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LOCAL MATERIALS AS FILTER MEDIA IN NIGERIA

INTRODUCTION

For purely economic reasons, sand from the nearest river-bed to water treatment plants are being used as filter media. Besides, Nigeria is endowed with other materials which can be suitable as filter media. Examples of such material are bituminous coal, coke coal, and ceramics.

However little is known about the properties of these materials in their local form. In spite of this, local sand is being substituted for imported sand as filter media in many of the new treatment works.

The common practice is to determine the suitability or non-suitability of the sand simply on the basis of sieve analysis alone. This is definitely an insufficient basis to accept or reject any sand as filter media.

Even when the particular sand has been selected, the problem of operating the filter optimally arises because of the lack of sufficient knowledge of its characteristics.

The objective of the research project is to determine the suitability of any of the local materials, develop performance criteria through pilot plant studies and improve design and operation in order to meet the desired quality goals.

However in this paper, we will report the results of the studies conducted to determine the physical characteristics of the sample sand from various locations in the country, full-scale plant studies of the performance of a filter plant using local sand as media, and pilot plant studies to compare the performance of some of the local sand.

PHYSICAL CHARACTERISTICS

Some of the physical properties presently measured include percentage solubility, percentage usable, % too coarse, % too fine, specific gravity, size, fall velocity, sphericity. Others that need to be measured are filtrability index and

durability.

Table 1 shows the properties of the stock sand from a number of locations in the country. It can be seen that for most of the sample sand, their effective sizes lie outside the standard requirements of 0.35 - 0.70mm (1). The uniformity coefficient for a few of the sample sand falls within the acceptable range of 1.3 - 1.7 (1).

The obvious inference is that only a small percentage of the stock sand is directly usable as filter media. However in a country where labour is still relatively cheap, it may not be uneconomical to use the graded stock.

The percentage solubility of the samples is well within the specification and a lot of them were found to be clean.

The sphericity for most of the different sizes in each stock sand ranges from 0.4 to 0.8.

The values in the table represent the averages. They do not compare well with the value for Leighton Buzzard ($\psi = 0.85$) or NCB anthracite ($\psi = 0.7$) (2).

FULL-SCALE STUDIES

The 5.5mgd (25 l/d) Zaria water treatment plant commissioned in 1975 has been using the sand from the bed of river Galma as its filter media. The filter media consists of 24 inches (61cm) sand of 14 mesh - 25 mesh grading, 4ins (10.2cm) of coarse sand (6mesh - 14mesh), 10ins (25.4cm) of pebbles (6mesh - $\frac{1}{2}$ ").² The average filter flow rate is 2.2gpm/ft² (1.4mm/s).

The purpose of the full scale plant studies is to evaluate the performance of the filtration process over a period of time. The performance criteria include filtrate quality, Break through Index and head loss pattern.

For the periods of study, the effluent

Table 1: Properties of the stock sand

Sources	Specific gravity	P_{10}	$U = \frac{P_{60}}{P_{10}}$	Solubility %	ψ	$P_1\%$	$P_2\%$	$P_3\%$
Jibiya	2.62	0.17	3.41	0.2	0.6	28.0	52.2 d=0.48mm	80.2 d=1.25mm
Minna	2.66	0.22	2.50	0.3	0.57	80.0	42.0 d=0.48	NIL
Gora	2.54	0.34	4.41	0.3	0.63	30.0	15.0 d=0.43mm	45.0 d=1.0mm
Batsari	2.66	0.25	6.60	0.4	0.58	24.0	23.6 d=0.46mm	47.6 d=1.0mm
Lagos	2.75	0.22	1.82	1.4	0.53	20.0	78.0 d=0.5mm	NIL
Sokoto	2.71	0.30	3.33	0.2	0.53	42.0	17.9 d=0.47mm	59.8 d=1.0mm
Kaduna	2.64	0.30	1.77	1.1	0.51	60.0	49% d=0.48mm	NIL
Kwall	2.69	0.34	2.33	0.6	0.49	50.0	12% d=.45mm	62.0 d=1.1mm

P_1 = % Usable

P_2 = % too fine

P_3 = % too coarse

turbidity was consistently less than 1.0JTU averaging about 0.6JTU. The turbidity removal was usually about 90% just after backwashing declining to 60% just before the next backwashing.

Figure 1 is a graph of filter quality as a ratio of the inlet quality (C/co) with filter run time. The rise which is referred to as the filter breakthrough is terminated at value of 0.28. This is higher than the acceptable value of 0.2 for a 24ins filter depth (3).

Figure 2 shows the headloss pattern for a typical filter run. The graph is almost linear indicating that there is filtration (or clogging) with depth. This is a desirable phenomenon for deep bed filters.

The average breakthrough Index $K = 1.28 \times 10^{-3}$. It falls between the values for water receiving average

degree of pretreatment and high degree of pretreatment (4).

PILOT PLANT STUDIES

The purpose of the pilot plant studies was to compare the performance of the stock sand from river Galma with anthracite coal-sand media under both coagulated and uncoagulated influent water.

The studies was then extended to compare the performance of three sand samples which closely satisfy standard specification for physical properties (Zaria, Kaduna and bar beach, Lagos).

The pilot plant was set up at the Zaria water treatment plant.

The pilot filter containing the river Galma sand performed equally well as the dual media with the effluent turbidity much less than 1.0JTU for coagulated influent water. As expected the performance of both

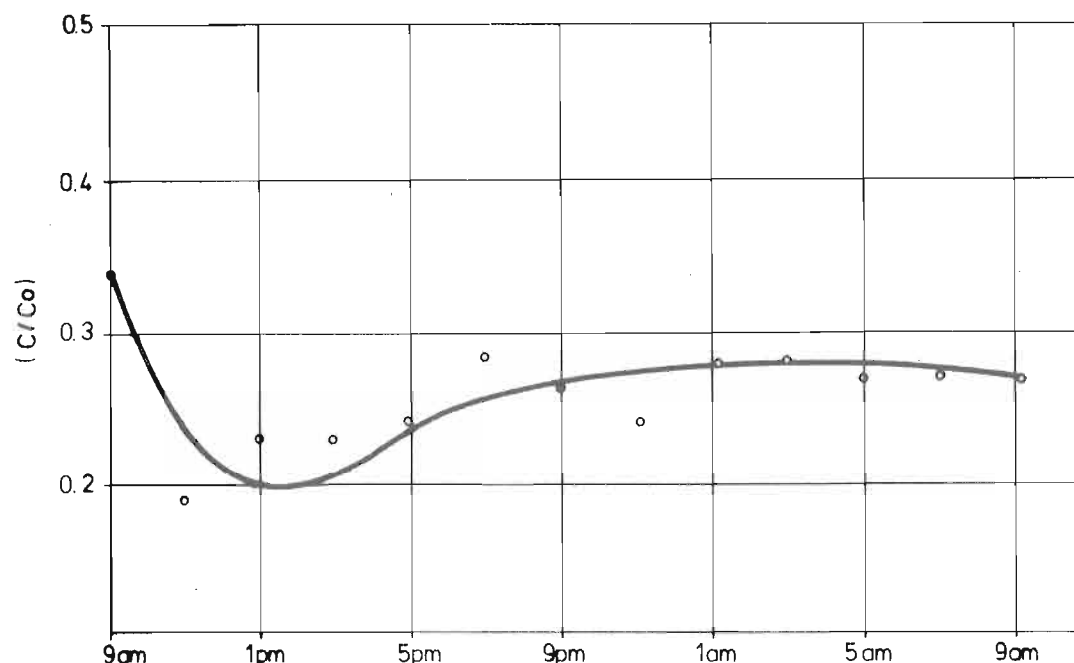


FIG. 1 FILTRATE QUALITY (C/C_o) VARIATION WITH TIME OF FILTER RUN.

filters were poor for uncoagulated influent water.

Figure 3 shows the headloss pattern for both pilot filters. Characteristically, the headloss developed by the dual media is lower, less rapid, and more linear. However the headloss pattern for the pilot filter is not different from that of the full scale.

The comparative performance studies clearly show that the Lagos bar beach sand and river

Kaduna sand perform better than the river Galma sand in terms of turbidity removal efficiency, filter run length time and head-loss development.

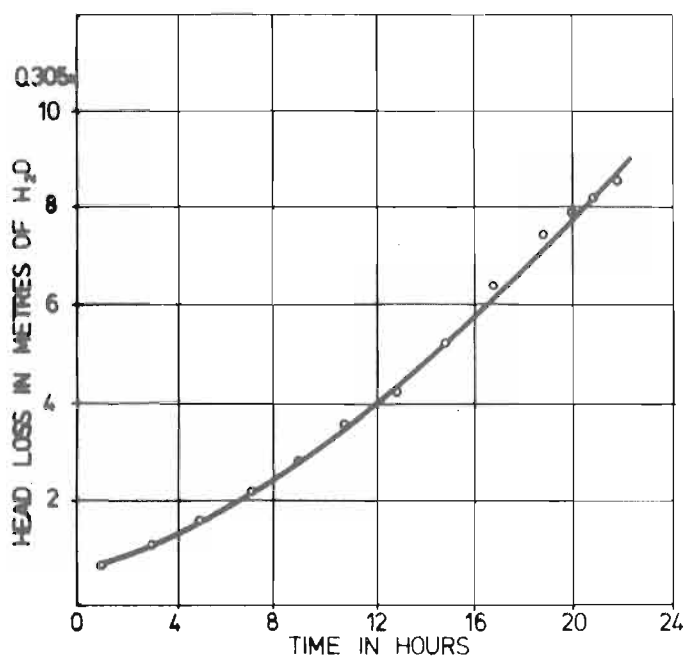


FIG. 2 HEAD LOSS VS TIME OF FILTRATION.

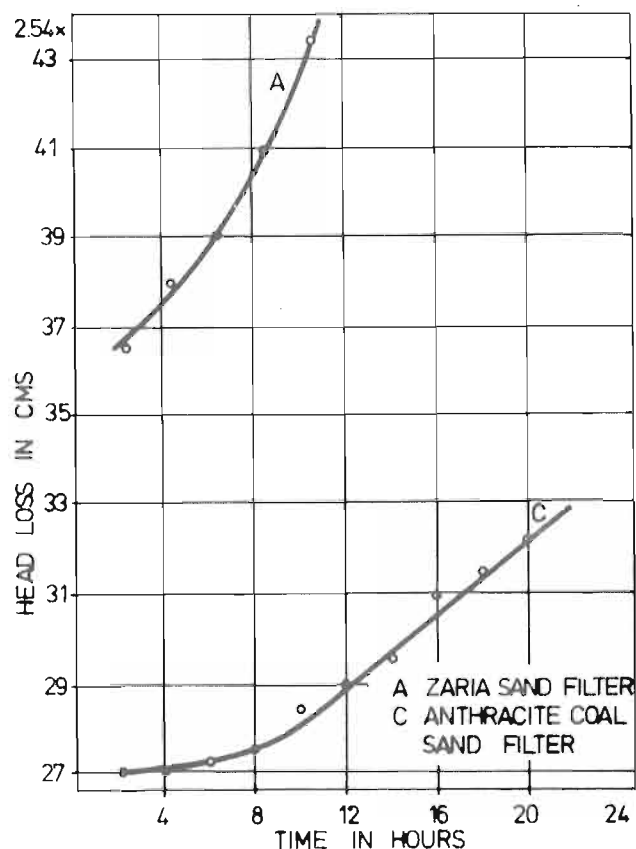


FIG. 3 HEAD LOSS VS TIME OF FILTRATION

CONCLUSION

The standard specification set for the various physical properties of a filter media can be met by the locally available sand even if it will require major regrading. But in a country with cheap labour, this may not be too uneconomical.

However the other aspect that is under active study is the modification that can be made to the present design criteria and standards (such as ideal filtration rate, optimum filter depth, type of flocculant and dosage) in order to make them more relevant to local materials, and conditions.

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