



## Household water filtration system for rural areas

Michael Chukwurah, Nigeria

ADEQUATE AND SAFE water supply is pre-requisite for significant socio-economic development of a community. A lot of resources has been committed to treat water related diseases which could have been used for other development, WHO (1971). Portable and safe water supply has been a concern to developing countries and international agencies like UNICEF, UNDP and WHO among others. These problems actually challenged engineers in water profession on how to assist salvage developing countries, in particular, develop and effectively manage their water supply system. (Diamant, 1985)

Various methods of treating water, based on appropriate technology have been developed and they range from slow sand filtration to conventional treatment plants with less technical-no-how in operation and maintenance. Despite these efforts, only little has been achieved. Wagner et al (1959) rightly claimed that "there is plenty of evidence of outbreaks of typhoid fever, cholera and epidemic jaundice due to breakdown of treatment plants, for this reason, most water agencies in developing countries find it difficult to supply adequate and safe drinking water to its communities. Individuals in these communities have no confidence in water supply by municipal water agencies, many were advised to go to the old system of treating water themselves through boiling before drinking.

Household treatment devices will be much welcome to these communities in both rural and urban centers as a supplement to the existing water treatment system. Although such devices have been discouraged by Schutz and Okon (1984), nevertheless, it is necessary, as an interim measure to use these devices (Like Household Water Filters) pending when water supply agencies will improve/provide adequate and portable water to these communities.

### Material and method

#### Nature and composition of diatomic

Diatomite is a fossilized rock consisting of dead diatomaceous earth, occurring in most clay or lime deposits; it is formed as a result of skeleton of siliceous organisms of algae and diatoms with occurrence in bed of ponds and lakes. (Read, 1970). The size of diatomite play an important role in filtration. It determines the permeability of the filter layer and hence improves the quality of filtration. Their size ranges from 25 $\mu$ m to 150 $\mu$ m. (Willy, 1992). The general physical properties of diatomite for fresh powder were enumerated by Wily (1992), as follows:

Melting point; 500 to 1600°C (if not pure, 1200 to 1300°C). Softening point; (100°C), Allotropic change; 870 to 875°C) Lighting reflection index; 1.44 to 1.46 Specific heat capacity; 1kJ/kg Density; 2.25kg/L Apparent density; wet – 310 to 380kg/m<sup>3</sup> Apparent density; dry – 170 to 270kg/m<sup>3</sup>. The diatomite was bought in Kaduna Central Market.

### Production of candle stick filters

The equipment and apparatus used in making candlestick filters include porcelain mortar and paste, measuring cylinder, cylindrical mould of 18cm length by 6cm diameter, furnace, oven, galvanized stand, and araldite solution.

### Procedure

Diatomic powder, sand and saw dust was measured by volume to a ration of 2:1:1 respectively after thorough cleaning and grading. These were mixed with water gradually until it became plastic (which is the paste). The mixtures were then poured into the cylindrical mould to produce the required shape to candlestick. It was allowed to settle for 4 hours removing out the mould for further drying at room temperature for 2 days; moisture was finally removed in the oven at temperature of 105<sup>o</sup> for 2 hours. The unbaked candle stick showed an ash colour. Dried candlestick filter was taken to furnace for baking at a temperature of 200°C for 7 hours. The candles were allowed to cool for hours before removal. The baked candlestick turned brown in colour indicating that it was fired to cake (Fig. 1.0). Caked filter was finally fixed to galvanized stand with the aid of araldite solution.

### Assembly of water filter and testing

Finished candlestick filters were fixed into the holes of raw water pot, along with rubber seal, and were firmly tightened with nuts. Plastic tap was also fixed into the clear water pot and tightened firmly to avoid leakage. Raw water pot was placed on the clear water pot and a cover made from ceramic product placed on the cover the raw water pot. Test for stability and effectiveness of the device was carried out by pouring portable water into the top pot and allowing it to filter into the lower pot with a continuous addition of water for 5 days to check for leakages.

### Sample collection

Figure 1: Setup of the Filtration System with Candle Stick Samples of raw water, collected from a stream in Mando,

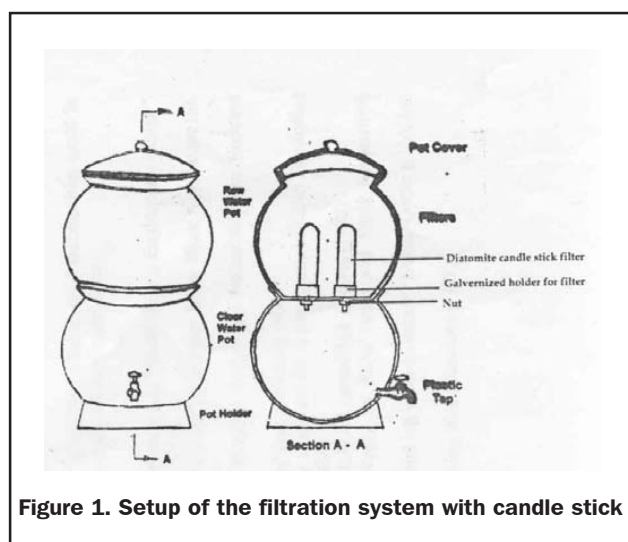


Figure 1. Setup of the filtration system with candle stick

Kaduna, were used for this study in accordance with the Bacteriological Examination of Drinking Water Supplies (1982). At the site, samples river and at a depth of 1 meter from the riverbank. These were mixed together as composite sample.

### Physical, chemical and bacteriological examination

Tests conducted in this study include pH, Turbidty, suspended solids and total solids. Others are iron, and microbiological examination. This is to determine the effectiveness of the filter device with respect to the sample used. Parameters were examined before and after filtration. The tests were carried out as specified in the standard methods.

### Results and discussion

#### Candles sticks filter and clay pot containers

The physical strength of the candlestick filter was tested in water for 5 days and then boiled at 100°C for 2 hours.

However, this indicated that, candlestick was appropriate fixed and caked; composition of diatomic, sand and sawdust was adequately proportioned. The porosity of the filter was achieved after the sawdust in the mixture had burned off during firing, creating cavities; sphericity of sand also contributed to the increase in the overall voids.

#### PH

Sample used in this reveals an average pH of 6.54 after filtration. The pH of the water was seen to always drop in value. It might be that some alkaline substances were filtered out each time. The pH of filtered water falls within WHO specifications.

#### Turbidity

Table 1 shows turbidity values. The average turbidity value of raw water is 62.88 NTU while filtered water is 2.12 NTU giving efficiency of filtration of 96.48%. The raw water turbidity value ranged from 46 NTU to 98 NTU while the filtered water value ranged from 1.3 NTU to 4.4 NTU. All the filtered water turbidity values met the WHO standard of less than 5 NTU (WHO, 1971)

#### Iron

Table 1 shows the iron values. The average value of iron in raw water is 0.38mg/1 while the average value of filtered water is 0.075mg/1 showing an efficiency of 78.9%. The value of iron in raw water is higher than the WHO (1971) standard of 0.3mg/1, while that of the filtered water met the WHO standard. The 78.9% efficiency of iron removal after filtration could be due to aeration process during the pouring of the raw water in the clay pot, thereby changing the iron from iron II to iron III and the precipitate is trapped by the filter medium and hence making the filtered water portable. When the levels of Iron is quite high, a separate method of aeration need to be carried out before filtration.

Table 1. Results

Sample No.	BEFORE FILTRATION					AFTER FILTRATION					EFFICIENCY (%)		
	PH	Turbidity NTU	Iron mg/L	Coliform No. Per 100ml	Temp. °C	pH	Turbidity NTU	Iron mg/L	Coliform No. Per 100ml	Temp. °C	Turbidity NTU	Iron mg/l	Coliform No. Per 100ml
1	6.8	4.8	0.38	496	26	6.6	2.1	0.08	2	20	95.4	78	99.56
2	6.8.	46	0.37	464	27	6.6	1.8	0.07	2	21	96	80.1	99.56
3	6.7	46	0.37	544	26	6.5	1.6	0.07	1	20	96.5	80.1	99.82
4	6.8	52	0.36	416	26	6.6	1.3	0.07	1	20	97.5	80.5	99.7
5	6.6	98	0.4	560	26	6.4	4.4	0.09	3	19	95.6	80.1	99.4
6	6.6	83	0.4	520	27	6.4	2.6	0.08	1	21	96.6	80.1	99.8
7	6.8	70	0.39	488	26	6.6	2	0.08	1	20	97.1	79.4	99.7
8	6.7	60	0.37	---	27	6.6	1.6	0.07	--	20	97.1	80.1	---
Avg.	6.73	62.88	0.38	498	26.4	6.54	2.12	0.075	2	20.1	96.48	78.9	99.6

### Bacteriological test

It is evidently clear from the test results in Table 1 that the filter could remove micro-organism up to 99.6% efficiency. The value did not meet WHO standard of 0 Coliform/100ml. The average total Coliform of 498/100mls was recorded before filtration, this was however reduced to average value of 2 coliform/100ml. 99.6% of micro-organism removal was achieved during filtration in which suspended particle matters were trapped by the filter allowing only clear water to pass through; biological activities also took place forming a thin layer of slim, making the system to act as slow sand filter.

### Conclusion and recommendations

From the result of the study conducted on the Rural Household Drinking Water Filter, the following conclusions and recommendations were drawn:

1. The diatomite candlestick filter shows good performance in the removal of iron and micro-organism in the raw water.
2. The treated water is fit for human consumption
3. Pre-sedimentation of high turbid raw water of 100 NTU and above is recommended before filtration is carried out to reduce clogging of the candlestick filter.
4. Washing of candlestick and disinfection by boiling in portable water for 10-20 minutes is recommended after filtering for 4 days to ensure good performance of the filter system.
5. The fabricated clay pots could also serve as a water cooling device in hot climates, as the temperature of the treated water dropped by over 5°C
6. Raw materials for making Rural Household Filter is locally available; rural communities could be encour-

aged to produce them with little training to improve their technical skills.

### References

1. AL-LAYAL, N.A AHMED, S. AND MIONERBROOKS J.E, "Water Supply Engineering Design". Ann Arbor Science Publisher; Inc. Michigan, USA (1978)
2. ASCW, AWWA, CESSE, "Water Treatment Plant Design", American Water Work Association Inc. New York (1969)
3. HUDSON, H.E Jr. "Water clarification Process- Practical design and evaluation" Van Nostrand Reinhold Company, New York (1981).
4. MARABA POTERY "Process of pottery production" (not published) 1990
5. SCHULZ, C.R. AND OKON D.A "Surface water treatment for Rural communities in Developing Countries, John Wiley and Sons Pub. New York (1984).
6. READ, H.H. Element of mineralogy "Published by Edward Arnold Ltd. London (1970)
7. WAGNER, E.G AND LANDIX J.N. "Water supply for Rural Areas and small communities monograph series No. 42 Geneva WHO (1959)
8. WILLEY J. MASSCHELEIN "Unit processes in drinking water treatment" Marcel Dekke (pub). Inc. USA (1992) WORLD HEALTH ORGANISATION (WHO), Drinking Water Standard (1971)

---

MICHAELCHUKWURAH  
([Michaelchukwurah@yahoo.co.uk](mailto:Michaelchukwurah@yahoo.co.uk))

National Water Resources Institute, Kaduna, Nigeria

---