More than three million people around the world die every year from drinking unsafe water. Most of these people are children. A May 2000 incident in the Canadian town of Walkerton, Ont., killed seven people and sickened more than 2,300 after E. coli *and other bacteria infected the town's water supply.*

SAFE *for drinking*

Disinfecting well water with liquid chlorination ensures safe drinking water

By Frank Daniels

Every year people in this country come in contact with water that is contaminated with pathogenic bacteria, viruses or viral cysts. Most go unreported because they attribute their sickness to the flu or some other form of stomach virus.

We say it can't happen to us, but is that true? Many live with the false confidence that well water is safe because it is filtered by the earth. To some extent that is true. The earth's crust can filter larger particles, but what happens if the water table is under a pasture or a field that has been fertilized with manure prior to raining?

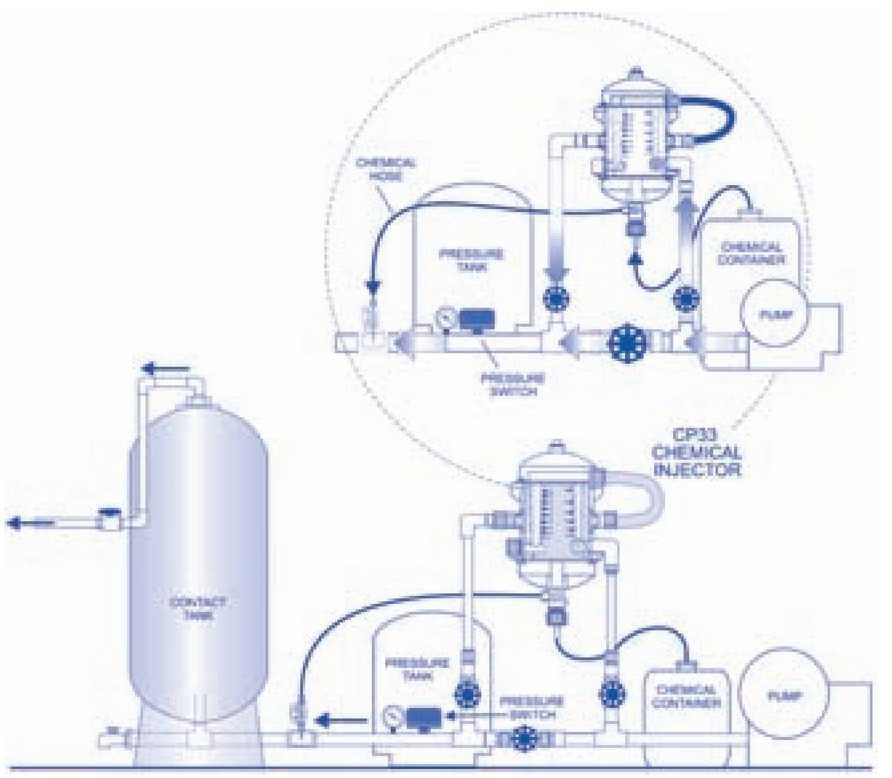
E. coli, which is found in manure, may not be removed by seepage and can find its way into the water table. In many cases, depending on the composition of the earth, this water table is not dormant—it may be flowing. The contaminated water may be coming from a source miles from the well.

There are two types of water sources—groundwater and surface water. Groundwater is water that is pulled from aquifers many feet beneath the earth's surface. Surface water is water that is open to the atmosphere, such as lakes, ponds, rivers or reservoirs.

Surface water has a greater likelihood of containing waterborne pathogens because of runoff conditions and decomposing organic matter. This was the case with the cholera epidemic in Latin America that began in January 1991 and by 1997 had spread to all but one Latin American country, killing 12,000 people and causing illness in 1.3-million others.

Prior to 1908, cities and towns in the U.S. did not treat their water supplies, and as a result thousands of citizens died every year from cholera, typhoid fever, hepatitis A and dysentery. In 1908, the U.S. began disinfecting drinking water with chlorine, and today we have all but eliminated deaths caused by those diseases.

Figure 1. CP33 Injector Installation in a Well System



Objections to Chlorination

Today, about 12 million households—roughly 15% of the American population—depend on private wells to provide drinking water. Public utilities today are required to meet U.S. Environmental Protection Agency (EPA) minimum standards for safe drinking water. Private citizens are not. With the exception of protozoan parasites such as *Cryptosporidium* and *Giardia lamblia* cysts, disinfection of drinking water will render it safe for human consumption. The big question before us is why do so many private well owners and farms choose not to chlorinate their water wells?

Several reasons come to mind: the negative or untrue information regarding the use of chlorine as a disinfectant, the presumed initial high cost of equipment that needs to be purchased and the "I don't like the taste of chlorine" excuse.

Effective Disinfectant

As for the first objection, while it is true that adding chlorine to the water can produce byproducts such as iron oxide, magnesium oxide or calcium oxide, it can also produce trihalomethanes (THMs), including the most often reported THM member—chloroform.

According to the EPA, the health risks from these THM byproducts at the levels at which they occur in drinking water are extremely small, especially when compared with the risks associated with inadequate disinfection. However, should a concern remain regarding these contaminants, inexpensive equipment is available to further lower the level of these contaminates.

Inexpensive Solution

As for the second objection, the cost is negligible compared with the expenses incurred from equipment maintenance and losses due to waterborne pathogens in the form of medical expenses, lost productive time and loss due to death.

Chlorine is available in one of three forms: gas, solid and liquid. Gas has advantages where large volumes of water are produced, but that advantage is lost when your water demand drops below several hundred thousand gallons per day. Federal and state requirements call for specialized safety equipment to be either on site or close at hand. Gas cylinders should be housed in a separate room with direct emergency access to outside air and fitted with an exhaust fan ventilation system. Personnel require specialized training in the event of a leak. Chlorine in its gaseous form is lethal at concentrations as low as 0.1% of air by volume.

The second type of chlorine, a solid, is also known as calcium hypochlorite. This is a white solid that contains 65% available chlorine and dissolves easily in water. While there are advantages such as long-term stability, there are also disadvantages. Calcium hypochlorite is a corrosive, and anyone who has a swimming pool can tell you it has a strong odor and requires proper handling.

What you may not know, however, is that it must be kept away from organic materials such as wood, cloth and petroleum products because reactions between calcium hypochlorite and organic materials can generate enough heat to cause a fire or an explosion. Calcium hypochlorite is extremely effervescent, absorbing moisture and in the process forming chlorine gas. Shipping containers, therefore, must be emptied completely or carefully resealed. Also, once dissolved in water, the user must purchase a chemical injector to place the concentrate in the water supply.

The last type of chlorine is in liquid form, known as sodium hypochlorite. This form is available from 5.25% household bleach to 15% available chlorine. The major disadvantage is the cost of the liquid form compared with the gaseous form; however, when the flow requirements are less than several hundred thousand gallons per day, that cost is offset.

The advantages, however, are numerous. First, as a liquid it is easier to handle and more readily available than either of the other two sources. The equipment to inject liquid chlorine is by comparison inexpensive to purchase. The Chemilizer CP-33 retails for around $400 and can treat water flows from 12 gpm up to 350 gpm. Installations can be made at the well water source using commercially available PVC fittings and the chlorine injector does not require an electrical connection. With the exception of controlling spillage, there are no special safety requirements or equipment to contend with (see Figure 1).

Without water testing to determine just what is in the water, there is no real way to accurately project how much chlorine needs to be added to the water to make it safe. Keep in mind that chlorine is an oxidizer and unlike the other methods of disinfection, it is depleted as it is used. Depletion depends on the type and the total amount of contaminate. It is important to remember that what you want at the end of the day is a chlorine residual.

Generally speaking, water that has a residual of 0.2 to 0.4 ppm of free chlorine has adequate residual to kill any bacteria or viruses that may reenter the water supply given 20 to 30 minutes of contact time. On the other hand, 1 ppm or greater of free chlorine will kill those same pathogens on contact. With the CP-33, water can be disinfected by starting the unit and testing the water at its farthest point with a chlorine test kit. Once the water has reached a point where there is 1 ppm of free chlorine, you have effectively oxidized most minerals and killed most pathogens. The water is now relatively safe for consumption.

Filter to Taste

The last of the objections is that of the taste. At 1 ppm, the taste of chlorinated water is going to be strong. There are inexpensive steps that can be taken to remove not only the byproducts of chlorine but also the suspended matter that occur naturally within the water supply.

Two such steps are filtration systems that are placed at the point of entry to the home. Activated charcoal filtration will remove chlorine but it will not remove THMs, PCBs, radon, arsenic or *Cryptosporidium* cysts. For that you need to use a green sand filter. Used in conjunction with activated charcoal filtration, you can be confident that you have removed all foreign matter from your drinking water.

This type of filtration can be used as either point-of-use or point-of-entry filtration. There are advantages and disadvantages to both that can only be determined by the specific use that you have.

Other Options

There are other types of liquid disinfection available. These include hydrogen peroxide, iodine, bromine, chloramines, ozone and chlorine dioxide. Ultraviolet (UV) disinfection is effective provided there is no suspended matter in the water being treated. Any suspended matter will cause the UV light to diffuse and diminish its effectiveness. However, chlorine is the only method that leaves a residual with secondary disinfection capabilities.

When the water is properly treated prior to use pathogens are stopped before they enter the body, reducing the need to treat the sickness, saving thousands of dollars. Clean, safe drinking water should always be the first step in a biosecurity program. *wqp*

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