International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 03 , March 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

DESIGNING RAPID SAND FILTER BY USING COCONUT SHELL FOR A VILLAGE

Ansari Mubeshshera Awais[1], Pathan Needa Galib[2], Donde Swapnali Siddharth[3], Prof. Bhosale Chaitaniya[4]

[1,2,3] UG Student, [4]Asst. Professor, Department of Civil Engineering,
GGSCOE&RC Nasik, S. P. Pune University (India)

ABSTRACT

Areas of the developing world are populated with poor people unable to fulfill the basic needs for Clean water and India is one of them . Water treatment plant is being designed for proper filtration of water. Treating it properly after all treatment process or trying to manage the good condition in water. It has being planned to implement this design scheme in the village under the sanction of Village Panchayat and other govt.bodies.
Rapid sand filters are very common in all conventional water treatment plants. The major problem associated with it is stratification, which restrict the complete utilization of sand bed used. Higher filtration rates even can be achieved. However, the use of such techniques is limited in India due to unavailability of filter materials apart from sand. Capping of existing rapid sand filters can be the promising method of improving the performance of rapid sand filters. Capping is a process of covering the filtration media by appropriates caps such as Anthracite coal, Bituminous coal, Crushed coconut shells, etc. The attempt is made to study the effect of capping of RSF by the use of coconut shell as a capping media by pilot scale study. The pilot scale study has shown very encouraging results. Comparative study shown that higher rate of filtration is possible along with higher filter run and less backwash requirement.

Key words: Filtration, water quality, coconut shell, filter run, backwash requirement

I. INTRODUCTION

Water is the basic need of human being; hence the provision of clean water is an important issue to solve. Different areas has different problems and resources and one solution can't be applied to all, but in villages the water is often pumped from a nearby lake or from ground water and it is necessary to be treated.
The rapid rate gravity filter is commonly used in the treatment of surface water supplies. It consists of a structure to house the unit, the filter media, an under-drain system, a surface washer, and a waste disposal system. The filter area should be divided into at least two separate units to allow operational flexibility. Some form of pre-treatment of the raw water, such as sedimentation, is usually needed.
Most of the conventional water treatment plants are overloaded due to increased demand which highlights the need of higher filtration rate. Dual media and multimedia filters can overcome these limitations of rapid

IJARSE
ISSN (O) 2319 - 8354
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sand filters. Alternatively, higher filtration rates even can be achieved. However, the use of such techniques is limited in India due to unavailability of filter materials apart from sand. Capping of existing rapid sand filters is the promising method of improving the performance of rapid sand filters.

Capping is a process of covering the filtration media by appropriates caps such as Anthracite coal, Bituminous coal, Crushed coconut shells, etc. Capping involves the replacement of a portion of the sand with appropriate caps. Such an improved filter, though inferior to the originally designed dual media filter, is better than the conventional RSF from the point of view of the rate of filtration as well as total filter run. The proposed study was made to assess the use of coconut shell as a capping media.

II. OBJECTIVES OF STUDY

The objectives of the study were,

2.1 Designing and constructing pilot scale model of rapid sand filter and capped rapid sand filter using crushed Coconut shell as capping materials.

2.2 To compare the performance of conventional rapid sand filter and capped rapid sand filter on the basis of total length of filter run, quality of effluent produced and back wash requirement.

To fulfill the objectives following methodology was adopted.

3.1 A pilot scale model of filter was constructed using glass columns with an inside area of 0.15m X 0.15m along with associated piping and valves. The pilot model was installed at Ichalkaranji water treatment plant, where the clarified water was used for the performance evaluation of capped RSF and comparison of its performance was made with the conventional RSF performance.

3.2 The sand media of desired effective size and uniformity coefficient was prepared by sieving the washed and sun dried stock sand. The coefficient of uniformity of sand used was 1.7 and effective size was 0.6mm.

3.3 The crushed coconut shell was used as capping materials. The size was determined by considering the fact that the settling velocity of the finest sand particle to be more than the settling of capped media particles. The depth of capping was kept as 10cm. Coconut shells of required size and uniformity are obtained by crushing and sieving it. The crushed coconut shell was charged by heating before use. The coefficient of uniformity of capping media used was about 1 and effective size was 1.91 mm.

3.4 The filter runs were conducted for about 3 days. During this, samples of influent and effluent are collected from for the conventional pilot scale filter (RSF) and capped pilot scale filter and the turbidity of these were checked.

III. DESIGN OF FILTER UNITS (CONVENTIONAL RSF)

3.1 Design steps followed

a. Rate of filtration Assume rate of filtration as 180 lit/min/m^2

b. Quantity of filtered water required per hour

c. Filter area

IJARSE
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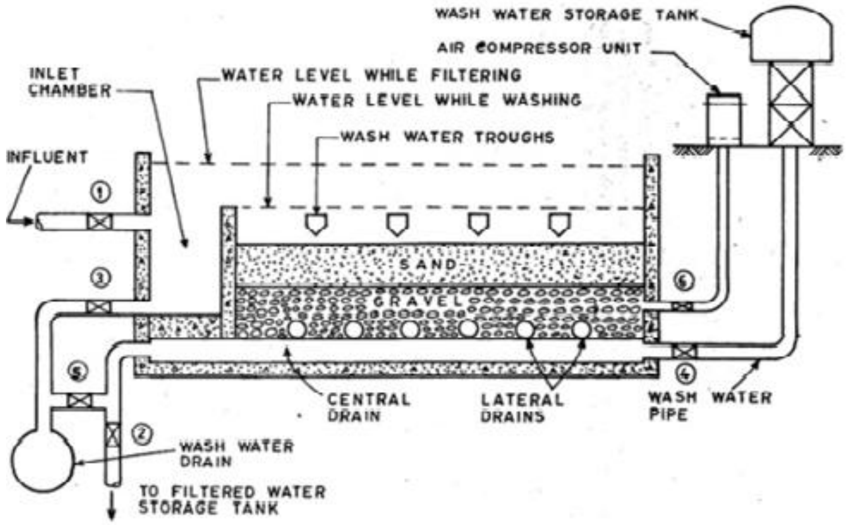

Fig.1

3.2 Estimation of sand depth

The depth of sand bed should be such that the flocs do not break through the sand bed .Normally the depth of sand varies from 60 to 90 cm .figure(ii) shows sand layer and gravel layer in a filter

Comparison of conventional R.S.F. and Capped R.S.F

Sr. no.	Parameters of comparison	Conventional R.S.F.	Capped R.S.F.(using 10cm coconut shell as capping)
01	Filter media	Sand (eff. Size 0.6mm, Cu-1.7,Depth-60cm)	Sand (eff. Size 0.6mm, Cu-1.7,Depth-50cm) Coconut shell(eff. Size 1.91mm)
02	Rate of Filtration	5m/hr	5 to 7m/hr
03	Filter Run	12 to 13.5 hr	22.5 to 23 hr
04	Period of Backwash	15min.	10min.

Table no.1

3.2.1 Design steps for estimation of sand depth

The depth of sand can be checked against break through of flocs through sand bed by calculating the minimum depth required by Hudson formula:

Q*D3*H/L = Bi*29323

Q = filtration rate in m3/m2/h

D = sand size in mm

H= terminal head loss in metres

L = depth of sand bed in metres

Bi = break through index whose value ranges between .00004 to .006 depending on response to coagulation and degree of pre-treatment in filter influent.

IJARSE
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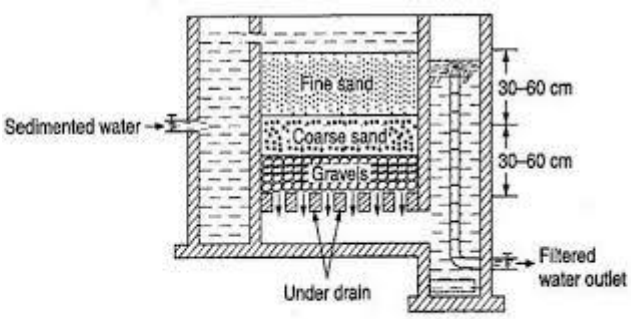

Figure(ii).shows different layers of the filter

Photograph of conventional sand media and capped sand media

3.2.2 Layer depth grade size

Top most layer 75 cm 2mm to 6mm

Intermediate layer 10cm 6mm to 10mm

Intermediate layer 10 cm 10mm to 20mm

Bottom layer 10 cm 20mm to 50mm

3.3 Wash water troughs and central gullet

Wash water troughs are provided at the top of filter to collect back wash water after it

emerges from the sand bed and to conduct it to the wash water gullet or drain.They are C.I. or R.C.C troughs spanning across the width or length of the tanks. The bottom of the trough is kept above the top of the expanded sand to prevent possibility of loss of sand during backwashing .At the same time the upper edge of the trough should be placed sufficiently near to the surface of sand so that a large quantity of dirty water is not left in the filter after completion of washing .The trough should be large enough to carry all the water delivered to it with F.B. of 6 to 8 cm. Any submergence of the gutter will reduce the efficiency of the wash. The bottom of the trough is kept at least 5cm above the top level of sand .The spacing of wash water troughs is kept between 1.5 to 2 cm.figure(iii) shows the arrangement of wash water trough in rapid filters.

IJARSE
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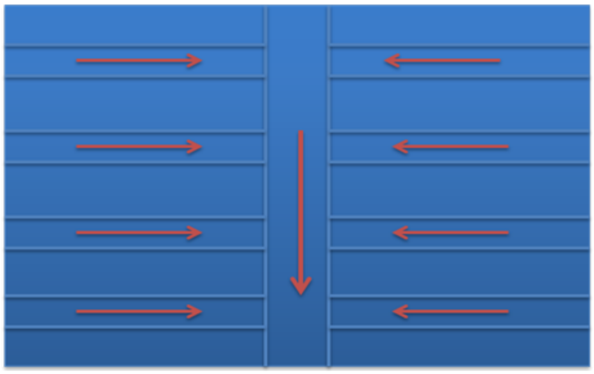

Figure (iii) Arrangement of wash water trough

3.4 Design of under drainage system

The under drainage system serves the following purposes-

1. Collects the filtered water uniformly over the gravel bed

2. Provides uniform distribution of backwash water without disturbing or upsetting the gravel bed and filter media. There are many types of under drainage systems, but in this programme.

Perforated pipe system has been designed. Also the **pipe and the strainer** system has been discussed in the following page. Figure (iv) in next page shows the view of rapid gravity filter with the under drainage system. General rules considered in the under drainage system:

1. Ratio of length to diameter of laterals should not exceed 60.Spacing of laterals should be between 150 to 300mm

2. Diameter of perforation in the laterals should be between 5 to 12mm.

3. Spacing of perforation varies from 80mm to 200mm.

4. Ratio of total area of perforations in the under drainage system to the total cross-sectional area of laterals should not exceed 0.5 to 0.25

5. Ratio of total area of perforations in the under drainage system to the entire filter area may be as low as 0.002 to 0.003

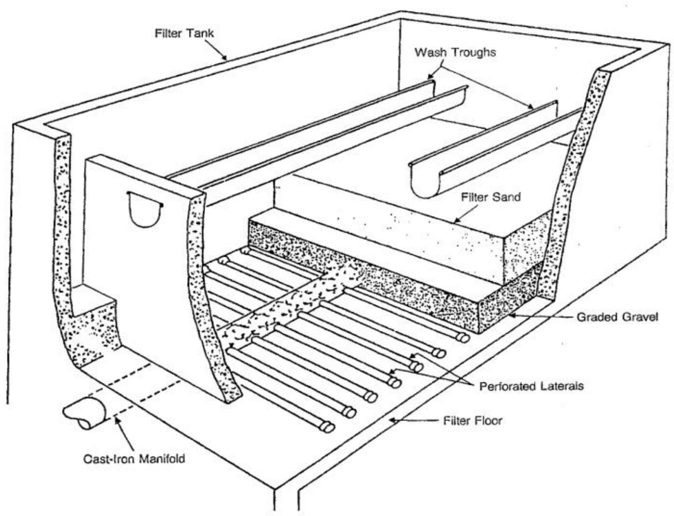

Figure (iv) Cross section of the rapid gravity filter showing the various parts

IJARSE
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IV. BACKWASHING OF FILTER

Backwashing a drinking water filter system means reversing and increasing the flow of water to flush out accumulated debris and particles. Backwashing is not only vital to the life of a filter, it is fundamental to the quality of water coming out of the filter. Sooner or later, all filters need to be backwashed or replaced.

Back-washing time in minutes	Conventional RSF		Capped RSF		Remark
	Turbidity of back wash influent (NTU)	Turbidity of Back wash effluent (NTU)	Turbidity of influent (NTU)	Turbidity of effluent (NTU)	
0	2.9	63	3.2	68	
5	2.9	39	3.2	20	
10	2.9	21	3.2	3.2	Backwash completes for capped RSF.
15	2.9	3.0	--	--	Backwash completes for conventional RSF.

Table no.2 Backwash period

4.1 Filter troubles

Some of the potential filter troubles are as follows:

1. **Cracking and clogging of filter bed** :Surface cracking and clogging are usually caused by rapid accumulations of solids on the top surface of the filter media. The formation of soft, gelatinous coatings on the sand grains tends to form cracks in the filter, as the head loss is increased. The effect is that it permits the dirty matter to penetrate into the filter media.

2. **Formation of mud balls**: Mud balls are conglomerations of coagulated turbidity, floc, sand, and other binders and are formed near the top of the filter media. Mud balls are formed due to insufficient washing of sand grains. Mud may accumulate on the sand surface and may form a dense mat. A 50 % expansion of the sand in washing is effective in minimizing the production of mud balls.

3. **Air binding:** The condition of air binding is caused by the release of dissolved gases and air from water , to form bubbles. These air bubbles occupy the void space of the filter media and the drainage system Air binding may be minimized by providing a water depth of at least 1.5 m above the unexpanded filter bed.

5. **Jetting and sand boils**. Jetting and sand boils result during backwashing when back wash water follow path of least resistance and break-through the scattered points due to small differences in porosity and permeability of sand and gravels.

4.2 Performance of rapid sand filter

1. **Turbidity**: If the influent water does not have turbidity of more than 35 to 40 ppm, the filter can reduce the turbidity to less than 1ppm.Since coagulation and sedimentation always precede filtration, the turbidity of water applied to filter is always less than 35 to 40 ppm.

2. **Colour:** Rapid sand filters are very efficient in colour removal .The intensity of colour can be brought down below 3on cobalt scale. Colourless water can be produced by rapid filtration after the addition of polyelectrolyte..

IJARSE
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3. **Iron and manganese**: Rapid filters remove oxidized or oxidizing iron, though it is less efficient in removing manganese.

4**. Taste and odour**: Unless special treatment such as activated carbon or prechlorination is provided, rapid filters will not ordinarily remove tastes and odours.

V. CONCLUSIONS

From the study made to evaluate the effect of capping of RSF following conclusions were made;

a) The capping of RSF using the crushed coconut shell as capping media can increase the filter run by about 80%.

b) Higher rate of filtration can be obtained after capping without much effect on the filtrate quality.

c) Backwash requirement for capped RSF is less as compared to conventional RSF by 33%.

d) Capping of conventional RSF can be very effective tool in case of overloaded conventional plants where higher rate of filtration can be possible without much modification.

FUTURE SCOPE

Capping with coconut shell proves very effective in improving performance of rapid sand filter in pilot scale. This material should be tested for full scale plant to access its suitability for mass scale filtration. Use of filter with coconut shell as capping media for longer period will give better

V. ACKNOWLEDGEMENT

The work produced in this report would not have been completed without the encouragement and support of many people who gave their precious time & encouragement throughout this period. We would like to sincerely thank our project guide **Asst. Prof. C.D.Bhosale** for the patience he showed during the process of preparation of project from initial conception to final design & construction. We would also like to extend our gratefulness to the head of department **Prof. Dadasaheb. O. Bhavar**. We would also like to thank the teaching & non-teaching staff. We would also like to express sincere gratitude towards the core of our heart principal **Dr. S.D. Kalpande** for being supportive and always encouraging. Last but not the least, the backbone of our success and confidence lies solely on blessings of our friends and parents.

REFERANCES

[1] Nelson O. Fred, "*Capping Sand Filters*", Journal of American Water Works Association, Vol. 61, Issue 10, p. 539-540, 1969.

[2] Punmia B.C., Jain A.K. and Jain A.K., "*Water supply engineering*", 2e, Dhanpat Rai Publishing Co., New Delhi. 1995.

[3] Qasim, S.R., Motley E.M., and G. Zhu, "*Water Works Engineering"*, PHI private ltd, 867-949, 2002.

[4] Seckler, D., Barker, R., and Amarasinghe, U. (1999) "Water Scarcity in the Twenty-First

[5] Century," International Journal of Water Resources Development, Vol. 15, No. 1-2, pp. 29-42.

[6] Design of water treatment plants by Dr.A.G,Bhole/Indian water works association/Nagpur centre.northambazari, near Shankar nagar square, Nagpur-440 010.