container. Obviously water in garbage cans would be used for non-drinking purposes unless filtered and purified.

OTHER WATER SOURCES -- You can use the water for the toilet tank (not the bowl) and it will offer several gallons. You may want to look in your tank right now to see if it needs a good cleaning.

Trapped water in house plumbing lines offers several gallons of clean water. As soon as the water pressure goes off, be careful to shut off your house lines from the street. This action will insure you do not draw in contaminated water or allow your trapped water to flow back into the connecting municipal system. Next, turn off the heat sources to your water heater. To gain access to trapped water in the house line, crack the faucet at the lowest level and drain the lines. I have installed a faucet in my basement to insure I can collect the water from the lines that run under my house. The basement is where I plan to be during a weather alert.

Your water heater tank holds 30 - 40 gallons. Check your water heater tank because it may have a foot or more of sediment in the tank bottom. Sediment removal is a good reason to drain the tank every year. In addition, the removal of sediment will improve the water heater's efficiency. The hot water tank can be drained by opening the faucet at the bottom of the tank. You may need to open the hot water faucet elsewhere in the house to allow the release of the vacuum to allow a free flow of water. The water inlet valve (faucet) should be turned off if you doubt the quality of the inlet water. If the inlet valve is turned off, you may need to vent the water tank by opening the "pop off" valve lever that is used to allow over heated tanks to vent excessive pressure. The faucet at the bottom is threaded to receive a regular garden hose.

The water in a water bed can also be used. Only use this water for non-drinking purposes because of the possibility of algaecide chemicals in the water and plastic chemicals being leached into the water.

A swimming pool offers a large volume of stored water for non-drinking use. In one case a swimming pool provided a whole neighborhood with water after a hurricane. The neighbors set up a temporary shower in the backyard next to the pool. Others who lived nearby carried the water back home in any containers they could find.

If it rains, place buckets or barrels under rain gutter down spouts. You may have to cut or disconnect them so the water can flow into the container. If your container is not clean, you can line it with plastic such as a clean garbage bag. Plastic sheets can be placed on a hillside or be strung between trees to funnel water into your containers.

PURIFYING WATER -- Pollution can affect ice, snow, water in streams and in shallow wells causing these water sources to be unsafe. Even clear streams can have parasites in them. Unpolluted water must be boiled to assure complete destruction of any dangerous organisms.

Properly stored water is the safest in an emergency. If you have to use water from an unknown source or of unknown quality, be aware that the following methods of purifying water do not guarantee the safety of the water but will reduce the risks involved.

Boiling water is one of the safest methods of water purification. It should be boiled for at least 20 minutes to insure that bacteria are killed. Boiling does not remove pollution. The boiling process will make the water taste flat since some air has been driven out. To add back the oxygen and to improve the taste, pour the water several times from one container to another. Another method is to pour the water into a closed container and vigorously shake it. A small piece of wood or a pinch of salt can be added to the boiling water to improve the taste.

Learn how to start an outdoor fire to be used in boiling water. Do not depend on electricity or gas for your heat source.

Only use chemical purification for questionable water if boiling is not possible. Understand that organic matter in the water increased the amount of chemical needed. The colder the water, the more time needed for the chemical to work.

Add 16 drops of bleach per gallon of water for clear water and double that amount for cloudy or sediment-filled water. Mix well and wait for 30 minutes before using. You should be able to smell the bleach after 30 minutes. If not, repeat the process until you smell the bleach, otherwise do not use the water. If you leave the container uncovered for several hours, the chlorine taste will be reduced and the water will be more palatable.

Always use fresh liquid bleach because it will lose its strength over time. Double the recommended amounts if the bleach is over one year old and do not use it if over two years old.

Water purification tablets can be used to purify water. They are readily available from sporting goods stores and military surplus outlets.

Use fresh tablets. Normal shelf life for iodine tablets is 3 to 5 years if unopened. Iodine tablets work better than bleach or halazone tablets for certain intestinal parasites. In addition, halazone tablets have a shelf life of only 2 years.

Commercial filters combine a filter substance and active ingredients to filter and treat the water at the same time. Some brands are not as effective as they claim.

Clear water should be used whenever possible when purification is needed. If sediment is present, it will settle out in time and the clear water can be poured off or the water can be poured through a cloth or coffee filter to speed up the process.

A novel method to clear up water is to use a cloth siphon arrangement. Place the full cloudy water container higher than the empty clean water container. Roll up a clean dry piece of cloth and put one end in the upper container and the other end in the lower clean container. If the cloth in the lower container is several inches below the cloudy water's water line, then a siphon

effect will begin and the water will be filtered. This is a very, very slow process, but is good to know about.

In the distilling process, questionable water is boiled and allowed to condense into safe water.

One method is to allow the water vapor escaping out of a tea kettle to enter an inverted milk jug. The water vapor will condense in the milk jug and run out into a pan set nearby to collect it.

Another method is to run the water vapor through copper tubing (same as used in your house) to condense the vapor into pure water. For quantity production, try to visualize a moonshiners still. Use a larger closed container heated over a fire with copper tubing coiled several times to make such a still.

CONSERVATION -- The more you conserve your water in an emergency, the less you will use or need from storage. For example, toilets use 3-4 gallons per each flush. Add several bricks in the tank to reduce usage (be careful not to have too much waste for each flush). And toilets need not always be flushed after each use. You might also want to build an outdoor toilet trench such as is described in "The Boy Scout Handbook" or other publications.

Stretch out the periods between your baths or showers, or use a Navy type shower procedure, where you turn on the water to wet down, turn off water, soap up and then turn on the water to rinse off. If water is very limited, take a sponge bath when ever practical.

Do not waste water washing clothing other than under clothing. Before you wash, leave clothes outside over night and they will pick up additional moisture reducing the amount of wash water needed. A heavy dew will make a wash towel moist enough to use for a sponge bath. It is even better to roll the clothes in the dew to make them very wet before beginning the wash.

Never throw water away without figuring out other uses for it. For example, use the tub water for flushing a toilet. Save the water when you wash your hands and use it for the initial clothes

washing water.

Do not dispose of dirty water just because it has sediment in it. You will be surprised how much sediment in dirty water will settle out over night or in several days if left undisturbed. The clearer surface water can be used again for non-drinking purposes.

Finally , it is very important to wash hands when preparing food. Intestinal problems can rapidly dehydrate the body and cause severe health problems.

As you can see, water storage is very simple to accomplish. A little advance preparation can add a great deal of security in our current water-sensitive and highly technological times as well as in any emergency situation.

DS> SE> The answer is Hydrogen Peroxide. Normally they use what is called
DS> SE> 35% Food Grade H2O2. Hydrogen Peroxide is water with an extra atom
DS> SE> of oxygen. Added to dairy products it will kill all harmful bacteri
DS> SE> that would otherwise cause the product to spoil. I use H2O2 to keep

DS>Interesting. I met a fellow who advocates putting 16oz of 30% H2O2 in 1000
DS>gallons of water and then using it for animal drinking water (sez it's good
DS>humans also). He claims that it promotes growth, increases milk production,
DS>and kills parasites. He claims that he does not have to use wormers on his
DS>dairy cattle as a result. I'm going to try it sometime on sheep. I bought
DS>chemical feed pump to inject it into the water over three years ago but neve
DS>got around to doing it.

My understanding is that oxygen is fundamental to ALL bodily processes and that H2O2 is an efficient way to supplant your supply. 30% food grade may be taken internally provided that you DILUTE IT !!! Start with about six drops in 8oz of water. The reason that food grade H2O2 is disappearing from health food stores is because of the number of people who drank or applied it undiluted and hurt themselves.

Chemical supply places like Van Waters & Rogers will sell food grade for a fraction of what it costs elsewhere. It is real

interesting stuff with lots of applications. The German V2 rocket used it for fuel oxydizer.

Jar Testing: Getting started on a low budget
by David Pask
NDWC Technical Services Coordinator

By now, almost everyone realizes that to get optimum performance from your filtration plant, it is necessary to do what are commonly known as "jar tests." Good operators may make treatment adjustments as they notice changes in raw water quality or temperature, judging their results by the look of the floc in the clarifier or filter. However, to ensure maximum efficiency, you should at least conduct jar tests.

A jar test is simply a pilot-scale test of the treatment you are using in your plant, and is used to determine if you're using the right amount of chemicals. I can hear some of you saying, "But I don't have all that fancy lab gear—nor the time to use it." However, jar testing need not be difficult or expensive, in time or equipment.

You can get started with substitute or make-do equipment; then buy the proper laboratory equipment and supplies as the need arises or as funds are made available. One should always acknowledge that tests to control a process do not need to be as precise or follow the exact specification as analyses that are used to verify compliance with regulations.

For instance, I can look at a sample of water through a 24-inch-long tube and be reasonably certain that the sample is less than one Neph-lometric Turbidity Units (NTUs), but, if it were possible, I would prefer to have a turbidimeter on my bench (at a cost of around \$850) to be sure.

Why perform jar tests?

By performing jar tests, you can:

- try alternative treatment doses and strategies without altering the performance of the full-scale treatment plant, and
 - easily compare the results of several different chemical treatments for time of formation, floc size, settleability, and perhaps filtration characteristics.
- One cannot make such comparisons with the full plant's treatment. Therefore,

when the quality or temperature of your raw water changes, do a jar test before you change the chemical dosing pumps, and you will likely get the right results the first time: no turbidity breakthrough, no unusual bacterial counts, and no complaints from your customers.

How are they done?

Jar tests simply entail adding treatment chemicals in the right amounts and sequence to a sample of raw water, which is in a jar or beaker. The sample is then stirred, so that the formation, development, and settlement of floc can be watched, just as it would be in the full-scale treatment plant. A series of tests are then performed to compare the effects of different amounts of flocculating agents at different pH values to achieve the right size floc for the requirements of your particular plant.

What equipment is needed?

The basic equipment requirements include:

- a) a stirring apparatus for 2 to 6 jars or beakers;
- b) a test kit or meter to measure pH and alkalinity;
- c) stock solutions of treatment chemicals;
- d) measuring cylinders and pipettes to measure raw water and chemicals;
- e) a thermometer;
- f) a clock or timer;
- g) a measuring tape, calculator, and notebook (used to calculate, to record results, and for future reference).

If you are using a new coagulant or filter aid, you will need either pre-weighed samples or a small chemical balance and weights to enable you to make up accurate solutions. Of course, if your system can afford one, a turbidimeter is another useful addition to your equipment supply.

A new six-gang stirrer will cost about \$850, but one can perform useful work with two magnetic stirrers, which cost about \$250. For occasional use, I have used two-gang stirrers made from workshop scraps, but for this article I made a set from parts available at national hardware and electronics suppliers for a total cost of \$25 (excluding labor). This handmade set of stirrers is shown in the photograph on page 4; a complete parts list is available by calling me at

(800) 624-8301.

The only awkward part of building the stirrers is reaming out the fitting cross, so that it will slide easily onto the 3/4-inch pipe. To do this, I used a piece of hacksaw blade and set it into a slot that was cut in the end of a section of pipe (see graphic in Figure 1).

Also, the 1.5-volt motors are not really designed to operate at such a low speed; however, they will work if each is controlled with a 25 ohm, two watt, variable resistor. One alkaline "D" cell battery will provide at least 10 hours of continuous stirring. (Of course, using batteries will ease the minds of your safety and insurance officials, who prefer that you do not have any non-certified mains voltage equipment around the plant.)

There also are practical alternatives to using standard laboratory equipment for some measurements. I particularly recommend using plastic disposable medical syringes (without the needles), instead of pipettes. The syringes are accurate enough, and if you have one for each chemical, they can be preloaded for rapid dosing into the jar. I have found the 3-milliliter (ml) and 20-ml size syringes to be suitable (1 ml = 1 cc).

The "square" mason jar has advantages over the standard laboratory beaker when used for flocculation testing. With the mason jar, the turbulence is increased and the overall rate of rotation is reduced, making observation easier.

I still use a readjusted cheap jewelry balance (which costs about \$20) with a set of lab weights (about \$25) for reagents. A basic laboratory balance weighing to 0.01 gram can be obtained for about \$100.

I have a 50-ml lab cylinder, but also use a 500-ml kitchen measuring jug (which I calibrated at 502 ml).

These substitutes are about as accurate as your supply meter and should not, therefore, provide misleading results.

What is the proper procedure?

Unless this is the start-up of a new plant, you will already have the chemical dosing rates that provide acceptable treatment results. Our objective with jar testing is to tune the plant for optimum performance; that is, for the longest possible filter runs with the least usage of chemicals to provide consistent, good quality water that is within required standards.

Water_Copendium_1995.txt

Before you begin jar testing, however, take an hour or two to check all of your equipment.

- Is the inlet flow meter accurate? Shut off your supply pumps and measure the rise in level of your clear well against the readings of the meter.
- Shut off the filters and do the same test on the supply pumps.
- Check that the chemical dosing pumps are delivering the correct rate by measuring the rate of fall in the daily supply tanks.
- Check that there is no accumulation of solids in the settling tanks and that the filter sand is clear of any "mudballing" and is properly graded and up to level.
- Check also that the backwash pumps are operating at the set flow rate by timing the rise in level at the start of the backwash cycle.
- Correct, or at least make a note of, any deficiencies.

The most awkward part of your jar tests will be the calculations to determine the correct amount of chemicals to add to the raw water in your jar. I find this much easier if you work in metric (SI) units, and then convert back to your own equipment units to transfer your results into practice. See the examples listed in the box on page 5.

What now?

This article only "scratches the surface" of the chemical treatment process for flocculation and filtration. Much more can be learned from a good manual and from the training sessions conducted by your local Rural Water Association and American Water Works Association. (For these organizations' telephone numbers, call 1-800-624-8301.)

What I have tried to illustrate is that you can achieve useful results with a modest outlay of time and money. The improvement in your plant performance may then help to persuade your manager or community to invest in better laboratory equipment, which you will undoubtedly need in the future.

I am working with some friends who have a place in rural Ontario and they want to build, as cheaply as possible,

a pond or water reservoir.

Aside from lining with cement or soil cement, will several layers of ordinary black plastic sheeting keep the water in? For how many years before the plastic begins to deteriorate?

>> a pond or water reservoir.

>> Aside from lining with cement or soil cement, will several layers of ordinary black plastic sheeting keep the water >filtering that out.

>

>If you can get hold of some thick plastic sheeting, it probably would >last long enough to be practical.

If you end up using plastic, you probably will want ultraviolet resistant greenhouse plastic. The last time I bought some it was about \$300 for a 40' by 100' roll of 6 mil. Greenhouses replace it (at least around here) every 2-3 years, but for my uses it lasts longer.

KB> The water supply problem is the issue here!

Water will be the problem everywhere Karen. There are many ways to conserve water in your gardening. I cut my watering costs in half in one year by using black plastic ground cover and mulch in combination with drip irrigation. We are talking from around \$50 a month to \$25 a month during the hottest/driest times. Since then, I have also placed 55 gal drums under all my downspouts to catch rainwater rather than letting it run off. I now have a supply of "free" water that usually makes it into August before running low and if we have any rain at all, I can make it through the year without having to "buy" any water. This is no small feat since my garden is about one-quarter acre in size but the

Water_Copendium_1995.txt

results are impressive when one considers the costs involved. The first year I started trying to reduce my water costs(1977) I was averaging about \$35 a month from May-Sept. Since then, water costs have sky-rocketed and this year, I spent \$0 for water. If I had paid today's prices for the water I normally consume in the garden, I would have spent over \$500. For that amount, I could probably purchase the same food in the local supermarket.

There are other considerations, like quality, taste, and nutritional values to consider in growing your own but cost is a major factor. Pesticides, herbicides, fungicides, etc., used by today's big agribiz conglomerates also is a consideration but will be discussed in another post.<g>

Hello Allan!

Wednesday August 25 1993, Allan writes to John :

JM>> Except for the fact that ozone has no residual effect, it is a good
JM>> contact disinfectant. It is fairly easily made as it is formed by
JM>> running oxygen through a high voltage (10-15 KV) field. An AC field
JM>> seems to work slightly better than a DC field. Automotive ignition coils
JM>> are adequate transformers for small applications.

AH> The transformers from oil burners produce about 10k with 110 input.

Neon sign transformers are usually higher output voltage and higher current...many junkyards have them.

AH> Remember that positive ion-charged air has a detrimental effect on the
AH> mood of those exposed, and negative ion-charged air has the opposite.
AH> Something to do with how the blood carries oxygen better when the
AH> oxygen is negatively charged. (Ever notice what a good feeling you have
AH> after a thunder-storm? It isn't ALL due to the fact that the lightning
AH> missed you <G>).

Water_Copendium_1995.txt

I think we have no choice...O₃ is negatively charged no matter what...

AH> After infusion with ozone, UV light (which will also generate ozone)
AH> will help kill what's left. (and look real pretty when you turn out
AH> the lights too!)

I still have my dayglow crayolas left from the sixties...UV tubes are available that have pipe fittings on them specifically for disinfection. The light surrounds a clear tube that screws in line with standard water pipe. These are good gadgets to have downline from filters just to make sure that pathogenic bacteria are killed.

John

From : Richard Mon 14 Feb 94 05:44

Subj : Sea water filtering

georgt writes:

>> Is it possible to filter sea water with the hand pump water filter
>systems?

>The salts in sea water dissociate in water, that is something like
>sodium-chloride splits apart into a sodium ion and chloride anion.
>This is what makes salty water a good electrical conductor.
>Anyway, the ions are smaller than water molecules, so there is
>no way to filter out the salts.

Thanks for playing, next contestant please <g>

Water_Copendium_1995.txt

It is possible to filter sea water and get potable water out of it. In fact, much of the water for the town of Avalon, on Catalina Island (26 miles across the sea from Los Angeles) gets it's water from this reverse osmosis filter process, as well as Santa Barbara (may not be on line); During the Gulf War, one of the main concerns of the destruction of the shipping terminals by the Iraqis was the oil getting into the Water Plants that provided much (all) of the water to the citizens in that part of the Gulf. The technology is widespread..

In fact, there are several small (including hand operated) filter/pump units for boats that do this, and work relatively well. They're not terribly cheap, and the pressures involved mean there not too easy to use, but they do exist, mainly for use in liferafts, etc. I believe that the pur water filters used by backpackers are made by the same company that makes one line of these, but ymmv.

Good Luck!

>Someone with knowledge of the oceans can tell us exactly what
>types of salts are actually found in the oceans.
>--
>George

From : heiden Mon 14 Feb 94 10:25

Subj : Sea water filtering

bmaccion writes:

>Is it possible to filter sea water with the hand pump water filter systems?
>I've seen ads that they can filter a mud puddle and am wondering if

Water_Copendium_1995.txt

>it's possible to get drinkable water from the ocean using one? (Of
>course I take the ads with a grain of salt anyway).

The Polnesians, you know the folks who invented the catamaran, had a very special technique. When it rained, they dived in the ocean and sipped the sweet water which floats on top of the salt water, because it is less dense. Of course you must not wait to long and you must take it with grain of salt.

Kees

From : Alan Malkiel Feb 94 16:14

Subj : Sea water filtering

From: exualan

If you want first hand information about RO water makers, buy a boating magazine at your favorite newstand and read the ads.

If you want second hand information, read on.

My PUR catalog has the following information (from memory) -
The smallest hand operated RO watermaker weighs about 2.2 pounds, makes about 16 ounces of fresh water in 30 minutes (of fairly hard pumping IMO), and costs about \$500.

The next larger unit makes 1.2 gallons per hour, costs \$1500 and I don't recall the weight (8? 10? lbs). It also can be converted to 12v with a motor.

Both units remove about 97% of the salt.
The catalog also claims virus removal in the process.

Alan

SAVING LIVES WITH THE SUN

Most people in the world do not know that contaminated water can be made safe to drink with sunlight and a cardboard box -- or even a hole in the ground. In fact, as far as we can determine, most international aid agencies are not aware of these simple facts either. With more than 7000 people dying each day from water-borne diseases, failure to employ these techniques is taking a devastating toll.

Our attention recently turned to water quality as we heard of the tragic loss of life in Iraq due to a lack of safe drinking water. With the destruction of much of their civilian infrastructure by American and British bombs, many Iraqis have resorted to drinking contaminated river water. Our scores of late-night telephone calls around the world have been mostly met with incredulity; our faxes are rarely answered. The tone of many of the conversations has been, "If it really works, why isn't everyone using it?" -- Catch-22.

In this issue we include plans for the simplest solar water pasteurizer we have been able to devise. While some members of the solar cooking community feel that scarce materials should be used to build more substantial, efficient solar cookers -- ones that can also cook large quantities of food -- a vote of our board affirmed the decision to make available plans for this simple model for situations where ease and speed of construction are essential.

Of the millions who died last year from water-borne diseases, how many knew that water can be made safe to drink using the sun and simple materials? We urge you to take this information and make it known as far and wide as possible.

/* Written 11:29 pm Nov 27, 1991 by tspanheim in cdp:at.library */
WATER PASTEURIZATION

A Microbiologist's Perspective

Pasteurization is a form of heat treatment which makes liquids safe for human consumption. Louis Pasteur first used this method when he gave a low heat treatment to young wines to prevent undesirable bacterial spoilage. Pasteur's process was soon extended to raw milk by the medical profession to kill the many disease-causing microbes milk may contain. Some bacteria are quite heat resistant and survive pasteurization temperatures, but these will not make one sick. They can spoil milk, however, which is the reason pasteurized milk must be refrigerated. Pasteurized milk is not sterile -- the condition where all microbes are killed.

Milk pasteurization temperatures are 145 F (62.8 C) for 30 minutes, or 161 F (71.1 C) for only 15 seconds. A one-second exposure to water at 161 F will burn your skin, but that heat kills microbes as well.

Contaminated water is a major source of disease and death in developing countries, especially in rural areas. People are often told to boil water for 10 minutes to make it safe to drink. This is not often done for several reasons, including the time and fuel required, and the poor flavor of smokey water. However, it is not necessary to boil water, just as milk doesn't have to be boiled to make it safe to drink. Heating water to 149 F (65 C) and keeping it at that temperature for 30 minutes will kill the pathogens it contains, similar to milk pasteurization.

With the realization that, like milk, water can be pasteurized at temperatures well below boiling, the solar box cooker (SBC) suddenly has the potential of being used not only for serious cooking, but also to pasteurize local contaminated

water. Adaptations of the SBC to fit various water-holding containers is not difficult. However, it is critical to make sure that all the water reaches 65 C. This is done by measuring the temperature of the water at the bottom of the container. Because hot water is lighter than cooler water, stratification may occur. It is not unusual for the water temperature at the top of a jug to be 20 F (11 C) hotter than the water temperature at the bottom .

Solar Box Cookers International has a promising prototype reusable temperature indicator based on the melting of a soya fat in a closed contained when 65 C is reached. If pasteurization temperatures have been reached or exceeded, this gauge will provide verification. When the water is cooled, it can be used for drinking.

Once water has been pasteurized, it must not be contaminated again before it is used. Safe water must not be mixed with contaminated water, poured into contaminated containers, or dipped into with contaminated hands or containers. It is best to pour from the vessel into clean cups. It is also advised to heat the cups or other vessels in a SBC to disinfect them before use.

Tea or coffee can be prepared directly in SBCs, and will be safe to consume if heated past 65 C as described.

(Dr. Metcalf is a professor of microbiology at California State University, Sacramento and President of Solar Box Cookers International. If you have questions, problems, or experiences with solar water pasteurization, please direct these to Dr. Bob Metcalf, SBCI, 1724 11th Street, Sacramento, CA 95814 USA.)

PIT COOKERS

Said Shakerin, an assistant professor at the University of

the Pacific in California recently did a series of experiments with solar cookers dug into the ground. The basic design tested was a pit 22.5" x 18.5" (57 cm x 46 cm) with a depth of 9" (23 cm). This pit had the same dimensions as the popular cardboard Kerr-Cole EcoCooker. This allowed him to check its performance relative to a known, high-capacity cooker. His tests were conducted during June and July in Stockton, California (37.5 degrees N. Latitude).

His results showed that even without foil on the walls and without a reflector, the earthen cooker could easily pasteurize two liters of water during the 4 hours in the middle of the day. He also found that with foil on the walls and a reflector, this cooker performed comparable to the Kerr-Cole model.

In similar tests, Barbara Kerr found that pot temperatures could be increased by keeping the pots in the sunny portion of the pit throughout the cooking session.

/* Written 11:29 pm Nov 27, 1991 by tspanheim in cdp:at.library */

SBCN has developed a simple solar water pasteurizer that can be built from a single cardboard box and a piece of plastic film. Aluminum foil is optional. Write to us for plans in English or Arabic.

The preceding article is from the Fall 1991 Edition of Solar Box Journal. Feel free to download, distribute, and reproduce. Subscriptions are available for \$20 a year domestic and \$25 international (Printed version includes photographs and diagrams). We urge you to subscribe so that we can continue to bring you this information.

Solar Box Journal is also a regular feature of the 'at.library'

conference on EcoNet, the global network for the environmental community. For EcoNet subscription information, write to support .

Published quarterly by Solar Box Cookers Northwest (SBCN), an independent, nonpartisan, nonprofit, educational organization dedicated to spreading the use of cooking with solar cookers made from low-tech materials. SBCN was founded in 1989.

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Subj : world-wide water use fee?

AP 06/19/94

WASHINGTON (AP) -- A proposal by the World Bank to charge fees in poor countries to users of water, transportation and electricity has come under attack from private aid groups as favoring the rich.

As it nears its 50th birthday next month, the bank is renewing emphasis on its original mission -- to help the world's poor.

But a coalition of private aid bodies called "Fifty Years Is Enough" said the bank's unwillingness to admit mistakes is evident in the bank's latest report, released Sunday.

"If the bank is so concerned about the poor, why doesn't it suggest raising property and income taxes on higher-income

neighborhoods and use this money to expand access to ... services by the poor, rather than introduce user fees," which must be paid by rich and poor alike, asked Walter Hook. He is executive director of the Institute for Transportation and Development Policy, one of the groups involved in Fifty Years is Enough.

If users of water, railroads and electricity alone paid their full cost, Third World governments would collect another \$123 billion a year in revenue, the bank figures. Making such projects more efficient could save another \$55 billion a year.

The estimates appear in the bank's newly released annual report. The bank, owned by 177 countries, is the biggest source of aid to the Third World; it lends about \$25 billion a year and makes a profit.

The bank maintains that its programs have helped the poor.

"Countries that have made concerted efforts to improve basic infrastructure in rural areas -- such as Indonesia and Malaysia -- have reduced poverty dramatically," said Gregory Ingram, who led the team that put together the bank's report.

The bank has estimated the income of the average Malaysian at \$1,870 in 1982, and \$2,790 a decade later. But during that period, incomes declined in many African countries despite billions of dollars in aid.

The bank's report argues that improving public services would help the poor and save money for Third World governments.

Running water means women and children spend less time fetching from the well. Better rail service gets people to work faster. Improved roads cut the cost of bringing crops to market, the report

said.

It emphasizes maintaining services, as well as extending them.

"In Africa, for example, a dollar of road maintenance saves four dollars in new road construction," the bank's president, Lewis T. Preston, said in a statement.

But developing nations still have a long way to go. Preston estimated that the number of families that can get clean water has increased by half in 15 years, and power production has doubled. But he said a billion people still lack clean water and 2 billion lack electricity.

The report recommends that public services be handled like businesses rather than government bureaucracies, but cautioned that privatization is not always the answer.

Subject: The New Standard in Water Treatment

Date: Thu, 21 Sep 1995 07:18:54 -0800

Arctic Clear: The New Standard in Water Treatment. Proven in Bosnia, Somalia, Rwanda, Haiti, and the 1993 Iowa floods, the Arctic Clear uses state-of-the-art, four-phase filtration plus UV sterilization technology. Two models produce 1000 to 2000 gallons per day of safe, clean, clear drinking water from any freshwater source. Patented "fail-safe" system ensures that only fully treated water can leave the unit.

Yet Arctic Clear units are compact (less than 50 pounds in a rugged go-anywhere suitcase format), require less than 80 watts, and can run off just about any power source including AC or DC, generator, battery, or customized battery/solar combination. Larger customized models also

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available. The Arctic Clear technology is proven worldwide; let's explore how it can support your programs.

See our WWW Pages at <http://www.connexx.org> or, for more details, <http://www.halcyon.com/tsirlr/welcome.html>. Email: tsirlr
Fax: (206) 542-9340.

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August 11, 1991

SURVIVAL WATER MANAGEMENT

The need for water is the next thing to attend to after you have made shelter against extreme weather conditions. You can only survive three (3) without water (and go a lot longer without food). Water makes up some 60% of your body's weight/mass.

You d-a-i-l-y need two (2) quarts of water at sea level. If you are in a location over 15,000 above sea level your body's requirements increase to four (4) quarts per day.

The human body loses water (call "dehydration") through three main processes:

1. Respiration (breathing in and out).
2. Urination (some loss through defecation).
3. Perspiration (sweating).

Your plan should be to ration your sweat, not your intake of water. By this I mean to have you avoid (as much as possible) any activity which increases sweating.

Your urine output is probably the best indicator of your level of dehydration. You should normally urinate about 2 cups per day. Under dehydrated conditions, the body cuts back on the amount of water in the urine, reducing output. You want to avoid having your urine appear dark yellow in color. This is an indication that you need to increase your intake of water.

Another thing that matters is maintaining the proper electrolyte balance within your body. This is especially true in desert and high altitude environments. Your body needs sodium, chlorine, magnesium and potassium compounds to maintain the electrolyte balance. Salt intake helps.

Water is located in a variety of places, including streams, lakes, ice, snow, rainfall and dew on plants. Study the things and activities around you. Observe birds, animals and plants. Understand the concept of the "water table." Learn how to build and use a survival water still.

WATER CONTAMINANTS

Certain things can contaminate water and make it unfit for

drinking. Chemical pollutants (especially near population centers) can make water dangerous to drink. But it is the presence of organisms in the water than are your main survival concern. These organisms (bacteria like salmonella, shigella, e. coli, cholera and typhoid; protozoan cysts like giardia lamblia, viruses like hepatitis, parasites such as schistosomiasis and intestinal worms such as tapeworms and hookworms) can quickly cause diarrhea and illness/death shortly after ingesting them. Many mistakenly believe that cholera and typhoid are only concerns in the "third world" but they forget how those water borne diseases ravaged America before the creation of proper water treatment facilities.

DISINFECTING WATER

To disinfect water, filter it first by pouring it through a filter, such as a handkerchief. This removes the larger particles.

Next, boil the water to kill any and all organisms in the water. Boil it for 10 minutes at sea level and add one (1) minute for each 1,000 feet you are above sea level.

Another way to remove very small, microscopic contaminants is with the use of a special filtration device, such as a Katadyn filter. The pores to such a filter must be smaller than 0.45 microns. However, such a filter will n-o-t filter out viruses.

Water can also be treated with chlorine chemicals, such as Clorox (TM) or halazone. But I urge you not to rely on these chemical treatments too much. They sometimes fail to disinfect the water. Also note that halazone loses its potency from being exposed to storage conditions that were warm, exposure to air or

if simply left on the shelf for a long period of time (which is why you should not purchase water treatment chemicals from surplus stores). Halazone often will not work correctly if the water being treated is too hot, too cold or too alkaline.

Iodine based chemicals kill all of the organisms most of the time. To use iodine compounds, you must follow the instructions that accompany them to the letter. What follows are some general instructions on their use.

Tetraglycine hydroperiodide (such as "Portable Aqua") treats water effectively if you use one tablet per quart of water and allow it to stand while the chemicals work their magic. Allow 1/2 hour (30 minutes) per quart of water (2 hours per gallon). If the water is cold or cloudy, use 2 tablets per quart and let the water sit for 1 hour per quart (4 hours per gallon).

A 2% iodine tincture works also. Basically you add 8 to 10 drops of the tincture per quart of water. Allow the water to stand for 30 minutes per quart (2 hours per gallon). If the water is cold or cloudy, do not add more tincture but do let the water sit for 1 hour per quart (4 hours per gallon).

MAKING A WATER STILL

To make a basic water still, dig a hole in the dirt in a V shape (see illustration). Set a clean container in the center of the hole. The hole needs to be about 2 1/2 times as deep as the height of the container. If you have a plastic tube of sufficient length, insert it into the container and lay the end you will be sucking the water out with on the ground above the hole.

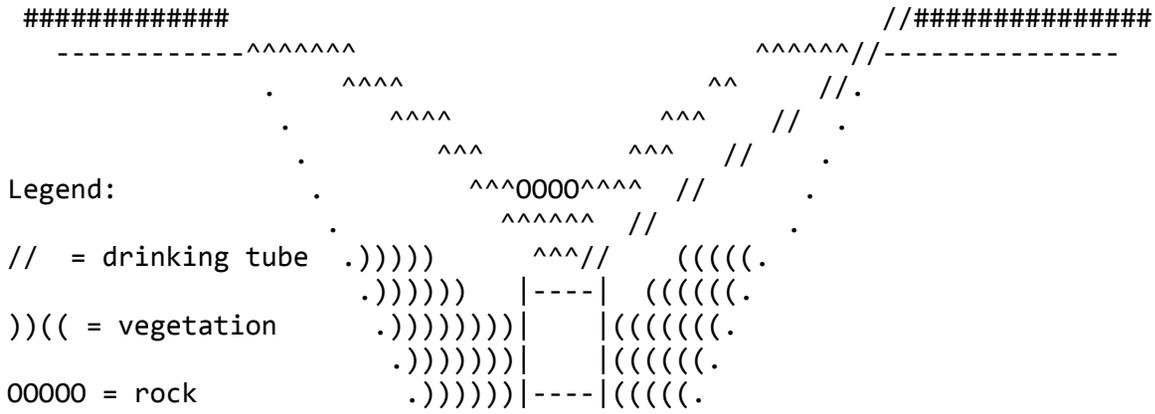
Pack vegetation around, but not in, the collection

container.

Lay the plastic sheet (clear preferred but this is no time to get picky) across the hole. Secure the sheet by setting sand, rocks or dirt at the edge of the plastic sheet to anchor it to the ground. The sheet should droop down into the hole about a foot below the surface level. Carefully set a rock in the center of the sheet.

Water will, over time, condense on the inner surface of the plastic sheet, roll down to the lowest point and drop into your container. Then you can either siphon it out with the tube (which keeps the still intact) or dismantle the still and drink from the container.

This is a s-l-o-w process. It works best in desert areas that are hot during the day and cold at night. Expect about a pint (55 cubic centimeters) per 24 hours to collect in your container.



= sheet anchor

.-----.

This article is based upon information from Survival research Associates (2179 Canal Drive, Lake Park, Florida 33410, telephone 407-622-8922). I urge you to also purchase "Survive Safely Anywhere - The SAS Survival Manual" by John Wiseman, published by Crown Publishers Inc., New York, 1986. If you have survival related articles, please post them to the Combat Arms BBS. Thank you.

Richard
-Your SysOp-

Water Storage and Purification

As mentioned previously, water is probably the most necessary element for human life, with the exception of oxygen.

When planning your water resources for survival you need to deal with three areas:

- Storing water
- Finding or obtaining water
- Purifying water

Storing Water

For your in-home cache or survival retreat stash, you should count

on two gallons of water per-person per-day. While this is more water than necessary to survive (except in hot climates or after strenuous exertion) it ensures water is available for hygiene and cooking as well as drinking.

Captain Dave's personal in-home stash has enough water for a week, and he lives near a stream in an area where it rains frequently!

Commercial gallon bottles of filtered/purified spring water often carry expiration dates two years after the bottling date. A good rotation program is necessary to ensure your supply of water remains fresh and drinkable (see previous section on food for information on rotation). Captain Dave purchases cases of six one-gallon jugs, which frequently go on sale for just under 50 cents per gallon. The heavy-duty cardboard boxes stack easily and protect the jugs from rupturing.

If you prefer to store your own water, don't use milk cartons.; it's practically impossible to remove the milk residue (ugh!).

Bleach bottles are recommended by others, and although Captain Dave has never used this method, and apparently bleach manufacturers don't recommend it.

For self-storage, you're probably better off with containers of at least 5 gallons. Food-grade plastic storage containers are available commercially in sizes from five gallons to 250 or more.

Containers with handles and spouts are usually five to seven gallons, which will weigh between 40 and 56 pounds. Get too far beyond that and you'll have great difficulty moving a full tank.

15 gallon and 30 gallon containers used for food service -- such as delivery of syrups to soda bottlers and other manufacturers -- are often available on the surplus market. After proper cleaning,

these are ideal for water storage -- as long as a tight seal can be maintained. 55 gallon drums and larger tanks are also useful for long-term storage. But make sure you have a good pump on hand!

Solutions designed to be added to water to prepare it for long-term storage are commercially available. Bleach can also be used to treat tap water from municipal sources. Added at a rate of about 1 teaspoon per 10 gallons, bleach can ensure the water will remain drinkable. Captain Dave recommends rotating the water in storage tanks every year.

Once you're in a survival situation where there is a limited amount of water, conservation is an important consideration. While drinking water is critical, water is also necessary for rehydrating and cooking dried foods. Water from boiling pasta, cooking vegetables and similar sources can and should be retained and drunk, after it has cooled. Canned vegetables also contain liquid that can be consumed.

Short Term Storage

People who have electric pumps drawing water from their well have learned the lesson of filling up all available pots and pans when a thunderstorm is brewing. What would you do if you knew your water supply would be disrupted in an hour?

Here are a few options in addition to filling the pots and pans:

The simplest option is to put two or three heavy-duty plastic trash bags (avoid those with post-consumer recycled content) inside each other. Then fill the inner bag with water. You can even use the trash can to give structure to the bag. (A good argument for keeping your trash can fairly clean!)

Fill your bath tub almost to the top. While you probably won't want to drink this water, it can be used to flush toilets, wash your hands, etc.

If you are at home, a fair amount of water will be stored in your water pipes and related system.

To get access to this water, first close the valve to the outside as soon as possible. This will prevent the water from running out as pressure to the entire system drops and prevent contaminated water from entering your house.

Then open a faucet on the top floor. This will let air into the system so a vacuum doesn't hold the water in. Next, you can open a faucet in the basement. Gravity should allow the water in your pipes to run out the open faucet. You can repeat this procedure for both hot and cold systems.

Your hot water heater will also have plenty of water inside it. You can access this water from the valve on the bottom. Again, you may need to open a faucet somewhere else in the house to ensure a smooth flow of water. Sediment often collects in the bottom of a hot water heater. While a good maintenance program can prevent this, it should not be dangerous. Simply allow any stirred up dirt to again drift to the bottom.

Finding or Obtaining Water

There are certain climates and geographic locations where finding water will either be extremely easy or nearly impossible. You'll have to take your location into account when you read the following.

Captain Dave's best suggestion: Buy a guide book tailored for your location, be it desert, jungle, arctic or temperate.

Wherever you live, your best bet for finding a source of water is to scout out suitable locations and stock up necessary equipment before an emergency befalls you. With proper preparedness, you should know not only the location of the nearest streams, springs or other water source but specific locations where it would be easy to fill a container and the safest way to get it home.

Preparedness also means having at hand an easily installable system for collecting rain water. This can range from large tarps or sheets of plastic to a system for collecting water run off from your roof or gutters.

Once you have identified a source of water, you need to have bottles or other containers ready to transport it or store it.

Purification

And while you may think any water will do in a pinch, water that is not purified may make you sick, possibly even killing you.

In a survival situation, with little or no medical attention available, you need to remain as healthy as possible. And a bad case of the runs is terribly uncomfortable in the best of times!

Boiling water is the best method for purifying running water you gather from natural sources. It doesn't require any chemicals, or expensive equipment -- all you need is a large pot and a good fire or similar heat source. Plus, a rolling boil for 20 or 30 minutes should kill common bacteria such as *guardia* and *cryptosporidium*.

One should consider that boiling water will not remove foreign contaminants such as radiation or heavy metals.

Outside of boiling, commercial purification/filter devices made by companies such as PUR or Katadyn are the excellent choices.

They range in size from small pump filters designed for backpackers to large filters designed for entire camps. Probably the best filtering devices for survival retreats are the model where you pour water into the top and allow it to slowly seep through the media into a reservoir on the bottom. No pumping is required.

On the down side, most such filtering devices are expensive and have a limited capacity. Filters are good for anywhere from 200 liters to thousands of gallons, depending on the filter size and mechanism. Some filters used fiberglass and activated charcoal.

Others use impregnated resin or even ceramic elements.

Chemical additives are another, often less suitable option. The water purification pills sold to hikers and campers have a limited shelf life, especially once the bottle has been opened. Captain Dave considers these good for the car's emergency kit, as long as they are frequently replaced.

Pour-through filtering systems can be made in an emergency. Here's one example that will remove many contaminants:

Take a five or seven gallon pail (a 55-gallon drum can also be used for a larger scale system) and drill or punch a series of small holes on the bottom.

Place several layers of cloth on the bottom of the bucket, this can be anything from denim to an old table cloth.

Add a thick layer of sand (preferred) or loose dirt. This will be the main filtering element, so you should add at least half of the pail's depth.

On top of the sand, add some larger gravel.

Add another few layers of cloths, weighted down with a few larger rocks.

Your home-made filter should be several inches below the top of the bucket.

Place another bucket or other collection device under the holes you punched on the bottom.

Pour collected or gathered water into the top of your new filter system. As gravity works its magic, the water will filter through the media and drip out the bottom, into your collection device.

If the water is cloudy or full of sediment, simply let it drop to the bottom and draw the cleaner water off the top of your collection device with a straw or tube.

While this system may not be the best purification method, it has been successfully used in the past. For rain water or water gathered from what appear to be relatively clean sources of running water, the system should work fine. If you have no water source but a contaminated puddle, oily highway runoff or similar polluted source, the filter may be better than nothing, but it's not a great option.

Once the system has been established and works, you must remember to change the sand or dirt regularly.

The following description of "Hard" water was used as part of presentation to a company describing the benefits of treating

their incoming water from a well, used to clean parts prior to painting and plating.

Water Supply

What is considered normally good, mineral laden, drinking water is not always good process water. All ground water supplies contain a certain amount of dissolved minerals. In those areas where the ground water is predominantly limestone, rain water dissolves significant amounts of calcium and magnesium carbonate. This is caused by the fact that the rain water starts out relatively pure, and on it's way through the air, dissolves large quantities of carbon dioxide from the air. Carbon dioxide gas, when dissolved in water forms carbonic acid and causes the rain water to be slightly acidic (did you ever hear of putting a rusty nail in Coca-Cola?). This "acidity" is then neutralized as the rain filters through the limestone changing the water from slightly "acidic" to slightly "alkaline". Because most waters are not completely alkaline, they contain a mixture of carbonates and partially neutralized carbonic acid known as bicarbonates.

Over the years , these particular dissolved minerals have become known by the trouble they cause. Calcium and magnesium, because they retard the action of soaps and detergents, got the name "hardness". They leave their evidence in wasted cleaners, soap film and insoluble sludge. Carbonates and bicarbonate, because they are the opposite of acids, got the name "alkalinity". When found with calcium and magnesium, alkalinity forms a tightly adherent sludge called "hardness scale" that is found in most pipes, water heaters, untreated boilers, cooling towers and industrial washers.

The most common form of treatment is softening, where "soft" sodium carbonates are exchanged for the "hard" calcium and magne-

sium carbonates. This however does not reduce the total amount of material that is dissolved in the water. An alternate method, known as "dealkalization", takes the process one step further where "soft" hydrogen carbonates are exchanged for the "hard" calcium and magnesium carbonates. The hydrogen carbonates, also known as carbonic acid, (carbon dioxide dissolved in water) are then removed from the water by passing through an air stripper. The resulting water is substantially reduced in both hardness and alkalinity. The water is then close in comparison to typical fresh lake, brook or rain water.

This process is about half the capital cost of D.I. (deionized) water and substantially less expensive to operate. It provides many production benefits by improving chemical ability to clean, thereby decreasing chemical consumption and cost. It would significantly reduce sludging and scaling in all stages of the washer.

Dave Wright - Texo Corporation

The problems associated with water are acquisition, purification, and transportation OR get, good, and go.

FACTS

1 gallon of water weighs 8 1/3 pounds and is 231 cu. in. about 6 1/8" cube
1 liter of water weighs 1 kilogram and is 1 cubic decimeter

ACQUISITION

DEW
STREAM OR POOL

GROUND WATER (DIGGING)

PURIFICATION All water is good to drink, it is the extras that can kill you

-BIOLOGICAL HAZARDS

PHYSICAL REMOVAL

ULTRAFILTER

CONDENSATION

KILLING ORGANISMS

BOILING

CHEMICAL

-ORGANIC HAZARDS

FILTER CARBON

DISTILLATION *IF* 212 degrees isn't the boiling point of the hazard

-INORGANIC HAZARDS -WILD WEST ADAGE, IF SLIME CAN DRINK IT SO CAN YOU

pH AND FILTERING

ACTIVATED CARBON

ELECTROLYTES

PRETREATMENT All water purification will work better and allow your equipment to last longer if you get rid of as much mechanical solids as possible.

Cheap paper filters

shirt, socks, pants, screen, Kearney bucket

Absorbtion = incorporate

adsorbtion = block/stick

Once you have your water, you need to purify it to make sure that it is not contaminated with material that will cause sickness or death. The most common contaminants are

BIOLOGICAL - SOME THING THAT IS ALIVE AND HARMFUL

E. Colii - Infectious disease specialist said, If shit were red, we'd be living in a rose colored world.

ORGANIC TOXIN - SOMETHING THAT CAME FROM A LIVING CREATURE AND IS HARMFUL
Venom, vitamin A, cyanide, micotoxins, etc.

INORGANIC TOXIC - SOME ELEMENT OR COMPOUND THAT IS TOXIC
Beryllium, cadmium, lead, arsenic, methal mercury, lead, etc.

The most common methods of water purification are boiling, adding disinfectants, and various types of filtering.

Most biological hazards consist of naturally occurring bacteria and other organisms.

BIOLOGICAL HAZARDS

* METHODS

KILL ORGANISM - toxin that can kill all forms of life.

MECHANICALLY REMOVE ORGANISM

K BOILING. Boiling water for one minute will kill all bacteria. However, since additional various organisms that are harmful and commonly found in water are not bacteria, 15 to 20 minutes of boiling is needed to kill these other organisms to give you sterile water.

M DISTILLATION. Distillation is the most reliable method for obtaining pure water as the resulting water is sterile, soft, neutral in pH and removes all other contaminants as well. If the distiller does not have some sort of system that preheats the water to remove various gases, the various gases can be collected in the distillate if all boiled off contaminants are not purged by running steam through the condensor at the beginning of the batch.

K DISINFECTANTS. The most common disinfectant is chlorine. Chlorine is a poisonous gas and hazardous to handle. Two safer forms of chlorine are common household bleach which is a 5.25% solution of sodium hypochlorite, and dry pool chlorine ("burn out" or "shock treatment") which is 65% calcium hypochlorite. Dry pool chlorine can be used to make a solution that is the same concentration as

Water_Copendium_1995.txt

household bleach, 24.5 grams (about 10 Tablespoons) of powder in 1 gallon of water. This mixing MUST be done in a very well ventilated area and stored in an air tight enclosure since it gives off enough chlorine gas to cause problems. Please note that many bleaches state, "not for human consumption." If the listed ingrediants contains anything other than sodium hypochlorite, avoid it. If it contains ONLY sodium hypochlorite, it is okay. For water purification use hypochorite solution in the following mixes

Volume	clear water	1:5,000	cloudy water	1:2,500
1 Quart	2 drops		4 drops	
1 Gallon	8 drops		16 drops	
5 gallons	1/2 tsp.		1 tsp.	

Allow at least 30 minutes for the chlorine to kill all microorganisms.

Tuberculosis organisms are the only organism that is resistant to chlorine.

Use a 1 to 10 solution for cleaning instruments and surfaces. Do NOT use hypochlorite solutions for irrigating wounds (as was done in WW1) as the hypochlorite dissolves blood clots.

Iodine is extremely toxic. One source of iodine are the solid crystals.

How to use iodine to sterilize water. Put 4-8 grams of iodine crystals in a 1 oz. glass jar (must have glass or bakelite stopper otherwise the iodine will react with the plastic or metal stopper and destroy it.) Actually 0.1 gram is adequate for the job, but using a larger amount of iodine creates a saturated solution much quicker.

Put in 1 oz. (1 tablespoon or 3 teaspoons) of water (at least room temperature, body temperature preferred).

Close stopper and shake for several minutes. You now have a saturated solution. A saturated solution is when as much solid has dissolved in a liquid as it can.

Carefully pour off 10ml (10cc, 2 teaspoons) of the saturated solution. REMEMBER, the iodine crystals are VERY TOXIC! The reason that adding more water than needed is suggested is so that you need not tip the bottle over too far thus spilling some crytals.

Add the 10ml (2 teaspoons) of saturated solution to 1 liter (1.06 quart) of water.

Let stand at least 15 minutes at 77 degrees F. or higher. Make sure all

of the interior surface including lid get treated.

Another form of iodine is the familiar tincture of iodine which is 2% iodine and 2% sodium iodide in alcohol. Use 3-5 drops of tincture per quart of clear water and 10 drops of tincture in cloudy water. Please remember, very old tincture or tincture that has been left unstoppered may have lost some of its alcohol due to evaporation and would have an excessive concentration of iodine.

NOTE: Iodine is not very soluble in water, but VERY soluble in alcohol

Betadines are not suitable for water purification. Betadine scrub should be only used for cleaning intact skin as it is very toxic to tissues. Betadine solution when diluted 1:100 (3 drops per ounce of water) is suitable for cleaning wounds.

M FILTERING. Only extremely sophisticated filters are precise enough to remove micro organisms. One device that is able to do this is the Katadyn family of water filters from Switzerland. It consists of a core of ceramic material whose holes are so small that no living organism can pass through. There are available synthetic woven filters for use in industry that are able to filter out micro-organisms. Example, Coors beer is pasteurized by the micro filtration process.

Another type of filter is the 800 PSI reverse osmosis style filter, the Survivor-06 from Phoenix Systems \$525 will remove salt for 2 pints per hour.

ORGANIC TOXINS

Many of these will be broken down by heat during the boiling of water or boiled away if they evaporate below 212 degrees.

NOTE on distillation. If you have a sophisticated still and put in the water, seal the still, and start the still - any toxin that boils below 212 degrees is going to pass right through on the first minute of distillation

INORGANIC HAZARDS

Toxic substances like arsenic, various heavy metals, aluminum, salt etc. are a less common hazard. They can be found however in water near mining sites and in areas that have alkaline lakes. A lack of normal plant growth around a

water source or unusually colored algae are frequently signs of abnormal pH or unusual contamination.

Many of these toxins are only water soluble if the water has an unusual pH factor. That is these factors can only be in solution in the water if the water is fairly acidic (low pH) or fairly alkaline (high pH). Totally neutral pH is 7 and most water sources will be between 5 and 8 in pH. If you have the papers to measure pH and add lyes or acids to the water to bring the pH within a normal range, the metal may go out of solution and become a solid, but in particles that are so small that they stay suspended in the water. Letting the water set overnight will allow the particles to drop to the bottom, but since they are so small pouring the water from the container might be enough to put them back in suspension again. A better method would be to filter the neutralized water. A microfiltration filter could be used for this, but even common laboratory filter papers would remove most of the precipitated solids, even though common filter paper is not fine enough to filter out biological hazards. Many inorganics are highly reactive and are adsorbed by dirt or activated carbon filters.

Some inorganic hazards like asbestos fibers are mechanically hazardous, any filtration method will remove these items. If no filters are available, just letting the water stand still for several hours or overnight will help reduce contamination. Siphoning water off of the top of standing water is the best way to remove the water as pouring the container will kick up the sediment again.

A NOTE ON LABORATORY FILTER PAPERS

These filters should be used to prefilter any water that you are going to treat. They aren't suitable for an entire process, but their removal of larger contaminants improves performance of disinfectants and extends the working life of microfiltration units. Filter papers come in various speeds. The faster the speed of the paper, the less that is filtered out. Filter papers are very inexpensive, lightweight and compact. For maximum effect you can prefilter water through a fast filter and then put that water through a slow filter.

ORGANIC HAZARDS

These substances can be removed via activated carbon filters. An item to note about activated carbon filters: water or moisture in the carbon filters

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is a breeding ground for biological organisms. Many filters are doped with silver compounds to prevent or retard organism growth.

Note never pour hot water through activated carbon. Also, powdered activated carbon is more likely to release its toxin content.

Hartz Mountain 191 grams ~6 oz \$2 dusty in cardboard box
VRP 300 grams ~10 oz \$10 (three month supply) very low dust, in sealed plastic bottle

SOIL FILTERS

The book NUCLEAR WAR SURVIVAL SKILLS, in addition to having good information on water storage and transportation, has an excellent design for a water filter based on a bucket, gravel, towels and clayey soil (4" down). page 71-74

This device will buffer the pH (assuming normal soil) and adsorb 99% of radioactivity. It produces 6 quarts of water/hour initially and 2 quarts an hour after several hours of use. If you get 1 quart/ 10 minutes you need to repack the soil. Buy shaving off 1/2" of the 6-7" soil stack every time the filter clogs, you can get 50 quarts out before a complete soil change is needed.

ELECTROLYTES

Nutshell	single dose	storage ratios for 300 quarts
Lite salt	1 teaspoon	5 - 11 oz. tubes of Morton Lite Salt
Baking soda	1/3 teaspoon	one pound box
sugar	10 teaspoons	25 pound sack
water	1 quart	

Subj: ELECTROLYTE AND FLUID REPLACEMENT

For those that do not subscribe to the FIGHTING CHANCE newsletter P.O.Box 1279, Cave Junction, Oregon 97523 \$60/12 issues/year or haven't purchased the Medical Preparation video tape by Dr. Jane Orient (president of Doctors for Disaster Preparedness) \$29.50 from same address, here is a good little life saver that you might be interested in.

One teaspoon of "Lite Salt" (by Morton, 1/2 iodized potassium chloride, 1/2 sodium chloride in a blue cylinder), 1/3 teaspoon of baking soda (sodium

Water_Copendium_1995.txt

bicarbonate), 10 teaspoons of table sugar (sucrose), and one quart of water. That happens to be a life saving fluid replacement and partial electrolyte expedient replacement. At least it is expedient if you have had the foresight to purchase the above three items BEFORE an emergency happens while it is readily available and very cheap. Many people die in times of emergency because of fluid losses. This can be from burns, vomiting, or diarrhea. The body needs water and certain water soluble chemicals to function. If either or both of these drop below a certain level, you die. There are many non-fatal diseases like cholera that become fatal due to lack of simple things like proper fluid replacement. If you have ever had a bad case of diarrhea and start to have pain in your muscles or joints, congratulations, you have had the early warning symptoms of a potassium deficiency.

Bananas are very high in potassium.

For ease of purchasing the items for Dr. Orient's formula, Morton Lite Salt comes in a 11 oz. light blue cylinder. Baking soda a 1 or 4 pound box. Sugar 5, 10, or 25 pound sack. To make approximately 300 quarts of the solution you need 5 - 11 oz. units of Morton's Lite salt, 1 - 1 pound box of baking soda, and 25 pounds of sugar.

FIGHTING CHANCE is a great publication for those that are installing blast/fallout shelters. It also is the place that tells you where to buy ventilators for \$20 that other places charge \$245.00 and in this month they tell you where to purchase 12-120 volt AC/DC PM motor generators for \$12 that other survival stores sell for \$100-275.

TOXIN STORAGE IN THE BODY

Most in fat cells, rapid fat burning without adequate water can cause kidney damage

HOW MUCH WATER IS ENOUGH? enough to keep your urine a normal color and smell

One exercise fitness center recommends

1/2 oz water per 1 pound body weight (sedentary) (me ~ 3 quarts)

3/4 oz water per 1 pound body weight (athletic) (me ~ 4 quarts)

Water_Copendium_1995.txt

In the desert under heavy labor you might go through 2-5 gallons
Sweating = losing water + losing electrolytes

No activity in a cool cave 1 quart a day might be all you need short term
with no bathing or food preparation needs.

TRANSPORTATION

Page 67 of NWSS plastic trash sack inside pillowcase or burlap sack.

Canteens, plastic, steel, aluminum (al + halide based tablets can produce
toxins)

Water bags of aluminized mylar and boxes

Polycarbonate jugs

Folding bags with handles

GOOD POTABLE WATER DEVICE

From: hpn

Newsgroups: misc.survivalism

Subject: Re: Recommend a good potable water device?

Date: Mon, 01 Jul 1996 12:31:35 GMT

Geri Guidetti <arkinst

MMedi13720 wrote, suggesting painting a pressure cooker black and
allowing solar heat to distill water. Then he wrote,

I don't see it taking any longer than a regular solar still (as in
visqueen, a bucket, and a rock), not if you paint the cooker with black
barbecue paint. Maybe a bit longer....snip

Mike S. Medintz

Though the solar heat absorbed by a blackened pressure cooker would
increase the rate of evaporation inside the pot, there are a couple of

reasons that it would not be an effective distillation apparatus for more than a bit of water without providing additional heat.

First, distillation is dependent on water reaching the gas phase and then recondensing within the cooler tube or coils that then take the droplets down into a collection container.

Though more water would become vapor in a sun-warmed pot than a cooler one, the surface area through which those randomly moving water vapor molecules must travel, i.e., the small hole at the top of the pressure cooker, would mean that a very small number of molecules would actually exit the pot into the tubing.

The majority of them would bounce against the top and sides of the pot and, many of these would condense again, dripping back into the water below.

This would especially be true if there was any moving (cooling effect) air around the pot. In a classic, visqueen, solar still, the surface area for evaporation and condensation is much greater and would result in a more sizable collection of water.

In order to drive the water vapor molecules through the hole at the top of the pot with any further degree of efficiency would require the addition of much more energy (heat) which would increase the pressure of that vapor phase above the water, forcing more of the molecules to travel out of the hole and diminishing the probability of their condensing on the lid of the pot.

The entire pot would be hotter and the lid would be less likely to serve as a cooling, hence condensing, surface. The placement of the pot in a parabolic-type solar cooker would increase the concentration of solar energy hitting the pot and could work, but it would have to be quite a large cooker, IMO.

Water_Copendium_1995.txt

The pressure cooker could be an excellent distillation device if sufficient heat was applied to meet all of the conditions, above...Geri Guidetti, The Ark Institute

I just found a purification kit for about \$50. It is really compact and it does 1,000 gallons of water. You only need to put a small amount of Clorox in the water to kill bacteria and the kit will filter that and other contaminants out. It is really easy to use and it requires no power to operate.

From: mmedi13720

How does it work? Unless there's something besides bleach, it'll get rid of bacteria, but not protozoans, viruses, VOC's or heavy metals.

Mike

From: hpn

Subject: Re: Recommend a good potable water device?

Date: Wed, 03 Jul 1996 22:53:37 GMT

mmedi13720 wrote:

How does it work? Unless there's something besides bleach, it'll get rid of bacteria, but not protozoans, viruses, VOC's or heavy metals.

Mike

According to the documentation, it uses a blended carbon filter to remove everything that the chlorine doesn't kill. It also removes the chlorine or iodine. To use it you take it apart and pour water into the top of the unit. You let it filter through and collect in a receiver at the bottom. Just remove the receiver and drink.

Water_Copendium_1995.txt

The exact size is 6"x3" and it weighs one pound.