Chlorine testing

The importance of testing for chlorine in water

Chlorine is added to drinking water to kill the microorganisms which cause typhoid, cholera, hepatitis A and other diarrhoeal diseases. Chlorine testing is important for the following reasons :

- If there is not enough chlorine in the water, the microorganisms will not be killed.
- If there is too much chlorine in the water, the users may not want to drink it because of the taste of chlorine and may be tempted to use other less safe water supplies.

Chlorine residual

One of the advantages of chlorine as a disinfectant is that it is easy to measure both in a laboratory and in the field. Another advantage is that when chlorine is dosed correctly, it leaves a disinfectant residual which helps to prevent re-contamination in the distribution system or household storage tank. When chlorine cannot be detected in a distribution system, this may indicate that contamination has entered the system or that the dosing is incorrect.

Three types of chlorine residual can be measured :

- Free chlorine - which kills microorganisms most effectively.
- Combined chlorine - formed when free chlorine reacts with other chemicals in the water.
- Total chlorine - the sum of free and combined chlorine.

Free chlorine is the most important type of chlorine and a description of how to measure free chlorine is given below.

Sampling

Free chlorine in water is unstable and the amount of chlorine in water may go down quickly, especially in warm climates. Sunlight and mixing of the water will allow free chlorine to disappear more rapidly. For this reason, chlorine testing should be carried out on-site and samples should not be taken back to the laboratory for analysis later as this may give false results.

Testing methods

The method used for testing chlorine residual in water employs a chemical known as DPD (N,N-diethylparaphenylenediamine). Previous methods involved the use of OT (Orthotolidine) and starch-potassium iodide. OT is now known to cause cancer and so is not recommended, and starch potassium iodide only measures total chlorine residual and is therefore not recommended except where it is impossible to obtain DPD.

There are many types of equipment for measuring chlorine using the DPD reagent. The simplest and cheapest type, the chlorine comparator will be described here. Most comparators are designed for use with the manufacturers' reagents which normally come as small tablets packed in foil strips. It is important to keep a good stock of the reagents. This means that testing can be carried out quickly in the field without having to make up DPD solution. Figure 1 shows an example of a chlorine comparator.

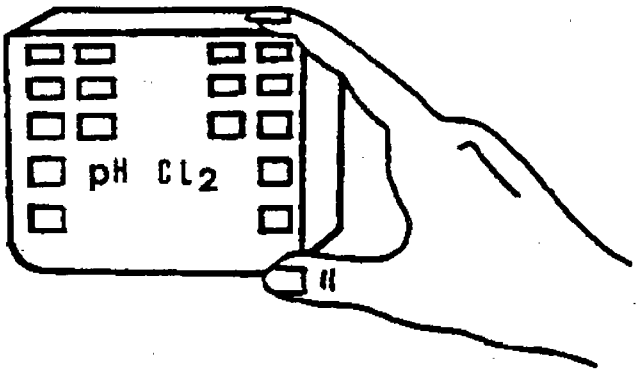

Figure 1. Chlorine comparator

A DPD solution can also be used for the measurement of chlorine residual. This, however, needs to be done in a laboratory as a spectrometer, a filter photometer and titration equipment are required. The DPD solution also requires the preparation of a buffer solution and other reagents. This method can be very accurate, but it is beyond the scope of this Fact Sheet to give full details of the methodology and reagents required. If these are required, refer to a chemical methods manual. Generally, the level of accuracy given by the liquid DPD method is not required and the use of simple on-site tests are recommended in most circumstances.

Measurement of pH

It is important to measure pH at the same time as chlorine residual, since chlorine works most effectively at pH values between 6.5 and 8.5. Outside this range, the water may need addition of chemicals to buffer the pH. This is usually done through addition of lime to acidic water (pH below 6.5) or of aluminium sulphate to alkaline water (pH above 8.5).

Some chlorine comparators allow pH to be tested at the same time as chlorine residual using a tablet reagent known as phenol red.

Use of the chlorine comparator

The method of use of one type of chlorine comparator to measure chlorine in water is as follows :

- Rinse the comparator cells three times with the water which is to be tested and finally fill all the comparator cells with the same water (see Figure 2).

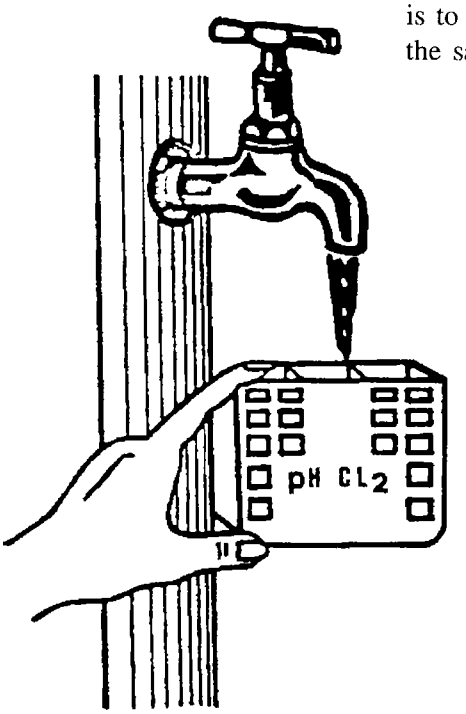

Figure 2. Filling the comparator cells with water

- Tear a foil strip containing DPD No. 1 tablets and allow one tablet to fall into the cell marked Cl_2 in the comparator (see Figure 3).

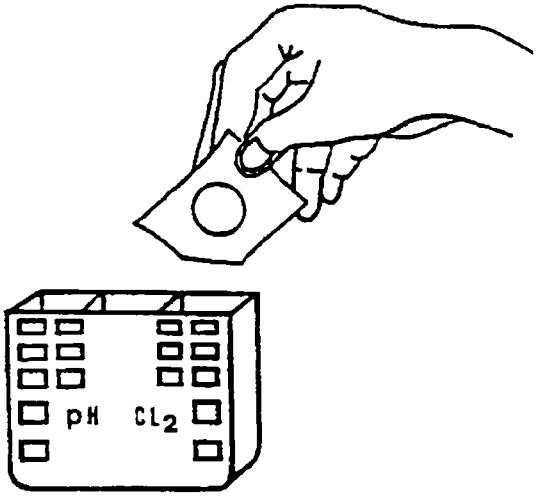

Figure 3. Adding a DPD tablet to a cell

- *If the comparator has a cell marked " phenol red " or " pH ", tear a foil strip containing phenol red tablets and allow one tablet to fall into that cell.*

- *Replace the lid on the comparator and shake the comparator until the tablets have dissolved (see Figure 4).*

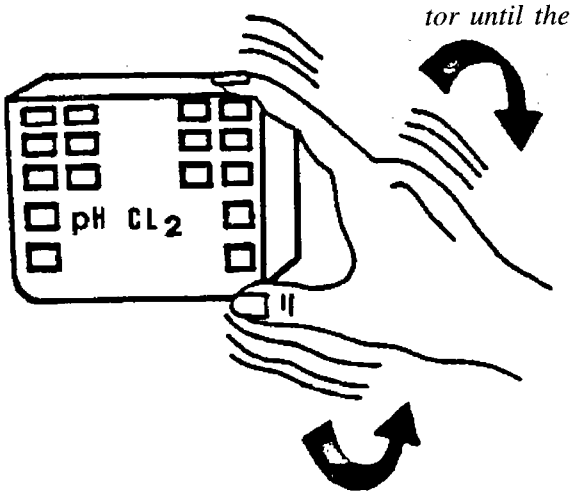

Figure 4. Dissolving the tablets

- *Hold the comparator up to allow plenty of daylight to enter the cells and look at the water in the cells. If chlorine is present in the water, the dissolved DPD tablet should give a pink colour to the water. Match this colour to the nearest colour on the colour scale which is permanently fixed to the comparator and read the amount of chlorine in the water from the scale.*

- *If the comparator has a pH cell, compare the colour of the water in the cell with the permanent colour scale on the comparator and read the pH of the water from the scale.*

- *When the test is complete, remove the top of the comparator and pour the water onto soil, not into water supplies or other water sources. Wash the comparator out with clean water and store in a place where it cannot be damaged.*

Guidelines for chlorination of drinking water supplies

To make sure that drinking water is free of pathogens (disease-causing microorganisms) a free chlorine residual should be maintained. The level of chlorine residual required varies with type of water supply and local conditions. There should, however, always be a minimum of 0.5 mg/l residual chlorine after 30 minutes contact time in water.

Where there is a risk of cholera or an outbreak has occurred, the following chlorine residuals should be maintained :

At all points in a piped supply	**0.5 mg/l**
At standposts and wells	**1.0 mg/l**
In tanker trucks, at filling	**2.0 mg/l**

In areas where there is little risk of a cholera outbreak, there should be a chlorine residual of 0.2 to 0.5 mg/l at all points in the supply. This means that a chlorine residual of about 1 mg/l when water leaves the treatment plant is needed. Chlorine residual can be tasted in water at 0.8 mg/l, thus unless higher levels are vital for health reasons, it is recommended that such high levels are avoided at points of consumption.

Chlorine demand

When chlorine is added to water, some chlorine is used up immediately by the water. This is the chlorine demand of the water. The chlorine demand of a particular water source normally does not change much over many years. When chlorine is added to water, there must be enough chlorine to satisfy the chlorine demand and also leave a small amount of chlorine residual (0.2 to 1.0 mg/litre) to kill the pathogens left in the water. It is important to be able to check the chlorine demand of water supplies to estimate the amount of chlorine needed for a well or rainwater storage tank.

The chlorine demand of a water supply can be estimated as follows :

- *Make up an approximately one per cent solution of chlorine or buy a bottle of bleach.*
- *Measure one litre of clean water and pour it into a container with a lid or cap.*
- *Add six drops of the one per cent chlorine solution to the litre of water, mix well and leave for 30 minutes.*
- *After 30 minutes, test the water in the container for free chlorine, as described above.*
- *The free residual chlorine in the water should be within the range of the comparator, usually between 1.5 to 2.0 mg/litre (or ppm). If the result falls outside this range, either add more drops of the one per cent chlorine solution or dilute with clean water, as necessary, until the free chlorine residual is in this range. If you add chlorine solution or dilute with clean water, leave the water in the container for 30 minutes before testing again. Note the result of the chlorine test as " original chlorine ".*

- *When the free chlorine residual of the water in the container is within the range 1.5 to 2.0 mg/litre, measure out 500 millilitres of the water and pour into a second container.*

- *Measure out 500 millilitres of the water to be tested for chlorine demand, for example from a well and pour this water into the second container with the chlorinated water. Mix well and leave for 30 minutes.*

- *After 30 minutes, test the water in the second container for free chlorine residual. Note the result of this chlorine test as " residual chlorine ".*

- *Calculate the chlorine demand as follows :*

$$\text{Chlorine demand} = \frac{\text{Original chlorine}}{2} - \text{Residual chlorine}$$

The chlorine demand is in mg/litre and should be added to the amount of chlorine needed to create a free chlorine residual of 0.2 to 1.0 mg/litre in a well or tank.