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Filtration properties of local sands

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INTRODUCTION

Filtration is one of the principal unit operations used in the treatment of portable water and for achieving supplemental removals of suspended solids from waste water effluents of biological and chemical treatment process.

Niger State like most states of the Federation has large deposits of sands that could be used as filters either directly or in combination with others. For the purpose of investigating the filtration properties of sands around Bida discussed in this paper, sand samples from three different sources were analysed and used as filters for the laboratory scale model slow sand filtration unit, unlike the conventional down flow filtration unit. The upward flow type was used. Both ground water containing high iron content and simulated surface water with high turbidity were used for the investigation.

EXPERIMENTATION

Physical Properties Of Sands:

The sand samples used for filters were collected from three locations viz River Gbako at Mana (near Bida Water Works) River Kaduna at Wuya and River Musa (near National Cereals Research Institute - Badeggi). The sand samples were washed and dried and physical tests were carried out on them, and the results shown in Table [a].

The Model Unit

The Laboratory Filtration Unit consists of:

i) A Feeding System: This consists of two storage tanks i.e. the overhead tank and the ground level storage tank.

ii) Aeration Unit: This consists of a perforated plate and sheet baffle wall with an opening at the bottom to allow flow into the sedimentation basin. The aeration unit was not used for the surface water.

FILTER PACKING DETAILS

	Sand Grading		
River Gbako Sand sample	Sieve Size	Below " "	0.800mm 0.600mm 0.300mm
River Kaduna Sand sample	Sieve Size	Below " "	0.800mm 0.600mm 0.300mm
River Musa Sand sample	Sieve Size	Below " "	0.800mm 0.600mm 0.300mm
	Gravel Packing		
	Retain		13.2mm
	"		4.75mm

TABLE 1

iii) The Sedimentation Unit: This basin has a calibrated V-notch out flow used for flow measurement.

iv) The Filtration Unit: This consists of a well packed graded layers of gravel and sand from coarse to fine (about 3 to 4 layers). The slow sand filtration unit has pressure tapping which is connected to a manometer board. For details of model unit, see Fig. A.

Experimental Procedure And Results

Raw water (first, from the Polytechnic borehole and later simulated surface water with varying turbidity) were allowed to flow from the overhead tank through a pipe, and made to fall through a height of 450mm to the aeration unit (the aeration unit was not used for the surface water) From the aeration unit it passed through the sedimentation tank via the calibrated V-notch, into an open channel which has a drop hole exit linked to the bottom of the slow sand filter unit by a 25mm dia plastic

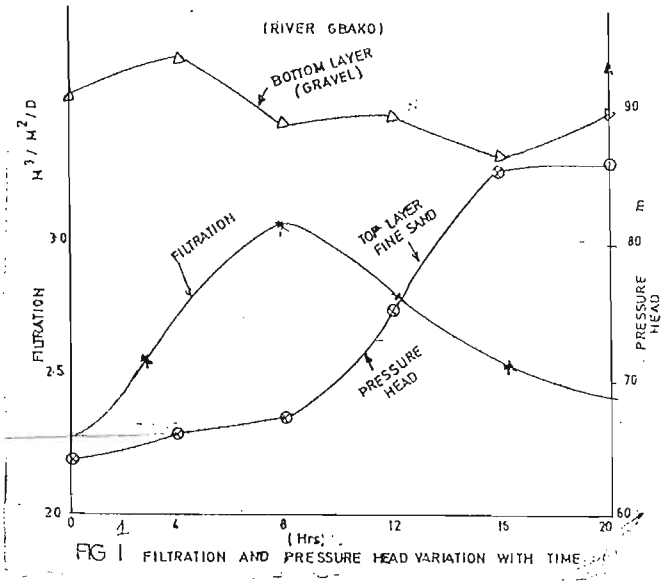


FIG 1 FILTRATION AND PRESSURE HEAD VARIATION WITH TIME

tubing. The slow sand filter is the 'up-flow' type in which raw water flows in from the bottom of the filter and the clear water is collected on top of the fine sand layer. The unit has pressure tappings which is connected to a manometer board. The initial water was allowed to rise 150mm above the fine sand layer and the system shut off for 3 days to allow for maturation. After this, the control value for the feeding system was adjusted to maintain a constant head over the weir and the filter allowed to run for about 2 hours for stabilization of the system.

The initial piezometric heads were recorded and repeated every 2 hours at an average of 6 hours per day initially and every hour at an average of 4 hours per day later. The filtration rate was measured for each day's monitoring. Water samples were collected at the end of each day which were later tested. See Fig.1 to 4 for the pressure head variation with time and filtration rate variation with time at constant discharge. The result of the laboratory examination of the treatment water is shown in Tables 2 and 3.

Discussion

From the graphs and tables, it will be observed that fairly good filtration results were obtained from the tests carried out with all of them fallen within required standards, with both turbidity and suspended solids decreasing with time.

For River Gbako sand there was a steady increase with time of the filtration rate until it peaks and then it starts to decline. For Rivers Kaduna and Musa sand, unlike River Gbako Sand, it peaked rapidly and the decline were equally rapid. This may be due to the better grading of River Gbako, see Table 1.

It could also be seen from the pressure curves that clogging is more rapid in Rivers Musa and Kaduna.

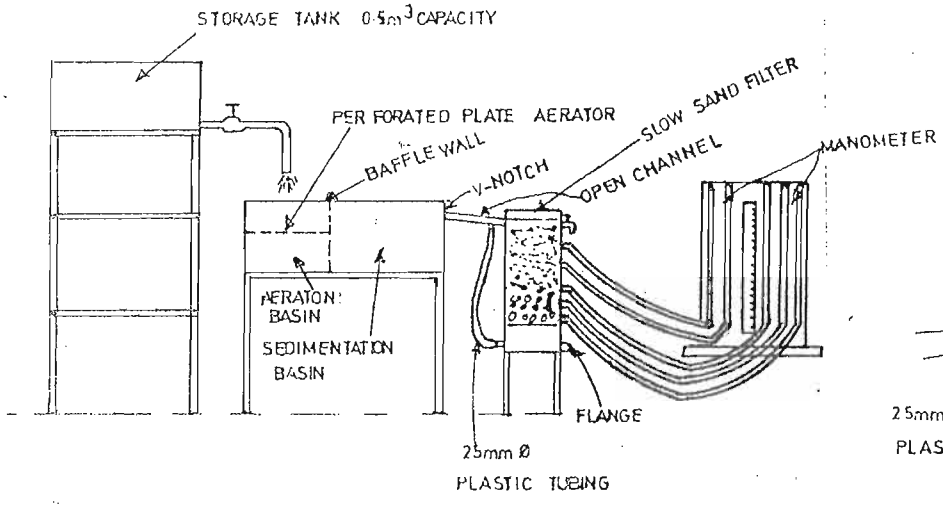
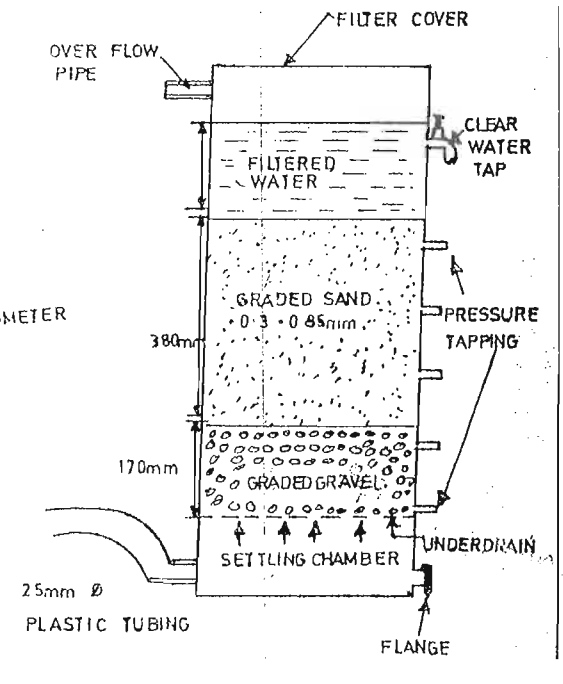


FIG A SCHEMATIC DIAGRAM OF AERATION-SEDIMENTATION - FITRATION SYSTEM



SECTION THROUGH SLOW SAND FILTER

RESULTS OF PHYSICAL PROPERTIES OF TESTED SANDS

S/No	Sand Sample	Uniformity Coeff.	Recommended Stand.	Effective Sizes	Recommended Stand.	Specific Gravity	Solubility Test 0.2 HCL %wt. loss in 24 hrs.
1	River Gbako at Mana	2.5	2.5 - 3.5 (ref 2) Less than 2.0 (ref 3)	300 µm	250 - 350 mref.2 150 - 400 mref.3	2.64	Nil
2	River Kaduna	2.42		212 µm		2.68	Nil
3	River Musa at N.C.R.I.	1.62		370 µm		2.63	Nil

TABLE 2

ANALYSIS OF RESULTS

RIVER GBAKO SAND: GROUND WATER

Parameter	Raw Water	MONITORING HOURS				
		4	8	12	16	20
Turbidity J.T.U.	14.4	0.25	0.22	0.09	0.08	0.04
Suspended particles	5.0	0.0	0.0	0.0	0.0	0.0
RIVER KADUNA SAND: GROUND WATER						
Turbidity J.T.U	14.4	0.70	0.55	0.52	0.50	0.45
Suspended particles	4.0	0.0	0.0	0.0	0.0	0.0
RIVER KADUNA SAND: SIMULATED SURFACE WATER						
Turbidity J.T.U.	88	4.4	4.1	2.9		
Suspended Solids	230	18.0	17.0	12.0		
RIVER MUSA SAND: SIMULATED SURFACE WATER						
Turbidity J.T.U.	8.8	4.0	3.6	2.8		
Suspended Solids	230	14.0	8.0	5.0		

TABLE 3

CONCLUSION

The main conclusions are as follows:

1. Local sands could be used as effective filters in slow sand filters for both surface and ground water, to achieve required water quality satisfying WHO recommendations.

2. These sands are available in large commercial quantities, hence avoiding the problem of importation of filter sands.

3. The filtration rates are within recommended standards and could be designed for treating water for villages and small towns.

4. Existing down flow type slow sand filters may be modified to up flow types to reduce the problems involved with cleaning of filter sand and also to increase the length of filter run.

5. The system will be easy to construct and operate using local personnel and materials after minimal training in an asset to developing countries with scarce foreign exchange and lack of highly skilled

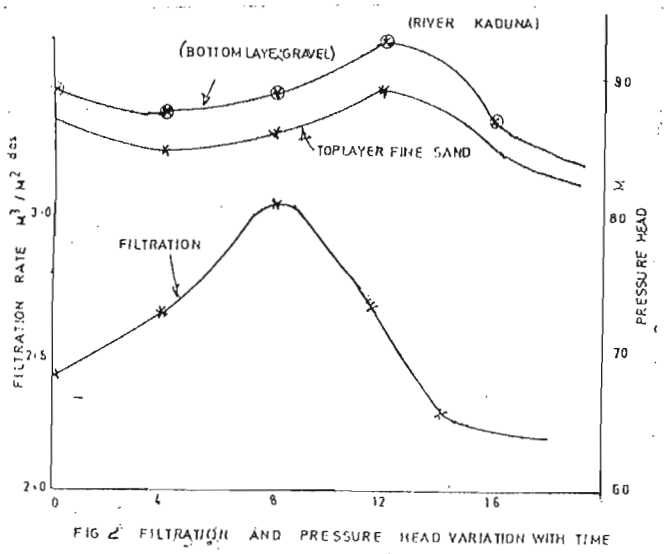


FIG 2 FILTRATION AND PRESSURE HEAD VARIATION WITH TIME

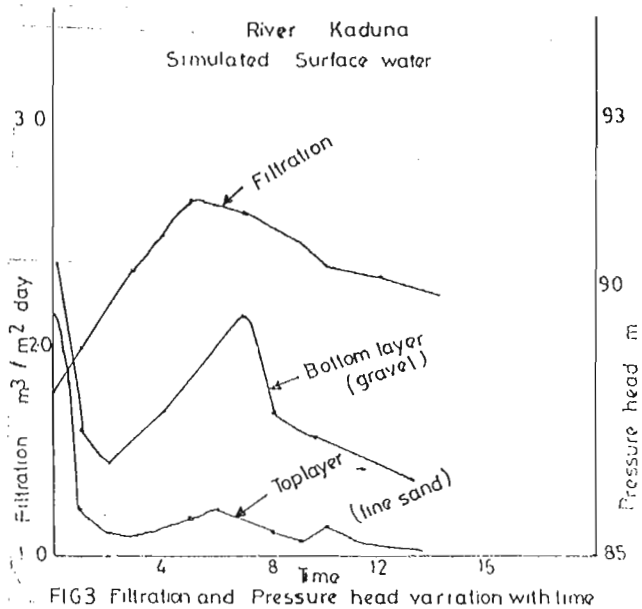


FIG3 Filtration and Pressure head variation with time (100mm Head)

personnel.

6. Studies should be carried out to see the possibility of achieving better filters by using a combination of these sands.

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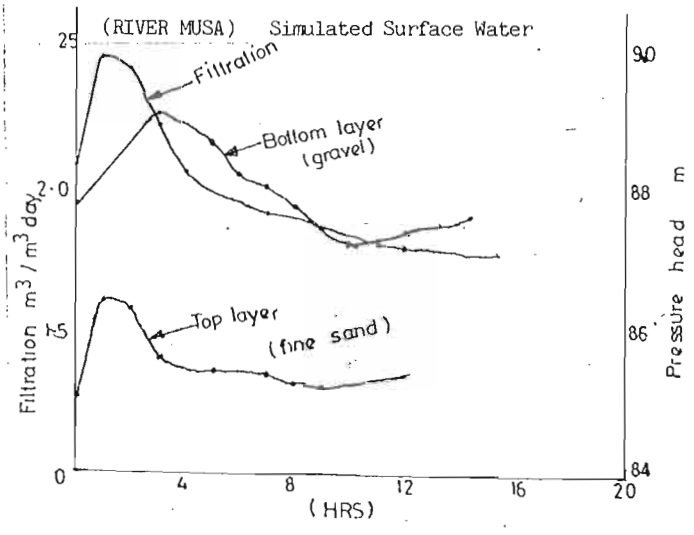

Fig 4 Filtration and pressure head variation with time

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