A Review on study performance of rapid sand filter using coconut shell

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Abstract*: The Rapid Sand Filter beds are suffering from the problems like Mudball formation, and unsatisfactory effluent. Dual Media and multimedia filters can overcome the limitations of RSF. Capping of Crushed Coconut shell is used as a Dual Media. Designing Dual Media Filter Capped with Crushed Coconut Shell proves to be more efficient, economical, and durable. The sample was collected from the nearby lake which was highly turbid and had a high amount of total solids. A Fabricated model was prepared to have dimensions of 0.5x0.5x0.9m. Gravel, Sand, and Coconut shell were filled in the model in a layer of size 20cm, 15cm, and 20cm respectively. The tests which are conducted on the sample are pH, Turbidity, BOD, and Total solids. It improves the performance of a filter in terms of high filtration rate, high turbidity removal, and high decrease in the percentage of total solids and thus making it more applicable. This filter media reduces about 90% of turbidity. The total solid was decreased by about 89%. In India, the quality of raw water available for drinking purposes varies significantly resulting in modifications to the conventional water treatment scheme consisting of aeration, chemical coagulation, flocculation, sedimentation, filtration and disinfection. Different alterations in these stages could lead to improvised levels of water quality. A novel solution to reinstate the sand filtration process is by utilizing activated carbon (AC) derived from coconut shells. A pilot-scale study of filtration units with different grades (on size basis) of coconut shell activated carbon (CS-AC) such as WTD816, WTE830 and WTE124wase were carried out. These ACs were assembled at different depths independently as well as in combination. This work examined the reduction and removal of iron, turbidity, biochemical oxygen demand (BOD), and chemical oxygen demand (COD) in river water by making different arrangements of CS-AC in the filtration unit. Also its comparison with sand, conventional practice in water treatment plants in India was done to reduce these parameters.

***Keywords*: Rapid sand filter, Coconut shell, Filtration, Turbidity, pH, BOD, Total solids.**

1. INTRODUCTION:-

Filtration is a widely used process for removing fine particles from water. Almost all conventional Surface water treatment facilities and some Groundwater treatment facilities make use of Rapid Sand Filter. A rapid sand filter is commonly used in the treatment of surface water supplies. Some form of pre-treatment of raw water, such as sedimentation, is usually needed. Most conventional water treatment plants are overloaded due to increased demand, which highlights a higher filtration rate. Dual media and multimedia filters can overcome this limitation of RSF alternatively higher filtration rates even can be achieved. However, such techniques are limited in India due to the unavailability of filter materials apart from the sand.
Capping covers the filtration media with appropriate caps such as anthracite coal, bituminous coal, and crushed coconut shell. Capping involves the replacement of a portion of sand with appropriate caps. The Proposed study was made to assess the use of Coconut shells as a capping media. Coconut shells are easily available and it helps to tackle some additional flock loads. It improves the quality of filtration concerning bacterial measures.

2. LITERATURE REVIEW:-

FARJANA.N et al. (2012) studied the effect of the capping of RSF by the use of coconut shells as a capping media in a pilot-scale study. This study has shown that rapid sand filters are very common in all conventional water treatment plants. The major problem associated with it is stratification; it restricts the complete use of the sand beds. Almost all raid sand filter beds are suffering from problems like high backwash water requirement, unsatisfactory Effluent, and mudball formation. A pilot-scale model of the filter is constructed using glass columns with an inside area of 0.15m*0.15m along with piping and valves. The coefficient of uniformity of sand used was 1.7 and the effective size was 0.6mm. the coefficient of uniformity of co-efficient of uniformity of capping media used was about an effective size of 1.91mm. Capping is the process of covering the filter media by caps of crushed coconut shell, bituminous coal, anthrax file, etc. higher rate of filtration is possible along with less backwash requirement and higher filter run. Backwash requirement for capped RSF caps is less as compared to conventional RSF by 33% .crushed coconut shell as capping media can increase the filter run by 80%.

MISHA SINGH[2]et al. (2015) studied two pilot filter columns. One is conventional RSF and the other is capped RSF. The conventional filter has sand as filter media; capped RSF has PVC granules as filter media. Conventional rapid sand filters and capped rapid sand filters are compared. Sand media having characteristics as effective size (E.S.-0.35 to 0.60mm),uniformity co-efficient (U.C.-1.30 to 1.70),specific gravity -2.67, limiting head loss-1.80 to 3.0m,depth of sand - 60cm,depth of gravel support - 40cm, etc. Rapid sand has many advantages like easy operation, more filtration rate, easy backwashing, and output. Due to improper

backwashing, a major problem shown in the filter media is mud-ball formation. Stratification of sand media takes place at the time of the backwashing process. Sand grains having a small size come at the top layer, reducing the porosity. The filtration process is affected due to the increase in head loss in a shorter run time. Mapping of a rapid sand filter is suggested by the researchers to overcome these problems. Capping is the process in which the upper sand bed layer is replaced with a few centimeters of capping material. capping proves an efficient technique for improving the performance of RSF. Capping with PVC granules with 3cm depth gives turbidity removal up to 92%.

ANSARI MUBESHSHERA AWAIS et al.(2017) attempt is made to study the effect of capping off the pilot SF by the use of coconut as a capping media in a pilot-scale study. The pilot-scale study has shown very encouraging results. The comparative study showed that a higher rate of filtration is possible along with higher filter run and less backwash requirement. Topmost layer 75cm 2mm to 6mm to 10mm. Intermediate layer 10cm 10mm to 20mm. The bottom layer is 10cm 20mm to 50mm. capping with coconut shell proves to be very effective in improving the performance of RSF on a pilot scale. The use of a filter with coconut shell as capping media for a longer period will give better efficiency. The backwash requirement for capped RSF is less compared to conventional RSF by 33%. A higher rate of filtration can be obtained after capping without much effect on the filtrate quality. Capping of RSF using the crushed coconut shell as capping media can increase the filter run by about 80%.

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3. MATERIALS AND METHODOLOGY:-

In this chapter, testing facilities, experimental procedures, and experimental programs are included. The design of the experimental setup is done based on the basic design of rapid sand filtration. As per the literature review, the design for set-up is done.

Materials:

Gravel

1] Gravel:

Gravel which is retained on 4.75mm has been used as supporting media for the sand layer. The depth of the gravel layer in the filtration units is 20cm. The gravel was washed and oven-dried thoroughly before using as the supporting filter media layer.

2] Sand:

sand

River sand having a uniformity coefficient of 1.7 and an effect size of 0.60mm is used as filter material. The sand was washed clean, sun-dried, and oven-dried before using as filter media. The depth of the sand layer maintained in the filtration unit is 15cm.

Crushed coconut shell

3] Crushed coconut shell:

Crushed coconut shells having an effective size of 1.91 mm were used as capping media above the sand layer. crushed coconut shells were placed in layers above the sand as capping. The depth of the coconut layer infiltration unit was 20 cm. Coconut shells were crushed into pieces manually using a rammer and then thoroughly cleaned before using it as capping. Crushed coconut shells were washed and oven-dried for 24 hrs.

4] Fabrication of model:

Project work was carried out in the Environmental Engineering lab, STJIT College of engineering. Glass fiber sheet of Thickness 3mm was cut as per the design. A pilot-scale of size 0.5mx0.5mx0.9m is fabricated using a fiber sheet. an outlet is provided at the bottom for the collection of filtered water. A tap is attached to the outlet opening for controlling the filtration rate. Necessary care has been taken to make the model watertight.

Study Area:

The Sample was collected from the **Dhor** district **Neera river** (412102). The sample collected was turbid. The sample was collected in water bottles. The water was transported from the river to the environmental engineering laboratory and necessary tests were conducted. The water sample was bought to the laboratory and it was kept in large containers for the sedimentation process with a detention period of 3-4 hrs. The supernatant water was collected and then passed through Rapid Sand Filter.

5. Methodology-

The following procedure was adopted for conducting the test.

A filter layer consisting of a gravel bed of 20 cm thickness, a sand layer of 15 cm thickness, and a crushed coconut shell layer of 20 cm thickness was spread in the filter unit. The water obtained from the river is stored in a large container for a detention period of about 3-4 hours. The supernatant water after the sedimentation process was passed through a rapid sand filter. Influent water is fed into the filter with the help of a dispenser of 20liters capacity that has been placed well above the filter unit.

Ahead of water above the filter media in the filtration unit of 10 cm was maintained throughout the test period. the raw water was fed to the filtration unit continuously through a dispenser placed above the filtration unit. Effluent samples were taken at a frequency of every 1 hour. These samples are tested for turbidity, pH, total solids, and BOD. The experiment has been carried out for up to 8 hours. The following procedures were adopted to test the water sample in the laboratory.

Fig 2: Experimental setup in the laboratory.

4 PERFORMANCE ANALYSIS

4. Results and Discussion:-

The result obtained during the sampling was as follows:

During the Filtration process of Influent and Effluent water, the sample was tested for various Parameters like Turbidity, ph. Total Solid, and BOD. Every 1 hour during the filtration process the Effluent samples were collected and tested.

Table-1: Turbidity values from hour to hour

Sr. No.	Time in hour	Turbidity
1	1	8NTU
2	2	8 NTU
3	3	8 NTU
4	4	7 NTU
5	5	6 NTU
6	6	4 NTU
7	7	4 NTU
8	8	2 NTU

Chart-1: Typical Graph differentiating the Influent and Effluent turbidity.

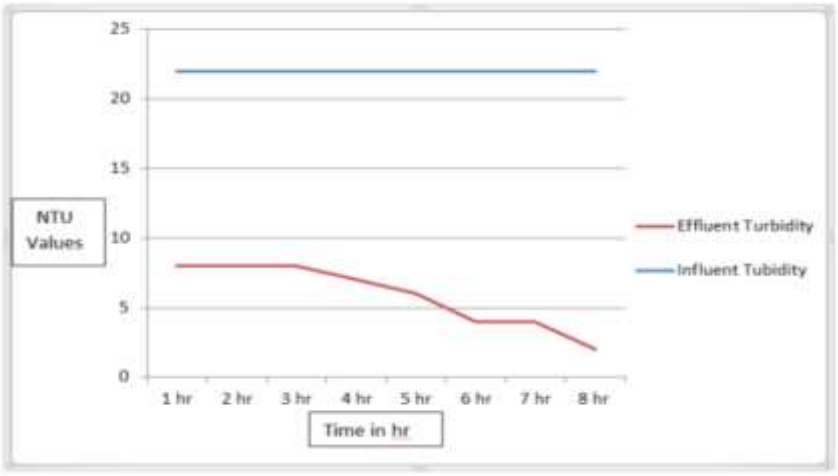
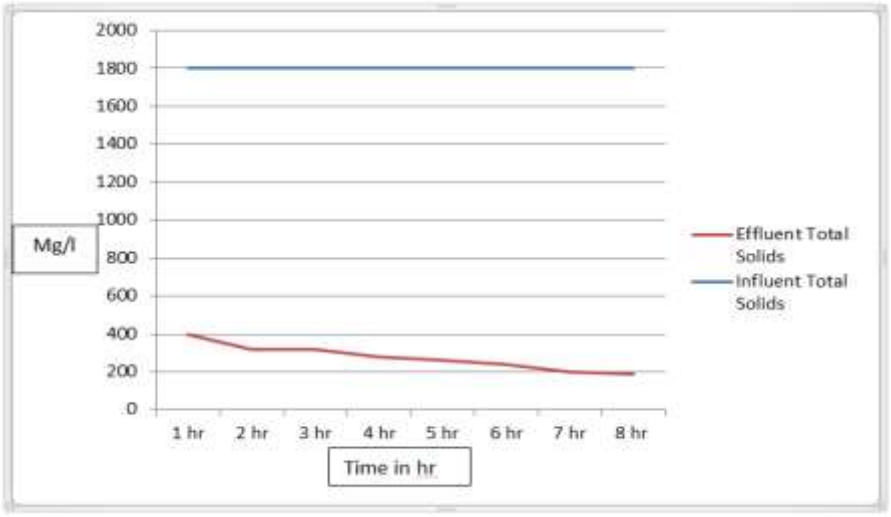


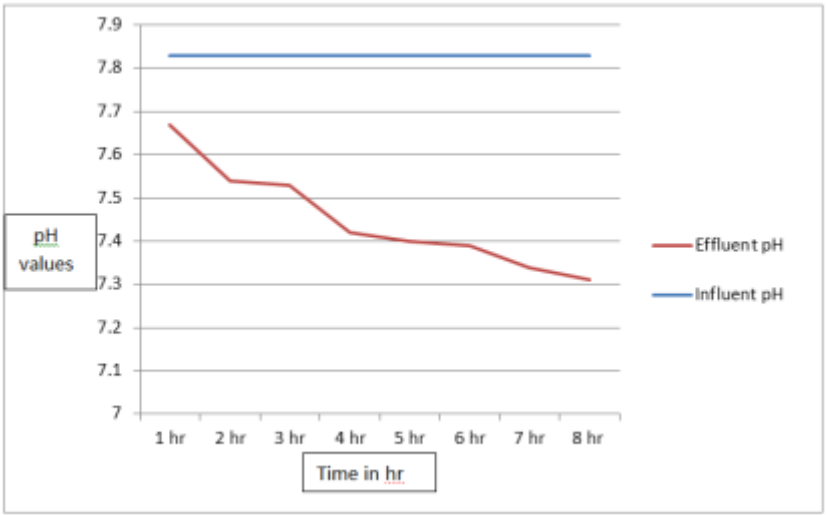
Table-2: Total solids values from hour to hour



`	Time in hr	Total Solids Values
1	1	400 mg/l
2	2	320 mg/l
3	3	320 mg/l
4	4	280 mg/l
5	5	260 mg/l
6	6	240 mg/l
7	7	200 mg/l
8	8	190 mg/l

Table-3: pH values from hour to hour.

Sl.No	Time in hr	pH Values
1	1	7.67
2	2	7.54
3	3	7.53
4	4	7.42
5	5	7.40
6	6	7.39
7	7	7.34
8	8	7.31



5. CONCLUSION:-

Coconut shell when used as a filter media in the filtration The process gives good efficiency. There was a considerable reduction in turbidity, total solids, pH, and BOD. There was a considerable reduction in the color intensity.

The reduction in turbidity is up to 90%. The Decrease in the total solids was up to 89%. The reduction of BOD proves that organic compounds can be efficiently removed by Coconut shell.

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