19th WEDC Conference ACCRA, Ghana 1993

WATER, SANITATION, ENVIRONMENT and DEVELOPMENT

Slow sand filtration water treatment

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Introduction

Rural water supply can be sustainable, reliable and affordable only if a simple-to-operate technology and the sense of community ownership of the water supply system are the main features of design considerations.

The groundwater potential in Northern Ghana is inadequate, hence surface sources, predominately impoundment reservoirs, are the most reliable source options. Evidence of this are the numerous scattered dams and dugouts in Northern Ghana; therefore to supply pipe-borne potable water is by means of water treatment using chemicals. But the rising cost, irregular supply, difficult storage and improper dosing of chemicals are problems that go with the use of chemical water treatment in the region.

The alternative surface water treatment technology which minimises the use of chemicals is slow sand filtration.

GWSC is conducting on-going slow sand filtration pilot plant testing with the aim of establishing design criteria, determining performance efficiency, and developing both capital and operational cost estimates for full scale slow sand filtration plants to be adopted.

Salaga slow sand filtration (SFF) pilot plant, a CIDA funded project, is treating a river supply source. The SSF pilot plant was completely constructed at the end of 1991 and the testing programme started in January, 1992. The pilot plant has operated for over a year, covering both the dry and the rainy seasons. During the rainy season the water quality deteriorates significantly, resulting in increased turbidity, colour, organic matter, etc.

In this paper the results of the SSF pilot plant testing programme will be discussed.

Salaga SSF pilot plant

Brief description

The pilot plant is located at the existing Salaga water treatment plant on the River Daka, 14 km north of Salaga township along the Salaga - Bimbilla road, about 115 km from Tamale. The plant consists of a diesel engine pumpset, an overhead balancing tank, an aeration/precipitation unit, two horizontal flow roughing filter (HRF) units, four SSF units and a clear water sump, all of which have been interconnected with a suitable uPVC pipe network.

Schedule of sampling

The plant was visited once a week by staff from the GWSC regional laboratory, Tamale, and raw water and treated water samples, and data on the performance and operation of the filters, were collected. Water samples were collected from appropriate locations at each unit representative of raw and filtered water.

Test results

The main results considered are the hydraulic performance and treatment effectiveness of the filters as set out overleaf.

Within the recommended flowrate, the headloss recorded for an average of 7 months duration is satisfactory. From the results set out in table 2 flow rates between 0.1 - 0.2 for a SFF are recommended.

Samples were transported to the GWSC laboratory, Tamale, for analyses for E. Coli and Faecal Coliform. Multiple Tube Test (MTT) and a Del-Agua test kit are used for the analyses.

Even though bacteria percentage reduction of 92.5% is satisfactory, it is recommended to add a little chlorine as a residual in the distribution network.

Conclusions and recommendations

The most important SSF operational procedures are continuous plant operation and efficient filter cleaning procedures. To determine the effects of cultural altitudes and unreliable power supplies, future investigations will include:

- innovative filter cleaning procedures to suit local cultural conditions;
- assess the impact on treated water of intermittent operation of the plant to simulate power interruption.

Generally, the performance of the SFF is satisfactory. In rural water supply where a surface water source is used, SSF water treatment is the most appropriate technology compared with chemical water treatment. I recommend that a pilot plant should be constructed before a full scale SFF in any location, since it act as training for the operators.

Table 1.
Filter Design Features

HRF	
BED SIZE (LxBxH)	50 m x 0.6 m x 0.6 m
FILTER MEDIA SIZE	
COMPARTMENT	
1	12 - 20 mm
2	8 - 12 mm
3	4 - 8 mm
FLOW RATE	
HRF 1	0.75 m/h
HRF 2	1.50 m/h
SSF	
FILTER BED AREA	0.114 m^2
DEPTH OF SAND	
Initial	1000 mm
Final	600 mm
Effective Size	0.35 mm
Uniformity Co-efficient	1.80 mm
Depth of Underdrain	300 mm
Operational Head	1000 mm
Freeboard	100 mm
FLOW RATE	
SSF 1	0.4 m/h
SSF 2	0.3 m/h
SSF 3	0.2 m/h
SSF 4	0.1 m/h

Table 2
Hydraulic Performance

Unit	Flow Rate (mm/h)	Max.Design (headloss mm/h)	Recorded (headloss mm/h)	Duration (Ave. Period of operation)
HRF				
1	0.75	40	10	8 months
2	1.50	40	10	6 months
SSF				
1	0.4	1000	790	3.5 months
2	0.3	1000	790	3.5 months
3	0.2	1000	800	6.5 months
4	0.1	1000	800	6.5 months

Table 5
Bacteriological quality multiple tube test results

Raw Water			Filtered Water		
Min.	Max.	Ave.	Min.	Max.	Ave.
>16	>16	>16	<2.2	>16	<2.2

Table 3
Physical quality parameters analysed

Parameter	Raw Water Min.	Max.	Ave.	Filtered Water Min.	Max.	Ave.	% Reduction
Turbidity (NTU)	3.2	550	94	1.0	60	9	90%
Colour (Hu)	35	760	294	8	500	160	79%
pH	6.2	6.8	-	6.4	8.1	-	
Temperature (°C)	26	37.1	-	26	37.5	-	
Conductivity (Us)	23.6	60	-	29	70	-	

Table 4
Chemical quality parameters analysed

Parameter	Raw Water Min.	Max.	Ave.	Filtered Water Min.	Max.	Ave.	% Reduction
Iron (Mg/L)	0.03	3.5	1.7	<0.01	1.45	1.02	70%
Manganese (Mg/L)	<0.001	0.027	0.02	<0.001	0.01	0.004	79%
Chloride (Mg/L)	7.0	27.0	-	8	30	-	
Alkalinity (Mg/L)	25	63	-	35	-	-	
Hardness (Mg/L)	6	40	-	7	35	-	

References

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