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The Use of Local Sand as a Filter Media

Zaharaddeen Baffa Baba
Lecturer, Department of Civil Engineering, Kano University of Science and Technology, Wudil, Kano, Nigeria
Abubakar Ismail
Lecturer, Department of Water Resources and Environmental Engineering, Ahmadu Bello University, Zaria, Nigeria

Abstract:
This experiment was carried out in order to determine the possibility for the use of Local sand as a filter media, the graded sand were obtained using British Standard sieves No. 25, 36, 52, 72, 100 and 200 whose are having sizes of 0.6 mm, 0.42 mm, 0.03 mm, 0.212 mm and 0.075 mm respectively, the effective size of the sand and the uniformity coefficient was found to be 0.22 mm and 1.93 respectively. Analysis of both raw and filter water was carried out through turbidity test, pH test and coli form count in order to present the physical, chemical and biological characteristics of water, after passing the raw water through the filter media. The sand filter media obtained using a set of British Standard sieves filtered water about 90% removal of coli form, 75% removal of turbidity and insignificant change in pH. Finally, disinfection process as a measure of safety should be employed.

Keywords: *biological, coli form, disinfection, pH, turbidity, uniformity.*

1. Introduction

The amendment to the safe drinking water act 1986, require filtration and disinfection process for drinking water treated in public treatment system whose source is surface water, these two types of treatment will ensure that guardia cysts, viruses and legionella type of bacteria and eliminated colour, odour, pH e.t.c for the water to be satisfied. Filtration is one of the most important operations in the water purifucation process, through screening and sedimentation remove a large proportion of suspended matter, but they do not effectively remove fine, flocs particles, colour, dissolved materials and microorganism. [vi]The filtration process involves the removal of suspended particles, colloidal materials, bacteria and other organisms by combination of hydraulic and mechanical straining process. Basically the process of filtration consists of passing the water through a bed of sand, or other suitable medium at low speed. In order to achieve the final degree of clarity, the influent water from the settling basins must be of fairly low turbidity. This degree of settling may vary with the type of filter adopted. Filtration is most effective when used as a final treatment process after the use of sedimentation and/or coagulation, and can be loosely classified as pre-coat filtration or depth filtration. The former involves the use of particulate coating on thin materials support media such as cloth or finely woven wire while the latter utilizes a permanent, relatively thick medium usually granular of varying porosity and density [i]. In filtration, water is passed through a filter medium in order to remove the particulate matter not previously removed by sedimentation . during filtration, the turbidity and colloidal matter of non settleable type are removed, it precipitates the colour and the chemical characteristics of water are changed. The bacterial content of water is considerably reduced due to the presence of an active zoological layer on the top of filtering material.[iii]

Sand filters operate in a similar manner to bioretention systems; with the exception that stormwater passes through a filter media (typically sand) that has no vegetation growing on the surface. Sand filters do not incorporate vegetation because the filter media does not retain sufficient moisture to support plant growth and they are often installed underground (therefore light limits plant growth). The absence of vegetation and the associated biologically active soil layer typically created around the root zone of vegetation planted in bioretention systems, means sand filters have a reduced stormwater treatment performance compared to bioretention systems. [ii] There are many treatment methods capable of removing guardia pathogens, cysts, viruses, legionella type bacterial and other pathogens that might be presence in the water, the methods include the followings; diatomaceous earth filtration, sand filtration, direct filtration consisting of pressure filter proceeded by pretreatmentwith a chemical coagulant, convection treatment is another method that includes such process as rapid mix, chemical coagulant, flocculation and sedimentation followed by filtration, similar treatment can also be offered by small system. In addition to the being very effective in producing drinking water, some of these methods requires substance financial resources for their design, construction, operation and maintenance. All these requirement entails expenditure and considerable investment while filtration, through diatomaceous earth and through sand do not require pretreatment or constant maintenance which reduces the cost for the construction and maintenance. The high cost of some of these methods and the constant maintenance they require have created serious problems, for the people served by small plants, frequently these individuals

do not have significant financial resources for treatment and installation, lack of expert who are knowledgeable about the development and management, areas of specialized techniques or do not have people capable of operating the system.[vii]

2. Experimental Method

The sand media used was obtained along River wudil bank and allowed to dry, 1000 g out of the sample was measured using weighing balance, the measured sample was divided into four equal portion using cone quarter method, 150 g was mmeasued out of the division of the sample, which is the maximum amount carried by the sieves. The sample is then washed with clean water for it to be free from clay, silt and other impurities present in it and allowed to dry, the investigation was first carried out using a medium obtained as a result of mechanical sieving using sieves no. No. 25, 36, 52, 72, 100 and 200, the size of these media ranges between 0.075 mm to 0.6 mm and the effective size is 0.22 mm with a uniformity coefficient of 1.93, this compared favorably with values cited in literatures. The graded sand was put in a sieve no. 200 in layers, seven sample of raw water was collected at different time interval, the collected sample of raw water is then poured and allowed to drain in a pan, the remaining sample of water was regarded as raw water, while the drain sample as filtered water. The effectiveness of the granular material as filter media is dependent on the size, uniformity, and composition of the grains. The size of the granular media correlates with the surface area available to support the microorganisms that treat the wastewater. This consequently affects the quality of the filtered effluent. [ix]

The performance of the filter media was determined by the analysis of raw water and filtered water for turbidity, pH and coli form counts, which represent physical, chemical and biological characteristics of water respectively.

2.1. Turbidity

The turbidity depends upon the fineness and concentration of particles present in water. Although, the clay or other inert suspended particles may not be harmful to health, yet they are to be removed or reduced foe aesthetic and psychological reasons, since some people do not like turbid water, the turbidity of raw water must to be measured, and then reduced by treatment to permissible values, so as to make it almost invisible under naked eye. It is also considered to be a very important factor in drinking water due aesthetic and psychological reasons, besides being a sign of pollution in some cases, it may also effect the filtration and disinfection process in water treatment. [iv]The turbidity measurement was carried out by using a turbidimeter model DRT 100; it is measured in naphelometric turbidity unit (NTU)

2.2. pH Value

The pH value of water, thus indicates the acidity or alkalinity of water, the maximum acidity will be at 0 value of pH and maximum value of alkalinity will be at pH value of 14. The pH is having a large scale importance in water supply system, since it controls water as well as sewage treatment process, the pH value of raw water in fact, must be taken into account, while deciding the various treatment process like, coagulation, filtration, disinfection, water softening etc. the pH value also becomes important in corrosion controls, since the lower pH (acidic water) may cause tuberculation and corrosion of the pipes and treatment tanks etc, higher value pH (alkaline water) may on the other hand, produce incrustation, sediment deposit, difficulty in chlorination, besides certain psychological effects on human system, if such alkaline waters are consume. The permissible pH values for public supplies may range between 6.6 to 8.5 [iv] both raw and filtered water were measured using pH meter.

2.3. Coli form Count

The coli form count are the rod shaped non pathogenic bacteria (bacilli), whose presence or absence in water indicates presence or absence of fecal pollution and hence of pathogens. The coli forms group, fecal and total are most widely used organism now and historically, the total coli form group consist of members whose normal habitat is the colon (lower portion of intestine) of human and cold-blooded animals, some members are however found in the soil and vegetation as well as in faeces and which are not found in the soil, the vegetation constitutes about 96% of all the coli form of human faeces , such members are called fecal coli forms, they are also recently named by world health organization (WHO) as thermo tolerant coli forms. [viii] The coli form counts were carried out in accordance with standard method at an incubation period of 35˚C. This property of coli form organisms has been used since earlier days to detect their presence in the giving water sample. [iv]

3. Discussion of the Results

The sand filter media was undergone sieve analysis in order to get the effective size of the media, Table 1 shows the results for sieve analysis and particle size distribution curves was shown in figure 1, the effective size of the media is 0.22 mm. the effective sizes used are in conforming to suggested values of 0.15 mm to 0.35 mm. [v] the uniformity coefficient is 1.93, compares with suggested values provided. [iii]

Table 3 shows the values for turbidity for both raw and filtered water. It was observed that, the turbidity of the raw water was considerably reduced for about 50% in all the samples, this is as a result of suspended particles of the raw water by filter media. According to world health organization (WHO) standard for drinking water is between 0 to 5 NTU. Table 4 shows the result of coli form count for both raw and filtered water. It was observed that, there are no significant changes in pH values; this result is expected as there was no chemical used as pretreatment which may influence the pH changes. Table 5 shows the results of coli form count for both raw and filtered water, it is observed that, there is reduction of most probable number (MPN/100), between raw and filtered water which indicates the reduction of coli forms.

BS sieve No.	Aperture (mm)	Mass retained (g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage passing (%)
25	0.600	15.225	10.15	10.15	89.85
36	0.425	36.150	24.10	34.25	65.75
52	0.300	60.600	40.40	74.65	25.35
72	0.212	28.950	19.30	93.95	6.05
100	0.125	6.975	4.65	98.60	1040
200	0.075	0.525	0.35	98.95	1.05
pan	-	1.575	1.05	100	0.00

Table 1: Sieve analysis of the sand used

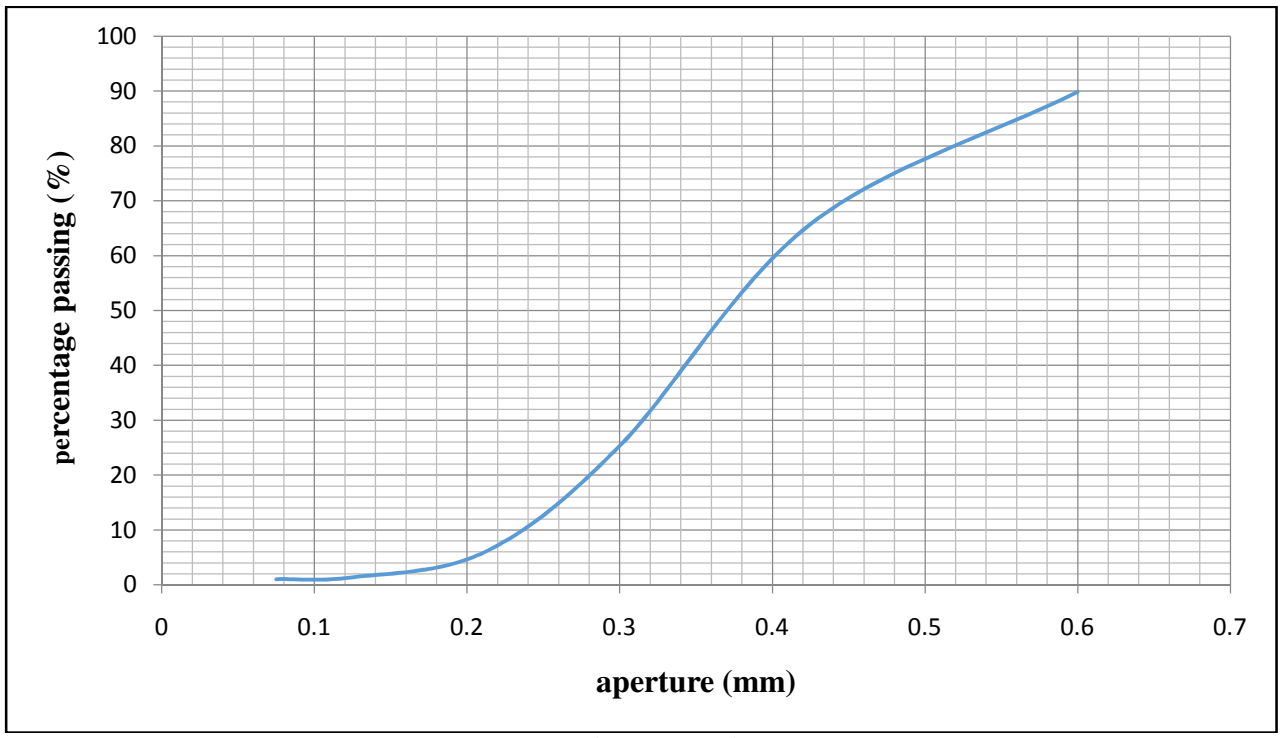

Figure 1: Particle Size Distribution Curve

Samples	A	B	C	D	E	F	G
Raw water	6	6	7	7	6	5	6
Filtered water	3	3	3	5	4	3	3

Table 2: Turbidity Measurement

Samples	A	B	C	D	E	F	G
Raw water	6.4	6.4	6.2	6.2	6.3	6.3	6.4
Filtered water	6.4	6.4	6.2	6.2	6.3	6.3	6.4

Table 3: pH Value Measurement

Samples	Coli form Count (MPN/100) ML		95% Confidence Limits			
			Raw water		Filtered water	
	Raw water	Filtered water	Lower	Upper	Lower	Upper
A	30	28	7	89	10	150
B	39	30	7	13	7	89
C	43	30	7	210	7	89
D	64	43	15	380	7	210
E	75	43	19	230	7	210
F	150	120	30	440	30	380
G	210	150	35	470	30	440

Table 4: Coli forn Count Measurement

4. Conclusion

Results of the foregoing research have indicated that, local sand can be use as a filter media, since the effective size of the sand was found to be 0.22 mm and uniformity coefficient is 1.93, which compares the values cited in the literature of 1.15 mm – 0.35 mm and 1.5 – 2.5 for effective size and uniformity coefficient respectively, by passing of raw water through the filter media there is considerable reduction of turbidity and coli form with insignificant changes in pH. As a result it will enable the setting up a slow sand filters in small community living in local areas along River Wudil, in setting up such facility, the usual media size/effective size of 0.15 mm – 0.35 mm and uniformity coefficient between 1.5 – 2.5 should always be use. This is because carefully graded media performed better in terms of turbidity and coli form removal. Disinfection process of the finally filtered water should also be employed as a measure of safety, judging from coli form count result obtained.

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