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Comparative study of the performance of conventional rapid sand filter and Dual media filter with coagulant aid

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Abstract: Rapid sand filters are very common in all conventional water treatment plants. Most of the rapid sand filter beds are suffering by the problems like stratification, mud ball formationand unsatisfactory effluent and high backwash water requirement. Dual media and multimedia filters can overcome the limitations of rapid sand filters. Alternatively, higher filtration rates even can be achieved. The attempts is made to the study of dual media filter using anthracite coal as a filter media along with filter aid along with conventional sand mediaby pilot scale study.Comparative study shown that higher rate of filtration is possible along with higher filter run and less backwash requirement.

Key words: -Rapid sand filter, Dual media filter, Anthracite, Pilot scale model, Filter aid etc.

1. INTRODUCTION

Filtration is one of the most important operationsin water purification process. Through sedimentation a large proportion of suspended particles are remove but they do not remove fine floc particle, colour, dissolved minerals and micro-organisms. In filtration, water is passed through a filter media in order to remove the particulate matter not removed by sedimentation.[6][5]

In India conventionally the rapid sand gravity filter are commonly used. The advantage of rapid sand filter is that it is easy to maintain and can be operated for high water demand with less area. Along with some advantages there are some drawbacks in rapid sand filter.Stratification of sand layers at time of backwash, mud ball formation, rapid increase in head loss, low effluent quality these problems are related to rapid sand filters. [4]

As the head loss builds up, the filter requires backwashing, and the filter run is reduced. This difficulty can be removed if filtration takes through fromcoarser to fine media by provision of a tow layer and multi-layer filtering media, known as dual media and multi-media respectively. [3]Dual media filter may be having like the two single media. Filters placed in series one above the other, each with a different grains size and different specific gravity.[5] In dual media filter comparatively more depth of filter is utilized for removal of solids rather in the stratified single medium filter. Such dual media filter helps in providing higher filtration rates up to as high as 12,500 lit/hr./m^2 of filter.

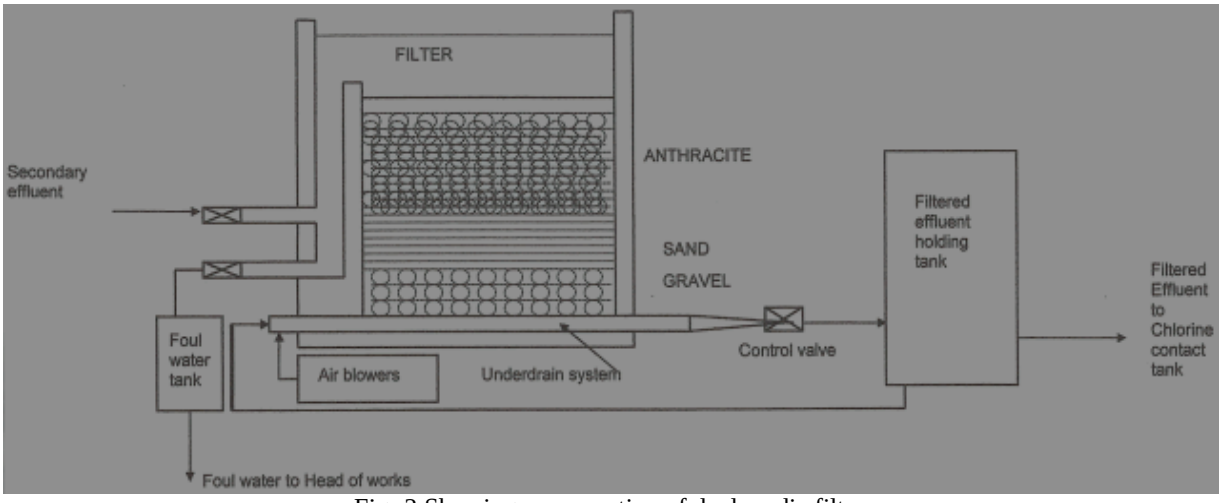


Fig:-2 Showing cross-section of dual media filter

The work was focus on '*the study of dual media filter using anthracite coal as a filter media along with conventional sand media.*' The study was based upon comparison between conventional rapid sand filter and dual media filter on the basis of overall water quality produced, total run of filter, development of head loss, backwashing requirements etc.

Scope of the work:

The scope of work includes the study of dual media filter with anthracite coal along with conventional sand. The comparison with R.S.F was done by installing pilot plant model at Ichalkaranji municipal water treatment plant. The water from clarifloculator was used as influent water. The parameter for comparison was overall water quality produce total run of filter development of head loss, backwashing requirements, and wrapping period of filter bed. The rate of filtration during analysis was 5000lit/m^2/hr. or more.

2. OBJECTIVES

The objectives of proposed work includes…..

1. Design and construct pilot scale model.
2. Prepare the media of required specification.
3. Install pilot scale method at Ichalkaranji Municipal Corporation.
4. Comparing the performance with conventional rapid sand filter.
5. Using anthracite coal along with sand

3. METHODOLOGY

To fulfill the objectives following methodology was adopted.

1. The media of appropriate specification of sand & anthracite coal was prepared; the principle based in the determination of media configuration was the settlement of finer sand particle before the courser anthracite coal particle. The media thus prepare was used in the pilot scale model to compare the performance of dual filter with conventional rapid sand filter.
   For conventional column:-

Table1:- Configuration of sandCu=1.5

	Size	Quantity
D_{10}	0.6mm or less	10%
D_{60}	0.6mm to 0.85mm	50%
Other	0.85mm to 1.18mm	40%

For modified column:-

Table 2:- Configuration of sandCu=1.42

	Size	Quantity
D_{10}	Less than 0.6mm	10%
D_{60}	0.6mm to 0.85mm	50%
Other	0.85mm to 1.18mm	40%

Table 3:- Configuration of anthracite Cu=1.18

	Size	Quantity
D_{10}	0.6mm to 1mm	10%
D_{60}	1mm to 1.18mm	50%
Other	1.18mm to 1.7mm	40%

The pilot scale model consisting two pilot column of internal size to be0.15 m* 0.15 m was constructed and installed at the Ichalkaranji municipal water treatment plant. The coagulated and settled water was used as influent for assessment of performance.

2. The centrifugal pump of 1/2HP used.
3. The performance of such dual media was tested using different filter aids by following parameters such as Ripening period, Development of head loss, Overall water quality produced, Backwash requirements.

(Fig:-Installation of pilot model)

4. RESULTS AND DISCUSSION

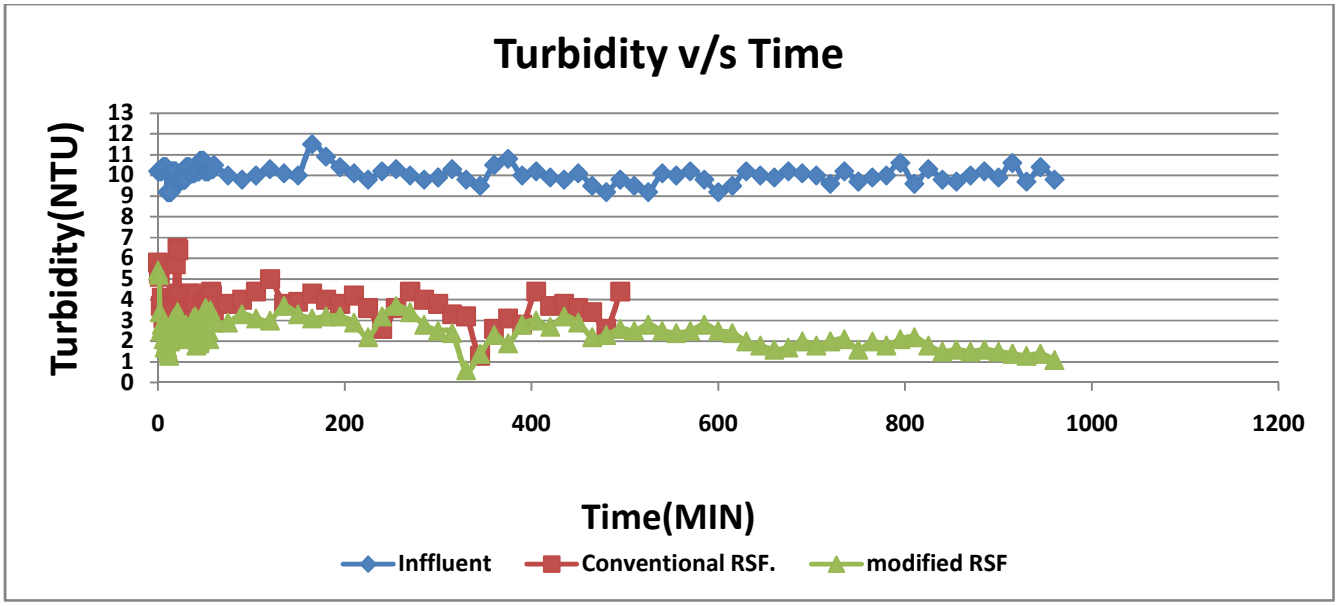
As per the decided methodology the reading were taken by installing the pilot scale model at Ichalkaranji water treatment plant total five filter runs were taken the typical set of observation is given below

Turbidity removal in first filter runs at flow rate of 6000lit/m^2/hr.

Time (MIN)	Influent turbidity	Conventional RSF	Flow rate (lit/m^2/hr)	modified RSF	Flow rate (lit/m^2/hr)	Time (MIN)	Influent turbidity	Conventional RSF	Flow rate (lit/m^2/hr)	modified RSF	Flow rate (lit/m^2/hr)
0	10.2	5.8	6000	5.4	6000	20	9.7	4.3		2.9	
1	10.2	5.3		5.2		21	9.7	6.5		3.4	
2	10.2	5.1		3.4		22	9.7	6.4		3.3	
3	10.2	3.7		2.5		23	9.7	4.2		3.2	
4	10.2	4.1		2.8		24	9.7	3.8		3.1	
5	10.4	4		2.7		25	9.8	3.2		2.8	
6	10.4	3.1		2.1		26	9.8	3.3		2.4	
7	10.4	3.2		1.7		27	9.8	3.7		2.4	
8	10.4	2.8		2.5		28	9.8	2.8		2.2	
9	10.4	2.9		1.9		29	9.8	3.2		2.5	
10	9.2	2.8		1.7		30	10.4	3.1		2.8	

11	9.2	2.6		1.5		31	10.4	2.7		2.4	
12	9.2	2.6		1.3		32	10.4	2.7		2.2	
13	9.2	2.5		2		33	10.4	4.3		2.1	
14	9.2	2.6		2.1		34	10.4	4.2		2.4	
15	10.2	3.9		2.7		35	10.1	3.6		2.6	
16	10.2	3.6		3		36	10.1	3.4		2.8	
17	10.2	3.7		3.1		37	10.1	4.2		2.4	
18	10.2	3.9		2.6		38	10.1	4		3.1	
19	10.2	5.7		3.2		39	10.1	3.2		2.5	
40	10.2	3.9		3.2		210	10.1	4.2		2.9	
41	10.2	2.5		1.8		225	9.8	3.6		2.2	
42	10.2	4.3		2.1		240	10.2	2.6	4000	3.2	
43	10.2	2.5		2		255	10.3	3.6		3.7	
44	10.2	2.2		1.9		270	10	4.4		3.4	
45	10.7	2.3		2		285	9.8	4		2.8	
46	10.7	2.2		2.2		300	9.9	3.8		2.5	
47	10.7	2.4		2.3		315	10.3	3.3		2.4	
48	10.7	2.8		2.5		330	9.8	3.2		0.6	6000
49	10.7	3.6		3.4		345	9.5	1.3		1.4	
50	10.2	3.8		2.9		360	10.5	2.6		2.3	
51	10.2	3.9		3.6		375	10.8	3.1		1.9	
52	10.2	3.8		2.9		390	10	2.8		2.8	
53	10.2	3.3		3.1		405	10.2	4.4		3	
54	10.2	4.1		2.5		420	9.9	3.7		2.7	
55	10.3	3.6		2.1		435	9.8	3.8		3.2	
56	10.3	4		3.5		450	10.1	3.6		2.9	
57	10.3	4.4		3.3		465	9.5	3.4		2.2	
58	10.3	4.2		3.1		480	9.2	2.6		2.3	
59	10.3	3.7		3		495	9.8	4.4		2.6	
60	10.5	3.5	5400	2.9		510	9.5			2.5	
75	10	3.8		2.9		525	9.2			2.8	
90	9.8	4		3.3		540	10.1			2.5	
105	10	4.4		3.1		555	10			2.4	
120	10.3	5		3		570	10.2			2.5	
135	10.1	3.8		3.7		585	9.8			2.8	
150	10	3.9		3.3		600	9.2			2.5	
165	11.5	4.3		3.1		615	9.5			2.4	
180	10.9	4		3.2		630	10.2			2	

195	10.4	3.8		3.2	6400	645	10			1.8	
660	9.9			1.6		810	9.6			2.2	2909
675	10.2			1.7	5000	825	10.3			1.8	
690	10.1			2		840	9.8			1.5	
705	10			1.8		855	9.7			1.6	
720	9.6			2		870	10			1.5	
735	10.2			2.1		885	10.2			1.6	
750	9.7			1.6		900	9.9			1.5	
765	9.9			2		915	10.6			1.4	
780	10			1.8		930	9.7			1.3	
795	10.6			2.1		945	10.4			1.4	
						960	9.8			1.1	



The rate of filtration of conventional rapid sand filter is reduced because of excessive head loss. The working of conventional rapid sand filter was stop because of excessive head loss. The working of conventional rapid sand filter was stop because of chocking of media on other hand dual media filter with coagulant aid was giving high rate of filtration along with longer filter run.

From the analysis of pilot scale installed it is observed that ripening period is in between 2min to 5min. The filter run of modified filter is more as compare to conventional filter. The quality of filtrate is good in modified filter. The backwash required for modified filter is more than the conventional filter.

During backwashing it is observed that conventional RSF was much easy to backwash as compared to modified RSF. The total quantity of backwash was required around 35% more in case of modified RSF because of use of filter aid. The time taken for backwash for the same rate of filtration was observed 35% more which is evident in table shown in below.

	Time	Water Consumed	Back wash rate.
Conventional RSF.	20 min	336.1 lit	0.747m/ min
Modified RSF.	27min	453.8 lit	0.747 m/min

The rate of backwash for conventional pilot scale filter (RSF) and modified pilot scale filter is around 14940lit/m^2 and 20169lit/m^2.

Filter	Conventional	Modified
Water produced	44824 lit	80487 lit
Water required for backwash	336.15 lit	453.8 lit
$\left(\frac{\text{Water produced}}{\text{Water required for backwash}}\right)$	133.34	177.36

5. CONCLUSION

From the study of dual media filter following conclusion were made….

1. Using anthracite as a dual media can increase the filter run is more as compared to conventional rapid sand filter about 84%.
2. Backwash requirement for dual media filter is more as compared to conventional rapid sand filter about 35%.
3. Ripening period for dual media filter is less as compared to conventional rapid sand filer.
4. The ratio of total water produced to water requirement for backwash is 133.34 conventional and 177.36 modified pilot scale model.

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