International Journal For Technological Research In Engineering
Volume 4, Issue 12, August-2017 *ISSN (Online): 2347 - 4718*

MODIFICATION IN RAPID SAND FILTER WITH COCONUT SHELLS AS CAPPING MEDIA

Snehal N. Chaudhari[1], Kalyani A. Bogawar[2]
[1]Assistant Professor, [2]B.E Student, Dept of Civil Engineering, K.K.Wagh College Of Engg, Nasik, India

ABSTRACT: Filtration is the important process in water treatment. It removes the particulate and other suspended impurities from water passing through filter media. Conventionally, Rapid Sand Gravity Filtration is preferred in India because of its easy operation and better results. The major problems associated with it are stratification, mud ball formation and more backwashing requirements. Hence we studied the performance of Dual Filter over the conventional Rapid Sand Filter where Capping of Crushed Coconut Shells is used as dual media. Both the conventional and alternative filter models were prepared and tested experimentally, comparing for their efficiency and quality of filtration. Designing 'Dual Media Filter Capped with Crushed Coconut Shells' proves to be more efficient, economical and durable. It improves the performance of filter in terms of high filtration rate, increased filter run, considerably reduced backwashing requirements, high turbidity removal and thus making it more applicable.

Keywords: Modification in rapid sand filter, Capping, Coconut Shell, Turbidity, Water Treatment.

I. INTRODUCTION

Conventional filtration, the traditional design for many years, provides effective treatment for just about any range of raw-water turbidity. Its success is due partially to the clarification that precedes filtration and follows coagulation and flocculation. Clarification includes any solid/liquid separation process following coagulation, where accumulated solids are removed. Clarification, if operated properly, should remove most of the suspended material. After clarification, the water passing through the filters should not have any turbidity higher than 40-50 Nephelometric Turbidity Units.

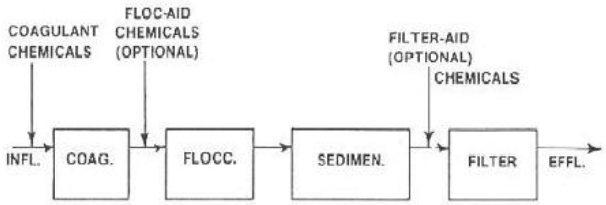

Fig1. Conventional filtration

Though slow sand filter has a lot of advantage and good for rural water treatment plant, the greatest disadvantage of the slow sand filter is that it needs to have a large space of its installation. Considering the future demand of water and the space required for other attached equipment for water Purification, 2000 m2 would be necessary so it would be too costly to follow the slow sand filtration method, so the rapid sand filtration has been put to use. Rapid Sand Filter has five essential parts such as enclosure tank, under drainage system, base material, filter media of sand and appurtenances. The functioning of the parts is as follows:

1. Enclosure tank - By using either of masonry or concrete a water tight tank is constructed with the surface area of tank varies between10 m2 and 50 m2 and the depth between 2.5 m and 3.5 m. These units are arranged in series.
2. Under drainage system - The most commonly used system are perforated pipe system, pipe and strainer system.
3. Base material - On the top of under drainage system, the base material is placed. The size of gravel varies between 3mm and 6mm in the top layer to 20mm to 40mm in the lowest level. The total depth of gravel is about 600mm.
4. Filter media of sand - The layer above of gravel, the sand is placed. The depth of sand layer is from 600mm to 900mm. The size of sand particles varies between 0.35mm and 60mm.
5. Appurtenances - Additional devices like air compressor, wash water troughs and venturi rate controller.

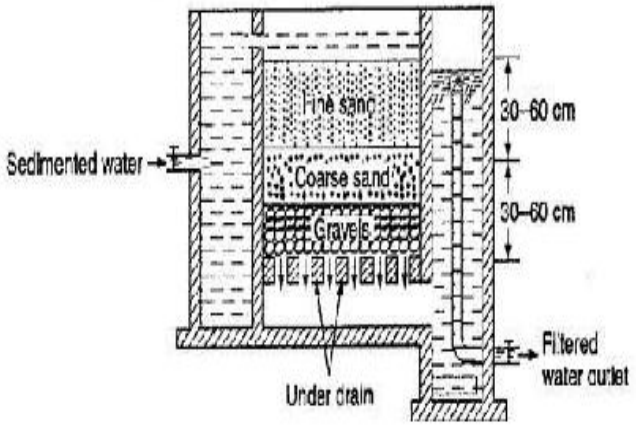

Fig2. Rapid Sand Filter

Rapid Sand Filter with a capping media operates at three-to-four times the rate of rapid sand filters, uses a combination of filter media. It consists of layer of coarse media
of crushed coconut shell at the top of the fine sand in the filter beds. In order to tackle some additional flock loads as compared to clarified water through conventional treatment unit, dual media filter beds can be used.

1. Design aspects of Dual Media Filter -The filter media consists of crushed coconut shell coarse media with effective size of 4 mm sieved through respective sieves.
2. Theory behind the Dual Media Filter - The theoretical aspects in design of dual media filter or multimedia filter is that the dual media filter with use of coarse size media at the top of fine sand media increases particulate storage capacity in the filter bed.

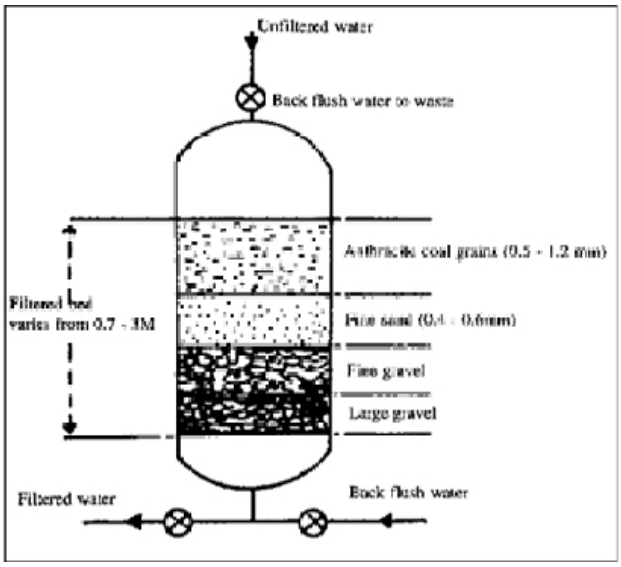

Fig3. Dual Media Filter

II. LITERATURE SURVEY

Introducing and filter capping for turbidity removal for potable water treatments plant of mosul/Iraq - This paper proposes sand filter capping technology in which the top portion of a rapid sand filter is replaced with anthracite coal in order to achieve the improved performance if introduced in water treatment plants. Improved rapid sand filter for performance enhancement –This paper focuses on a cheaper and easily available capping material for better operation of rapid sand filtration. So in these work PVC granules are used to check its suitability.

III. OBJECTIVE

Our objective is to achieve improved quality of filtration. We are interested in preparing alternative to the conventional filter design so that it can remove disadvantages of commonly used RSF in more efficient and economical way. This project leads the below objectives –

- To suggest more efficient filter design.
- To remove turbidity effectively.
- To increase filtration rate and run time.
- To reduce backwashing requirement.
- To provide economical method for purification of water.
- To compare performance of Dual Media Filter over conventional rapid sand filter.
- To check efficiency of Capping of Crushed Coconut Shells as dual media.
- To make use of largely easily and naturally available material like coconuts in filtration.
- To check quality of water and its pollution extent on basis of parameters such as pH, turbidity, hardness, bacterial measures.
- To study and suggest various applications of Capped dual media filters with coconut shells for all possible outcomes.

IV. METHODOLOGY

1. Highlights of project work –

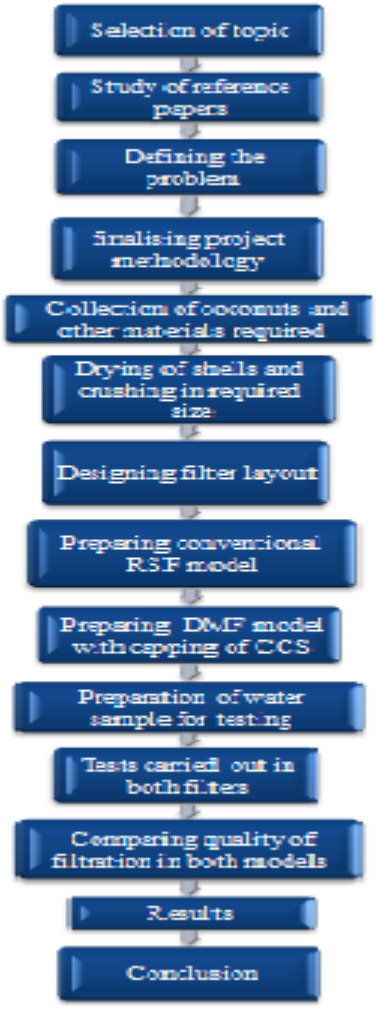

Fig3. Highlights of project work

2. Materials –

- Sand – The standard sand in laboratory is used as a filter sand. It features for angularity, size, sphere shape parameter and hardness for the most efficient filtering of water. The filter sand is first washed, dried and then screened by sieve analysis.
- Gravels - Filter gravel is used as a support media to Filter sand and coal in water filters. For maximum efficiency, filter gravel must possess the necessary attributes of hardness and be rounded rather than angular. The filter gravel like filter sand, contains hard durable particles with a slow breakdown rate. This helps to prolong filter media life.
- Coconut shells - The coconuts about two sacks full are collected and cut. Afterwards they are sundried for one month and then sized in pieces manually by hammer. These particle shells are then topped as capping above sand bed.

3. Development of models -

Two working model of 'The conventional rapid sand Filter (model 1)' and 'Coconut shell capped

dual media filter' is respectively prepared. It proceeds as below –

Sieve Analysis –

Sieve analysis for stratification in conventional rapid sand filter helps to determine the particle size distribution of course and fine aggregate. This is done by sieving the aggregates as per IS: 2386 (part1) – 1963. Different sieves as standardized by IS code are used. Aggregates are sieved through them and collected different size particles left over different sieves. A set of IS sieves of sizes 40mm, 20mm,9.5mm, 4.75mm, 2.36mm,1.18mm, 600micron, 425micron, 300micron is used for sieve analysis. 300micron, 425micron and 600micron are used for fine aggregates. For course aggregate sieve sizes used are 20mm and 9.5mm. The aggregates retained on sieves are thoroughly washed to remove silt and then allowed to dry in sunlight. Sieve analysis helps to achieve proper gradation of particle size in bed layers.

Fig 4. Sieve analysis for fine and coarse aggregates

Filter Design –

The filter designed is the cylindrical shaped column resting on tripod provided with the pipe fittings is required. The dimensions are as follows –

1.Height of filter is 45 cm.
2. Diameter is of 30 cm.
3. Volume i.e. capacity is 20 liters.
4. Size and depth of bed layers.

Serial no.	Aggregate type	Size	Thickness	
1	Coarse aggregate	20 mm	8cm	Model 1 & Model 2
2	Coarse aggregate	9.5mm	7cm	
3	Fine aggregate	600 micron	5cm	
4	Fine aggregate	425 micron	5cm	
5	Fine aggregate	300 micron	5cm	
6	Crushed coconut shells	4-6 mm	5 cm	Additional layer for model 2

Fig 5. Size and thickness of layer

Layout of Filter –

Different parts of filter layout are discussed with respect to their construction, purpose and working as below :

a)Under Drainage: The filtered water is taken out from rounded drain pipe provided at bottom of the filter.

The reduced diameter of filter at bottom is fitted with net at outlet of filter under the sand layers.

b) Overflow pipe: At the top of filter beds, board pipe is fitted to overflow the backwashed water after backwashing.

c) Side Tube: To know and measure the head loss during the working operation of filter, the vertical side tube is attached in design. It is kept transparent to make the head of the water in filter visible.

d) Tjunction: T junction is provided between drain pipe and side tube of filter. The fittings and connections are made such that the filtered water and backwashed water should not be interfered during backwashing. Also during filtration processing water should enter the side tube to avail head loss measurement. While backwashing, the reverse water flow must not be entered in side tube hence T junction is provided to close its approach.

e) Supporting stand: The whole working model of filter designed is supported on the tripod stand on some height from ground.

f) Finally the working of model is ensured by pouring sample water through layers until clear water is received.

V. EXPERIMENTAL TEST RESULTS

Tests are carried out with three samples accordingly as initial turbid samples, samples of water filtered from conventional rapid sand filter and sample of water filtered from coconut shell capped dual media filter.

Test results are as follows:

Sr. no.	Parameters	Initial sample	Conventional Rapid Sand Filter(Model 1) sample	Capped Dual Media Filter (Model 2) sample
1	Colour	Muddy	Colourless	Colourless
2	Odour	Odourful	No odour	No odour
3	Turbidity	40-50 NTU turbid water	About 50% turbidity removed	About 96% turbidity removed
4	Hardness	Hard water	Moderately hard water	Moderately hard water
5	pH	Desirable pH	Desirable pH	Desirable pH
6	M P N	High Bacterial count	High Bacterial count	High Bacterial count
7	Filtration rate	-	750 lit/hr	1500 lit/hr
8	Head loss	-	Large head loss	Comparatively less head loss
9	Backwashing requirement	-	Half an hour per day	Half an hour per week
10	Filter run	-	Less	Comparatively high
11	Efficiency		Less	High
12	Economy	-	Less economical	Economical
13	Ecofriendly	-	No ecofriendly	Ecofriendly
14	Durability	-	Less durable	More durable

Fig 6. Summary of experimental analysis

VI. CONCLUSION AND FUTURE WORK

Dual media filter proves to be better alternative for filtration units in treatment plant. Use of coconut shells as double media other than sand in filter adds qualitative features to conventional rapid sand filters. The effective depth of 5-6 cm of capping layer of shells having particle size of 4 mm gives efficient filter design. It facilitates main purpose of turbidity removal upto 96%, twice filtration rate, reduced head loss, removal of operational troubles like stratification, mud ball formation ,sand leakage and also backwashing requirements are reduced highly, thus reducing costs of maintenance as well as saves large quantity of filtered water to be wasted for backwashing. The concern filter model improves quality of filtration with respect to parameters such as colour, odour, turbidity and hardness. Our future scope includes to improve the quality of filtration with respect to bacterial measures.

ACKNOWLEDGEMENT
The authors feel a deep sense of gratitude to Prof. Dr. P. D. Jadhao HOD of Civil Engineering Department for his motivation and support during this work. The authors are also thankful to the Principal, K.K.Wagh College of Engineering and Research, Nasik for being a constant source of inspiration.

REFERENCES

[1] S. M. Al-raw, Introducing and filter capping for turbidity removal for potable water treatment plants of mosul/Iraq.
[2] Andrew Wt Wong, University Of Waterloo, Monica B. Emelko, Ph.D., University Of Waterloo, Timothy Walton, Simple filter capping approaches for enhancedbiological filtration performance.
[3] RanjeetSabale, SahilMujawar, Improved rapid sand filter for performance enhancement.
[4] Shilpa S. Ratnoji,Nimisha Singh, A study of Coconut shell - activated carbon for filtration and its comparison with sand filtration.
[5] K. Gunasekaran, P. S. Kumar, M. Lakshmipathy, Mechanical and bond properties of coconut shell Concrete.
[6] Dr. K. Mahammad Rafi, T. Ramachar, Dr. M. Umamahesh & Mr. B.Arun, Fabrication & testing of rapid sand filter equipment.

