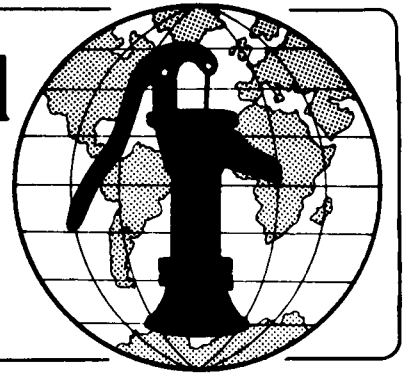


Water for the World



Designing a Small Community Disinfection Unit

Technical Note No. RWS. 3.D.4

Disinfection of ground and surface water is often necessary to ensure that drinking water is free from microorganisms that could cause disease. Usually, drinking water is disinfected by adding chlorine. Chlorine is used because it destroys pathogens quickly and because it is available in most areas at a moderate cost.

This technical note describes the design of three basic methods for chlorinating community water supplies: a pot and a drip feed chlorinator which are used to disinfect water in individual and community wells and cisterns, and a floating bowl chlorinator which feeds chlorine solution into the water supply. These methods are cheap to develop and do not require skilled labor to operate. However, adequate supervision must be available to ensure that the chlorinators work satisfactorily and that sufficient chlorine is added to the water to make it safe.

The design process should result in the following items which should be given to the people making the disinfection units:

1. A list of all materials needed for the chlorinators. A sample materials list appears in Table 2 for a pot chlorinator and in Table 3 for a floating bowl chlorinator.

2. A detailed plan of each type of chlorinator similar to those shown in Figures 1, 2 and 3. Figure 1 shows a typical pot chlorinator, Figure 2 a drip feed chlorinator and Figure 3 a floating bowl chlorinator.

Chlorine

Several types of chlorine are available for use in disinfection. The choice of which type to use depends primarily on what is readily available

Useful Definitions

AVAILABLE CHLORINE - The amount of chlorine present in a chemical compound.

CHLORINE RESIDUAL - Amount of chlorine left over in water after the chlorine demand has been met; residuals may be as chlorines combined with ammonia nitrogen (CAC) or free available chlorine (FAC). FAC kills bacteria more rapidly than CAC.

at a low cost. The most common form of chlorine is sodium or calcium hypochlorite which is available in either a powder or liquid form. The available chlorine in these compounds varies from 20 percent to approximately 5 percent. Table 1 lists the various types of chlorine and their strengths.

For chlorination to be effective, a sufficient amount of chlorine must be added to the water to provide a residual. A free available chlorine residual, FAC, of 0.4mg/l after contact of 30 minutes will surely kill bacteria. To test for chlorine residual, a field testing kit is needed. If that is not available, a guess can be made by taste and smell. If the water has a slight chlorine taste and odor, than adequate chlorination can be assumed.

Pot Chlorinators

Pot chlorinators are effective for disinfecting water in contaminated shallow dug wells. The simplest type of chlorinator is an open-mouthed pot containing a mixture of sand and bleaching powder. The pot is simply lowered into the well by a rope and left to hang underwater. See Figure 1.

Table 1. Chlorine Compounds

Compound	Available Chlorine	Basic Characteristics
High Test Hypochlorite (HTH)	70%	Retains strength for over a year under normal storage conditions; less common on the market.
Chlorinated Lime (Bleaching Powder)	33-37%	Very unstable; loses strength quickly with exposure to air, light or moisture; should be stored in a dark, cool, dry place in rust resistant containers; more usually available than HTH.
Sodium Hypochlorite Solutions a. Commercial b. Household (laundry bleach)	12-15% 3-5%	Like bleaching powder, very unstable and the same precautions must be taken; readily available in most areas.

To make a pot chlorinator, use a plastic or earthen jar with a capacity of 7-10 liters. Seven 6-8mm holes are made in the bottom of the pot, then it is filled half way with pebbles and pea gravel with a diameter of 20-40mm. Next, a mixture of sand and bleaching powder is made. The mixture should contain one part bleaching powder to two parts sand and should fill the pot almost to the neck. A thin layer of pea gravel is placed on top of the chlorine-sand mixture in order to fill the pot almost to the neck.

The pot containing 1.5kg of chlorine will effectively chlorinate for one week a well from which water is taken at a rate of 1000-1500 liters/day. Where volumes are smaller, the chlorination process will last longer. In larger wells, an additional pot or several pots may have to be added to kill pathogenic organisms. Pot chlorinators can be used for disinfecting water in cisterns and other storage units.

Drip Feed Chlorinators

Another method of disinfection of water in wells and small reservoirs or tanks is the drip feed method. A typical drip feed chlorinator is shown in

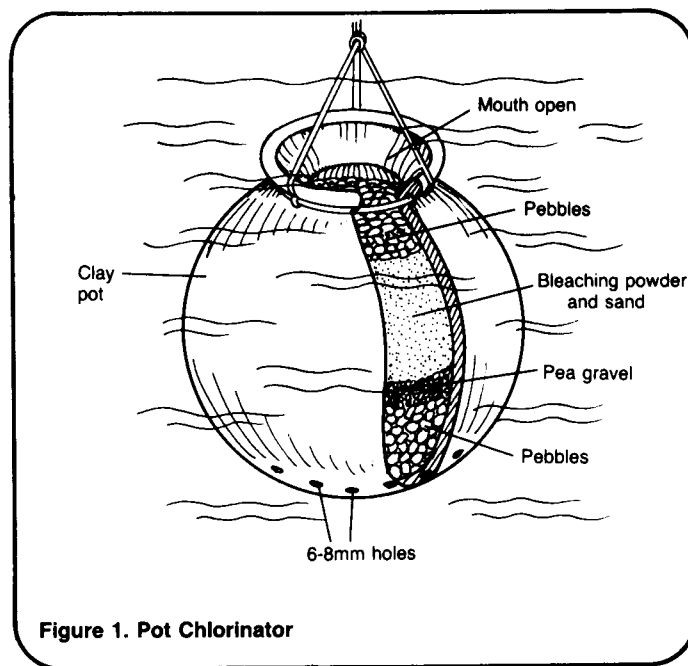
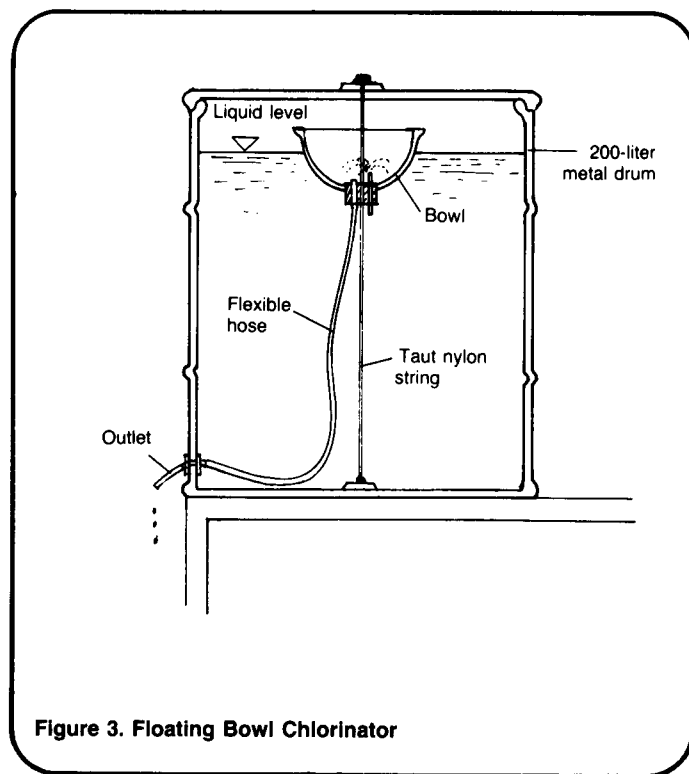
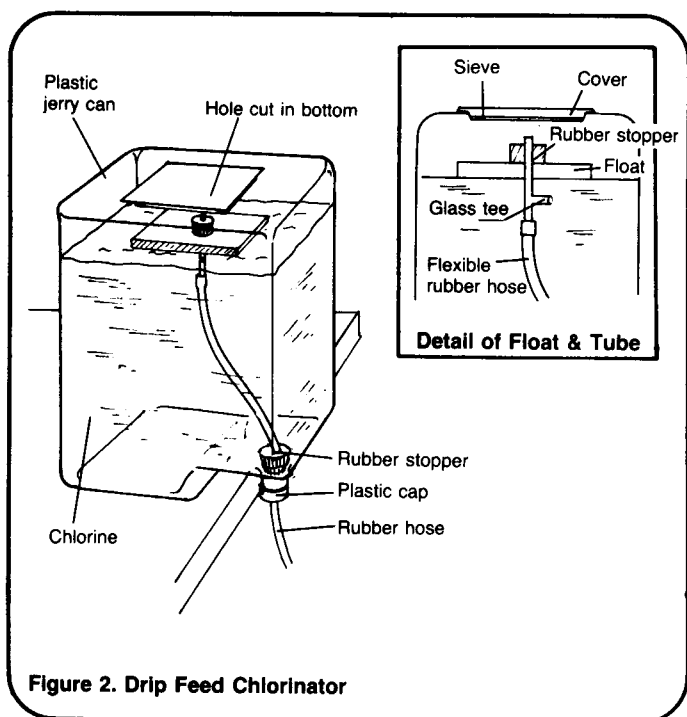


Figure 1. Pot Chlorinator

Figure 2. A small drip feed chlorinator can be made from plastic jars easily available in most areas. The spout of the container serves as the outlet and the bottom of the jar is cut out so that solution can be added.

A drip chlorinator requires a small float, rubber tubing, and stoppers. Choose a material to serve as a float.



A rubber stopper is placed in the middle of the float and a piece of hard tubing is placed through the stopper. Glass, brass, or plastic tubing can be used. The tubing should extend below the float into the solution. A small hole is placed in the tube for the solution to enter.

A small diameter flexible rubber hose is attached to the hard tubing. The hose extends from the hard tube to the outlet. It passes through a rubber or cork stopper placed in the container's neck and a plastic cap that covers the spout. Choose a long rubber hose so that it extends from the chlorinator to the water that is to be disinfected.

Use 2-5 percent chlorine bleach to fill the chlorinator. The chlorine solution can be used directly at full strength. No water must be added. To control the rate of flow, a small clamp is placed on the discharge hose to regulate the flow. Set it at a slow drip. The chlorinator is hung in a well or cistern and the hose extends into the water to be treated. The chlorinator must be refilled with chlorine bleach when it is nearly empty.

Floating Bowl Chlorinators

There are many commercial chlorinators on the market for disinfecting both small and large water supplies. If they are available, their use may be an economical and efficient method of disinfecting piped water supplies. Where such equipment is difficult to obtain and too costly for the community, homemade solution feeders that provide close control of the solution and a low rate of feed can be made locally. One device is the floating bowl chlorinator as shown in Figure 3.

Solution feed, drip chlorinators use the batch method of mixing to disinfect water in storage tanks or reservoirs. The batch method involves mixing a specific volume of water with a certain strength and volume of chlorine and adding it to the water through a gravity flow system. The strength of the batch should be about 1-2 percent.

The floating bowl chlorinator consists of a small tank, generally a 200-liter barrel, fitted with devices for controlling the rate of flow from it to the reservoir. See Figure 3.

The major part of the design is the tank or barrel. Use a 200-liter steel drum for this purpose, although a larger concrete tank can also be used. The drum should be painted inside with a latex or rubber base paint. This will prevent the chlorine from rusting the metal and damaging the water quality. The drum should have a drain. A small 10mm hole should be placed at the bottom of the drum for that purpose. The system must be drained periodically for cleaning. A cover over the top of the tank keeps out light. To allow air entry, do not place an airtight cover on the tank.

A floating bowl arrangement should be designed to ensure that the chlorine solution trickles from the outlet at a constant rate. Use a plastic or light metal bowl or cut out the bottom of a plastic bottle to form the floating bowl. Any material that floats should be adequate. A hole must be placed in the bottom of the bowl and stopped with a rubber stopper, or a large piece of cork. The size of the hole will depend on the cork size. The cork should be large enough so that three tubes can pass through. One tube should be 6-9mm in diameter and the other two 3mm. See Figure 4.

Choose either glass, plastic, copper, or brass tubes. The tubes should be pushed through the cork so that one end opens into the bowl. The larger tube, 6-9mm in diameter, should be connected to a flexible hose that runs to the outlet. A smaller tube, 3mm in diameter, should be pushed through the cork until the top of it is slightly below the liquid level in the tank. The other 3mm tube should be higher than the other two tubes as shown in Figure 4.

Finally, a string should run through the third tube which should be placed through the center of the cork. The string is secured to the top and bottom of the barrel as shown in Figure 3. The string keeps the bowl in the center of the tank and prevents it from catching on the sides. An outlet is placed on the lower side of the tank and the flexible hose is stretched out. This type of connection permits the water to drip into a funnel system which leads to the water.

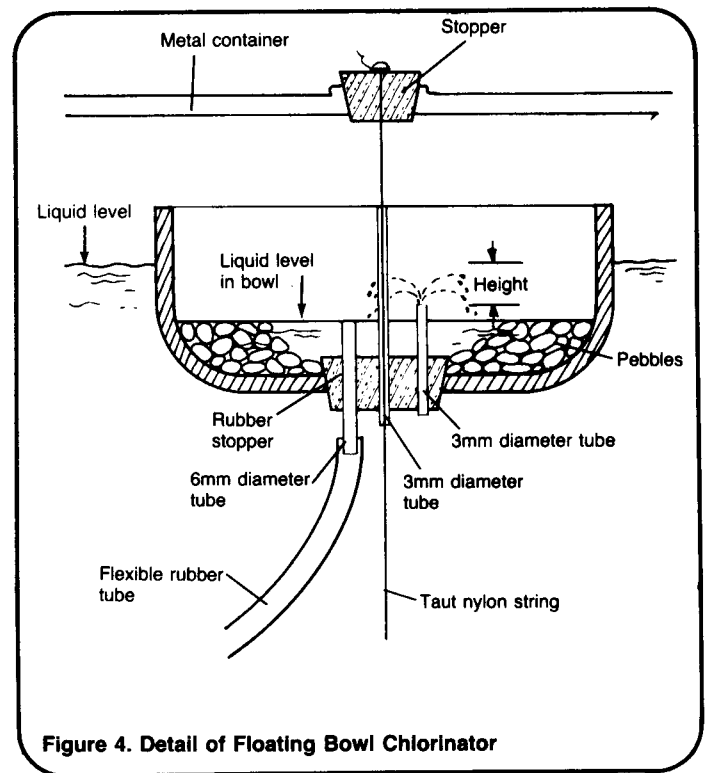


Figure 4. Detail of Floating Bowl Chlorinator

The chlorine solution should then be prepared and the tank filled with a solution of one percent chlorine. To determine the amount of chlorine to add to make a one percent solution, use the following calculation:

Kilograms of chlorine required =

$$\frac{\text{Percent strength of solution desired} \times \text{Liters of solution required}}{\text{Percent available chlorine in compound}}$$

For example, to prepare 200 liters of a one percent solution using hypochlorite powder with 70 percent available chlorine, find the amount of chlorine which must be added as shown below.

$$Q \text{ chlorine} = \frac{1\% \times 200 \text{ liters}}{70\%}$$

$$Q \text{ chlorine} = \frac{.01 \times 200}{.70}$$

$$Q \text{ chlorine} = 3\text{kg}$$

In other words, 3kg of hypochlorite powder would have to be added to 200 liters of water to make a one percent solution.

Add the solution to the tank. Then weight the float using small stones so that it floats steadily and straight. Figure 4 shows this technique. To function properly, the chlorinator must be effectively maintained.

Build a small platform above the reservoir holding the water to be treated. The platform allows the solution to be applied by gravity flow.

Chlorination is only effective if sufficient chlorine is added. Water should be tested after chlorination to ensure that there is a residual of 0.4mg/l after 30 minutes contact time. A color comparator tester is needed to make this test. Several brands of test kits are available on the market. Those using the orthotolidine test are most widely used and cheapest.

Although these kits are available in many areas at a low cost, not everyone has access to one. Therefore, the use of chlorinators may be a guessing game which may give poor results. If water is insufficiently chlorinated, the bacteriological quality will not improve and people may lose faith in chlorine and stop using it altogether. After chlorinating water, make sure that there is a slight chlorine taste and odor in the water. If not, chances are that insufficient quantities of chlorine have been added. The taste of chlorine should not be too strong, however, or it may keep people from using the water.

When chlorine is used in large quantities, the cost of maintaining an effective chlorination system rises. In the long run, the cost of developing a potable well or spring and protecting it from contamination may be lower than depending on chlorination.

Summary

Simple chlorination can be used to treat small community water supplies. The cost of a chlorination system is

Table 2. Materials List for Pot Chlorinator

Item	Description	Quantity	Estimated Cost
Labor	Members of household	_____	_____
Supplies	Earthen jar Gravel Chlorine bleach Clean sand Rope or wire	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____
Tools	Hammer Wire cutters Pliers Knife	_____ _____ _____ _____	_____ _____ _____ _____

Total Estimated Cost = _____

Table 3. Materials List for Floating Bowl Chlorinator

Item	Description	Quantity	Estimated Cost
Labor	Foreman Workers	_____ _____	_____ _____
Supplies	200-liter steel drum Rubber or cork stopper 3 small tubes 6-9mm and 3mm Flexible hose String Wood or plastic bowl Drain plug Outlet connection Small stones Planks and other wood for platform Paint Latex or rubber base	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____
Tools	Hardware Saw Nails Drill Knife Buckets Paint brush	_____ _____ _____ _____ _____ _____ _____	_____ _____ _____ _____ _____ _____ _____

Total Estimated Cost = _____

relatively low, if very large quantities of chlorine are not required. Simple pot chlorinators and solution feed systems are built with local materials and require little skilled labor. Chlorination systems are best used where water quality and chlorine levels can be tested periodically to ensure good water quality. Where testing is not possible, alternatives to chlorination should be sought.