



Appropriate chlorination techniques for wells in Angola

Sam Godfrey

Traditional wells in Internally Displaced People's camps are often contaminated. This eight-stage method describes how to select wells for chlorination, assess the correct dosage of chlorine and involve community members in water testing and hygiene education.

Following a resurgence of fighting in Angola in 1998, more than 500 000 people fled their homes and sought shelter in the central highland cities of Kuito, Huambo and Malange. Once settled, the displaced persons dug traditional wells (defined here as an unlined well with individual rope and bucket) to improve their access to a safe water supply. In response, Oxfam GB began a chlorination intervention to improve the water quality in these wells to within SPHERE standards.¹ The chlorination programme covered more than 400 hand-dug wells during an 18-month period.

The methods of chlorination presented here vary slightly from traditional point-source methods of chlorination,² and the article is intended

to provide alternative guidance to field staff undertaking routine chlorination and water-quality monitoring.

Stage 1: Zoning of wells

Overcrowding and unplanned settlement are common in Internally Displaced People's (IDPs) camps in Angola, with houses and wells sited close to one another. The initial stage of the chlorination programme therefore involved the identification of appropriate wells for chlorination. Camps were zoned to ensure that the areas with the least access to improved wells (defined here as lined wells with handpumps) were prioritized.

Due to the overcrowding in IDP camps, there is often limited space for crop production. Therefore the potential environmental risk posed to the surrounding ecosystem by chlorinating unlined wells is of lower priority than the provision of safe water.

The criteria used included:

- number of users per well
- distance of traditional well from improved well
- condition of well
- ownership.

Stage 2: Community sensitization

To help identify the most appropriate wells for chlorination, the Oxfam community mobilization team met with community leaders, well owners and community members to introduce the concept of the chlorination programme. Messages such as the importance of safe water usage and the process of chlorination were discussed using the

following techniques:

- focus group discussions
- community drama
- demonstrations of how a well is chlorinated.

Community leaders were then asked to identify wells within their communities with unrestricted public access. Mobilizers then talked to community members 'one-to-one' to confirm that there was public access.

Stage 3: Well selection

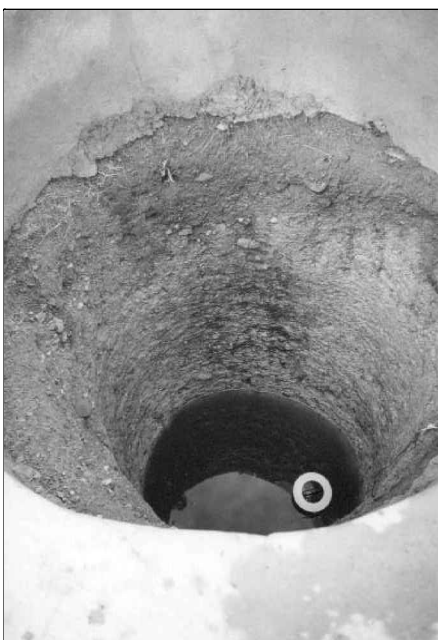
As well as the public access requirement, wells for chlorination were identified if they had:

- high levels of faecal contamination (thermotolerant coliforms at levels >1000 colony-forming units (cfu) per 100 ml)
- low turbidity (World Health Organisation guidelines for drinking water quality suggests <5 nephelometric turbidity units (NTU) for effective chlorination)³
- neutral pH (WHO guidelines suggests 6.2–8 for effective chlorination)
- sufficient yield throughout the year.

Once selected, the wells were chlorinated and equipped with a permanent rope and bucket in order to reduce potential cross contamination from the use of individual buckets.

Stage 4: Calculating volume

Initial calculations of the volume of the water in the well in cubic metres were undertaken using the following calculation:



Pot chlorinator in traditional hand dug well
Photo credit: Crispin Hughes

$$V = \pi \times r^2 \times h$$

where: r = radius in metres and h = depth of water above the base of the well in metres

For example if the depth of water (h) = 3.1m and r = 0.75m

$$V = \pi \times 0.75^2 \times 3.1 = 5.47\text{m}^3 \text{ (5475 l)}$$

Stage 5: Estimating correct chlorine dosage

The addition of chlorine to water results in the disinfection of selected microbial pollutants. Of greatest importance to public health is the disinfection of microbial pathogens which may be present in water sources as a result of faecal pollution.⁴ The aim of chlorination is therefore *to satisfy the chlorine demand of the water source* (dependent on the level of microbial and physico-chemical impurities in the water) and to leave a chlorine residual between 0.2 mg/l and 0.5 mg/l with *capacity to cope with any subsequent microbial contamination*.⁵ To achieve an appropriate chlorine demand and residual after 30 minutes for each individual well, the Modified Horrocks' Method was used (see Box 1).

A process of simple tabulation was then used to assist field workers in calculating appropriate chlorine dosages (see Table 1). The volume of the well (calculated using the radius and depth of water outlined in stage 4) was used to calculate the quantity in grams of 70 per cent grade HTH granule (High Test Calcium Hypochlorite) needed to be added to the well. HTH granules are usually dissolved as 10g/litre to make a 1% solution. If as in the example in Box 1, we require a 4 mg/l concentration of chlorine product in the well, this would require 0.4 ml of 1% solution for every litre of well water, or $0.4 \times V$ ml of 1% solution for every V litres of well water.

Stage 6: Chlorination

Once the appropriate chlorine dosage

Table 1 Required chlorine dosage to obtain 5 mg/l of available chlorine

Volume of water (litres)	10	100	1000
Quantity of 1% HTH solution	5 ml	50 ml	500 ml

Box 1. Modified Horrocks' method of chlorination (adapted from Shaw, 1999)

With most chlorination methods, the operator makes up a solution of a known concentration of chlorine. Each chlorine product (gas, bleaching powder, high test hypochlorite (HTH) tablets, granules and liquid) contains different amounts of usable chlorine depending on the quantity of time the product has been stored or exposed to the atmosphere. The modified Horrocks' method of chlorination is used to estimate chlorine concentrations and can be carried out without prior knowledge of the chlorine content of the chlorine product.

Equipment:

3 containers (plastic bottles of 1 litre capacity)
A 1g teaspoon
DPD test equipment (comparator)
HTH chlorine granules

Method:

- 1) Label the containers 1 to 3.
- 2) Place one level teaspoon (1g) of chlorine granules into the first 1 litre container.
- 3) Add a few drops of the water to be chlorinated and mix to a paste (dissolving the chlorine-product granules).
- 4) Dilute the paste with enough water to fill the container. If the container holds one litre, it now contains one spoonful per litre, or in this case, 1g per litre.
If we then take 1ml out of this container, this will contain 1 mg of chlorine product.
- 5) Transfer 2 ml of the diluted liquid from container 1 into container 2 and then 4 ml into container 3.
- 6) Fill containers 2 and 3 to capacity (1 litre) with the water to be chlorinated. Container 2 will then have 2 mg/l; and container 3 will have 4 mg/l.
- 7) Leave containers to stand for at least 30 minutes – this is the minimum contact time required for the chlorine to disinfect the water.
- 8) Test the water in each container for residual chlorine content using a DPD test kit.
- 9) The container with the concentration of chlorine within the range 0.2–0.5 mg/l indicates how much chlorine powder should be added to the water being disinfected.

Example:

A well needs chlorinating to make it safe to drink. Tests on the water using the modified Horrocks' method indicated residual chlorine concentrations (after 30 minutes) of 0.1 and 0.5 mg/l in containers 2 and 3 respectively. Therefore, container 3 had a chlorine residual concentration within WHO guidelines of 0.2–0.5 mg/l. The concentration of chlorine product in container 3 was 4 mg/l.

had been calculated, an appropriate quantity (calculated from Table 1) of chlorine at a 1% solution was mixed with water and placed in a floating pot chlorinator. The chlorinator was then placed in the well for a minimum of 30 minutes to obtain maximum contact time. The chlorine was dispersed and diluted by moving the pot chlorinator within the well in a circular motion for a period of 30 minutes (see Figure 3). Once the pot chlorinator had been in the well for a minimum of 30 minutes, communities tested the residual chlorine levels.

This method using pot chlorinators differs from conventional chlorination

procedures in which a well is dosed by a single shock chlorine dose, since it allows the community to participate in the chlorination process, thereby increasing understanding. Members of the community are helped to calculate the volume of water in the well, apply the appropriate chlorine dose (though this must be done with external supervision to ensure safe chlorine handling) and test the residual chlorine levels.

Stage 7: Hygiene promotion

While the pot chlorinator was in the well, a number of key hygiene messages

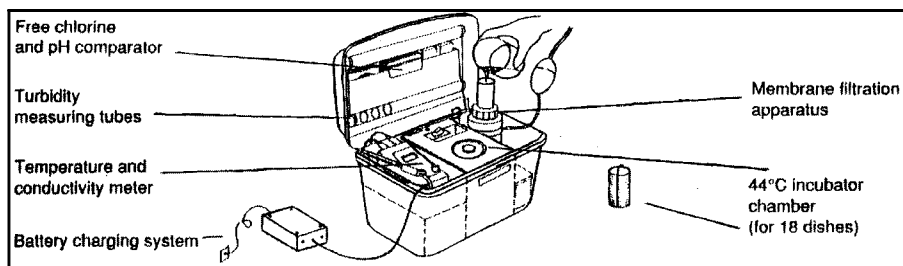


Figure 1 Field testing water equipment (adapted from Pickford, 1997)

were promoted through discussion and community drama. These include:

- *chlorine contact time*: the importance of the contact time (CT value)
- *rope and bucket*: only the provided rope and bucket must be used to avoid cross contamination
- *safe water*: drinking water must come from protected sources and must be carried safely to the household.

Stage 8: Water quality monitoring

In collaboration with communities, wells were monitored on a weekly basis. Communities were trained in weekly monitoring of chlorine residuals using DPD1 tablets and a simple comparator (see Figure 1).

Once residual chlorine levels measured in the well fell below recommended WHO guidelines, additional chlorination was undertaken. Microbiological water-quality monitoring of

thermotolerant coliforms was then undertaken on a weekly basis during the first four weeks of chlorination using the DelAgua field-testing microbiological and physico-chemical kit.

Summary

There are a number of studies to suggest that chlorination of traditional wells is not effective. For example, Rowe's et al. data on point source chlorination in an emergency situation in Guinea Bissau noted that chlorinating well water is not an effective water disinfection strategy as residual chlorine levels (RCL) after a single 'shock' dose of chlorine are only maintained on average for less than a day.⁶

Although not to dispute Rowe's study, results from the Angola project suggest that chlorination had a significant impact in reducing faecal contamination within the well. Results from Angola suggest that although a sufficiently high residual chlorine level (RCL) of 0.2–0.5 mg/l was not maintained in

all wells for more than a day, levels of faecal contamination reduced from TNC (Too Numerous to Count) to within SPHERE standards following a minimum of four chlorine doses per month.⁷

Furthermore, the data support the view that the process of chlorination used in Angola proved to be an effective vehicle to both an increase in dissemination of hygiene promotion messages and as an effective entry point into communities for the establishment of permanent water supply infrastructures.

About the author

Sam Godfrey was the National Water and Sanitation Adviser for Oxfam GB in Angola between 1999 and 2001. He is currently working as a Research Associate at the Water, Engineering and Development Centre (WEDC), Loughborough University, UK.

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Using a chlorine comparator to measure residual chlorine content
Photo credit: Crispin Hughes