# Chlorine Removal



# Showerhead Filters

By Kevin Wong

The Canadian Water Quality Association (CWQA) and its members have been flooded with calls about chlorine in home water since the *American Journal of Epidemiology* put out an article on chlorinated water exposure and the increased cancer risk it can pose in its January 2007 issue. That led to this paper on chlorine and what it does and my conclusions, which will hopefully put chlorine's risks into perspective.

We here in North America regard a long, hot shower as one of life's relaxing pleasures. The gentle liquid pelting…the soothing hot steam…the billowing cloud of steam cut by the pungent tang of toxic chlorine gas—whoa! Something's wrong with this picture, but fortunately it can be made right with a relatively simple technical fix.

A pour-through granular activated carbon pitcher filter can remove chlorine from our drinking water, but for high flows, the fix is a filter for your showerhead. Shower filters have become much more popular in recent years as evidence continues to mount that the chlorine added as a disinfectant to public water systems is a health hazard. Many people may be getting much more exposure to chlorine and its toxic byproducts by inhaling it and transdermally absorbing it in the shower than by drinking it in their tap water. Free chlorine and other chemicals are evaporated from hot shower water and easily inhaled in the close confines of the shower and the entire bathroom as well. The pores of your skin open up from the heat and steam and allow increased absorption of waterborne pollutants. One estimate is that a bather can be exposed to as much water pollution during a 20-minute hot shower as by drinking two quarts of tap water per day.

## Chlorine's health effects

Even if you can't detect its pungent odor, chlorine may be a hidden menace in your shower, causing ailments ranging from headaches to neurotoxic reactions to (possibly) cancer. In the digestive tract, chlorine can upset the balance of intestinal flora, promoting *candida* or other infections. Researchers have suggested that chlorine and its toxic byproducts may be responsible for an increased risk of heart disease, allergic reactions and spontaneous abortions. Studies indicate that consumption of chlorinated water is linked to significantly increased rates of bladder, colon and rectal cancer. One recent researcher has even noted that chlorine-related toxins may be proven in the future to be, "the most important environmental carcinogens in terms of the number of attributable cancers per year."

In addition to its adverse effects on health, chlorine has unwanted topical and cosmetic actions on hair and skin. Anyone who has spent too much time in an overly chlorinated swimming pool can attest to chlorine's ability to irritate the eyes and aggravate the mucous membranes in the nose and throat. Chlorine bonds with proteins in the hair, making it dry and brittle and causing color to wash out. Chlorine strips skin of its natural oils, leaving it dry, itchy and prematurely aged.

Chlorine has its place, as we'll see; but that place should not be in your shower.

## An illustrious history as an effective germ killer

A greenish-yellow gaseous element that readily dissolves in water, chlorine may seem an unlikely health hazard—after all, water treatment officials routinely add it to the public drinking supply throughout the United States. They do this with strong historical precedent. Since it began to be used as a disinfectant almost two centuries ago, chlorine has probably saved hundreds of thousands of lives because of its ability to destroy harmful bacteria and viruses. But what kills the bugs, logically could have a long-term toxic effect on us. (The example of DDT comes to mind.)

Chlorine disinfection was recognized as a potential lifesaver as early as the 1820s by European physicians who were concerned about the extremely high rates of post-birth deaths in hospital maternity wards. Well before Pasteur's work during the early 1860s convincingly

established the germ theory for transmitting disease, a number of pioneering physicians had begun to use chlorine to disinfect hospital rooms. Some concerned physicians also had doctors wash their hands in a chlorine solution before they examined patients. Such practices dramatically reduced maternal mortality from puerperal fever, a highly contagious *streptococcus* infection of the uterus after birth, which was killing as many as one-in-six recently delivered mothers in some hospitals. This was cutting edge medical practice in those days. In hindsight, we know that many (if not most) of these deaths were from bacterial infections induced by 'the examining finger' as doctors and medical students of the time routinely went directly from dissecting cadavers to probing the genitals of women.

Chlorine began to be used in US water systems in the early 1900s because it killed the *salmonella* bacteria that were causing outbreaks of typhoid fever and the *vibrio* bacteria responsible for cholera outbreaks. Chlorine is now used in approximately 75 percent of public water systems in the US to prevent waterborne diseases. It is added routinely in many areas to prevent bacterial growth in water mains. Water systems with leaky and aging pipes and other infrastructures are especially prone to contamination by microorganisms, such as from fecal matter from leaky septic systems. Water officials often add chlorine in higher amounts during the summer to shock water sources when the risk of bacterial contamination of water increases. If a routine water test suggests a potential bacterial contamination, public water may be spiked with higher-than-average levels of chlorine, in some instances up to eight parts per million (ppm).

Most people can smell residual free available chlorine at a concentration of about three-to-four ppm in their water.

## New understanding

Although chlorine has, without a doubt, saved many lives by preventing deadly diseases, its toxicity towards microorganisms is a double-edged sword. Although relatively small amounts are used to disinfect water supplies, even low concentrations of chlorine are detrimental to human and animal health. It is widely considered an air pollutant at a mere one ppm. Inhaling high levels, like 300 ppm, for 30 minutes can be fatal to humans. Chlorine is also toxic and irritating to the skin. This fact was put to lethal use during World War I when chlorine was used to manufacture mustard gas.

Chlorine is an effective bacteria-killer in part because it is so reactive. Free chlorine in water oxidizes and kills microorganisms and it also readily combines with other chemicals, such as carbon, to form toxic compounds such as carbon tetrachloride. When organic matter such as leaves fall into a reservoir, they decay and release organic compounds into the water. As chlorine combines with these, it forms water pollutants known as trihalomethanes (THMs). These highly toxic chlorination byproducts include chloroform and trichloroethylene (TCE). If chlorine is present in water, in all likelihood the volatile chemicals chloroform and TCE are as well.

## Don't underestimate shower exposure

Before the mid-1980s, when it came to water and chlorine, most studies that looked at adverse effects from waterborne contaminants considered people's exposure through only one route: ingestion. Research conducted since then, however, has demonstrated that this was a very one-dimensional approach to the issue and may have underestimated the risk. Trichloroethylene (TCE) and chlo-

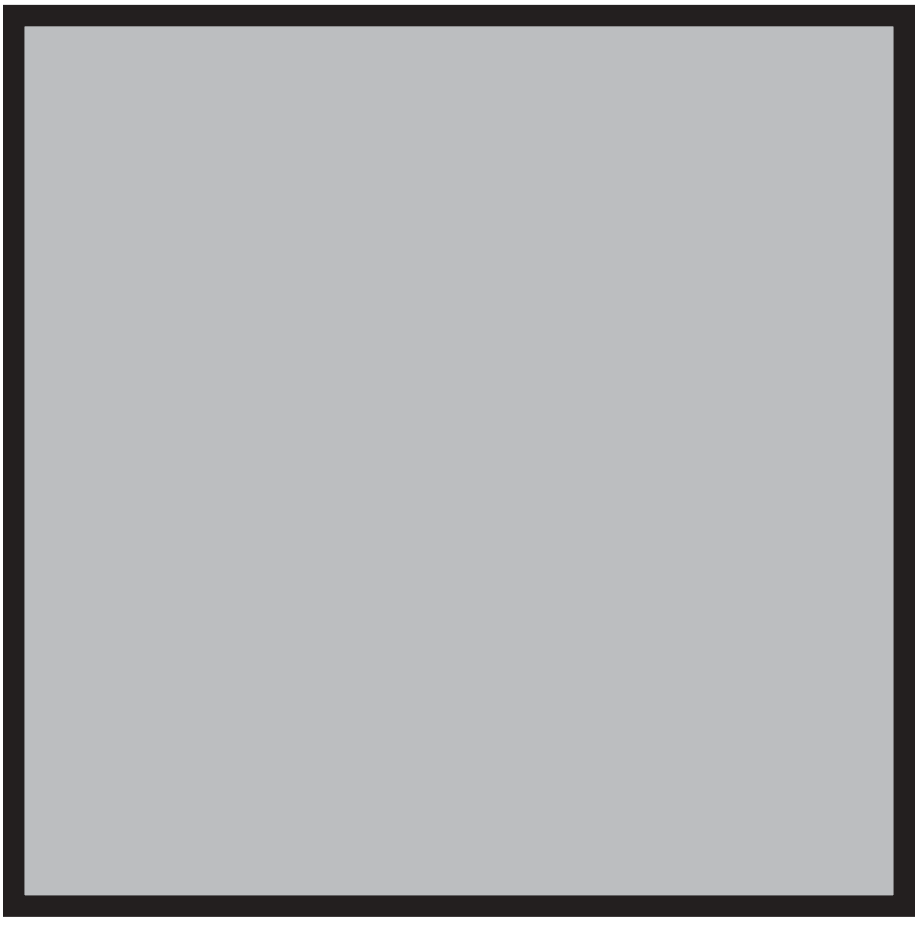
roform in particular may be much more worrisome as waterborne toxins that are inhaled or absorbed through the skin. Both TCE and chloroform are readily absorbed into the blood from the lungs. A number of recent studies have added to this concern.

According to a 1999 study conducted by researchers at the Environmental and Occupational Health Sciences Institute in Piscataway, N.J.: "Strong relationships were identified between the THM breath concentrations collected after a shower and both the THM water concentration and the THM exposure from a shower."

A 1998 study conducted in Taiwan compared the cancer risk at three major metropolitan areas with chloroform exposure during showering. The researchers considered exposure from all three major routes: ingestion, inhalation and dermal skin absorption. They concluded that a 10-minute shower would result in chloroform exposure with a 3:4:3 ratio (ingestion, inhalation, skin absorption); for a 20-minute shower the ratio was 1:7:2. In other words, those who were taking 20-minute showers were getting 90 percent of their exposure to chloroform from the shower. The researchers also determined that the cancer risk was almost 13 times as high for a person who took a 20-minute shower in the area with the highest chloroform concentrations in the water compared to the risk for a person who took a 10-minute shower in the area with the lowest concentration.

According to the authors of a 1996 study: "The volatilization of volatile organic chemicals during domestic water usage can result in significant indoor air concentrations of free chlorine and its byproducts and the subsequent inhalation of these contaminants is an important route of exposure….The simulated daily exposure is well described by a simplified equation that is a function of the amount of time the individual spends in the shower, the bath and the bathroom; the total water usage in the home; and the fraction of time the individual is at home."

The authors of another 1996 study set up an experimental shower to measure the release of toxins. At 40°C (104°F), a common shower temperature, volatilization was found to be approximately 80 percent for TCE and 60 percent for chloroform and free chlorine. According to the researchers, "The temperature of the water typically had a dominant effect on the total release of each of the three chemicals from the shower water to the air."



In 1986, the National Academy of Sciences estimated that up to 1,000 Americans die each year from cancers resulting from drinking water, but the figure may be many times higher when you consider people's exposure to these chemicals from inhaling them while taking showers. Again, this risk has been historically underestimated.

Chlorine's adverse health effects have caused the administrators of public water systems and the owners of private and public swimming pools to explore alternative, less-toxic methods of germ control. New technologies such as the use of ozone may eventually replace chlorine, but in the meantime, consumers can rely on water filters. Whole-house systems can remove chlorine in shower water, as well as various other contaminants, but the simplest and most cost-effective solution for many people is to install a filter for the showerhead.

### Granular activated carbon

The tried-and-true solution for removing chlorine from water has always been granular activated carbon (GAC), which works by reducing the free chlorines to chloride ions. This is the typical strength of the tabletop flow-through-pitcher-type gizmos we see on countertops across North America. Growing up in the tropics, GAC filters were used in whole-house applications right off the storage tank, before the water went to the hot water heater. GAC is not recommended for direct hot water use (like at the end of a showerhead) because of the media being continuously exposed to temperatures of 40.55°C (105°F). At these temperatures, some of contaminants absorbed by the carbon can slough off and re-enter the water. This is why you put cold water into your pitcher—read the back of the box!

### New shower filter technology

In recent years, a type of showerhead filter commonly called KDF has become available. The filter medium is made from a copper zinc alloy, which works by chemically reducing free chlorine to chloride ions and converting them to zinc chloride. Effective showerhead filters can remove chlorine to less than 0.1 ppm and reduce dirt, rust and bad odors, leaving shower water looking and smelling fresh and clean. High-output showerhead filters are available with replaceable and reversible (that is, able to operate in either direction) filter cartridges. (Periodic reversing of the filter ensures balanced filtration and back-flushes the cartridge as it is filtering.)

Adding a filter to your showerhead can make that long, hot shower the pleasure it ought to be.

## Chloramines in municipal waters

Before closing, a note about municipal water. In an effort to decrease the use of chlorine and the production of its harmful byproducts like THMs and TCE, many municipal water treatment operations have been moving to an increased use of chloramines. While this requires greater quantities and it takes longer to work, it decreases the byproducts that are becoming a critical issue for drinking water in both Canada and the US. Before seeking a filtration solution for chlorine, check with your local water works to see if they use chlorine or chloramines for water treatment.

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## About the author


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## About CWQA

♦ *The Canadian Water Quality Association promotes the individual right to quality water and growth of the water quality improvement industry; educates water quality professionals; serves as a unified voice in government and public relations and provides a role in consumer education. CWQA members are kept in the forefront of the industry by way of the latest technical and scientific information acquired through laboratory testing and research studies. This information is disseminated to members through newsletters and special publications.*