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SUSTAINABLE ENVIRONMENTAL SANITATION AND WATER SERVICES

Performance of Engineering Parameters of a Water Treatment Plant A Case Study

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Abstract

Kolkata Metropolitan Development Authority (KMDA), constructed a 30 mgd. capacity water treatment plant at Kamarhati, a municipal town, which is nearly 15 km. away from Kolkata. The plant started functioning in April, 1993. The plant consisted of conventional clariflocculators and rapid gravity filters. The source of water is river Hoogly. The plant supplies treated surface water to six adjoining municipalities catering the need of nearly 1.3 million population. In order to operate an efficient treatment system to achieve water of desirable quality, environmental safety and amenability for sustenance, a study was conducted throughout a year to identify and evaluate the performance of engineering parameters of treatment units such as clariflocculators, filter bed etc. A few technical findings are discussed in this paper on the efficiency of clarifloculators. The filter bed performance is assessed in terms of filter media, size distribution. Samples of backwash water is also collected for estimation of selective physico-chemical parameters.

Introduction

In order to design & operate an effective water treatment system, a thorough understanding of the process of coagulation-flocculation and filtration is essential in the delivery of water of the greatest clarity and lowest possible trubidity in the finished water. Clarity also aids filter operation by reasonably long filter runs. The flocculation stage in treatment process train is the aggregation step. A cousin system of the solids contact basin consists of a Sedimentation zone inside an annular clarification section. Filtration is the final and the most important solid-liquid separation step in potable water treatment.

Objective of the Study

The purpose of the study is to evaluate the performance of the existing water treatment plant with a view to identifying the gaps/ inadequacies (if any) regarding quality of water used and supplied after treatment including performance of clariflocculators and filter beds. It is well-neigh appreciated that the operation of the system mainly suffers due to lack of systematic approach and co-ordination.

Experimental Investigation

Features of the Experiments were:-

Flow through study period is determined for all the clariflocculators of Baranagar-Kamarhati water treatment plant on different dates during the study period. Engineering data are collected from all filter beds. Sand samples are collected for the analysis of particle size distribution (Uniformity Co-efficient and Effective size of sand). Samples of backwash water are collected for the estimation of selective physico-chemical parameters. Flow through study period is determined by mixing known quantity of common salt with raw water in the stilling chamber for a particular clariflocculator. Samples are collected from flocculators for every two minutes for one hour followed by every five and ten minutes for the consecutive hours and determined for chloride content. Whole study is continued for 3-4 hours. The study is carried out for clarifier nos. 1,2,3 & 4. For analysis of particle size distribution of sand, samples are collected from all filter beds as per CPHE&EO manual[1]. Selective physico-chemical parameter of backwash water are analysed as per Standard Methods, 17th. Edition[2].

Table 1 shows the performance indicator parameters for flocculator and clarifier. All the clariflocculators thus may be categorised as "Well designed basin."

To measure the efficiency of clarifier, surface loading rate and weir loading rate are calculated on the basis of the flow rate in the clariflocculator during the study period. This is summarised in Table 2. Sludge samples are also characterised by conducting analysis of selective parameters including metal content. Particle size distribution analysis are carried out for all the running filter beds in the treatment plant for Uniformity Co-efficient (UC) & Effective Size (ES) of sand. Quality of backwash water used, duration of backwashing, sand expansion, standing depth of water over filter beds are critically evaluated during the study period. Backwash water are collected from filter beds during the study period for analysis of physico-chemical parameters.

Results and Discussions

- It appears that all the clariflocculators can be designated as "well designed basin" as per CPHE&EO norms.

TABLE - 1

Performance of clariflocculators. Baranagar-Kamarhati Water Treatment Plant

Flocculator No.	Date	Flocculator			Clarifier			Efficiency (%)	
		D.D.T. Min.	Th D T min	Flow through Time (min)	D.D.T min	Th. D.T. Min	Flow through Time (min)	Flocculator	Clarifier
1	23.3.00	30	25.55	23.69	180	153.30	100.49	92.70	65.50
2	9.1.01	30	22.80	22.96	180	136.80	105.04	99.30	76.80
3	27.7.00	30	27.50	27.38	180	146.00	129.24	99.50	88.50
4	13.4.00	30	28.70	21.31	180	172.50	126.09	74.25	73.10

D. D. T. = Design Detention Time,

Th. D T = Theoretical Detention Time

Analysis : Raw water flow :- 5166 cu m/hr

Duration of salt addition: 4 min 40 secs.

Flocculator :- Flow through period $T_1 = \sum dc_1 * t_1 / \sum dc_1 - t/2 = 17586 / 744 - 4.67 / 2 = 21.31$ (mins)

where, $\sum dc_1$ = total concentration of chloride (mg/l)

t_1 = cumulative time (mins)

t = time taken for salt addition (mins)

Capacity of Flocculator = 825 cu m = 181718 gallons

Theoretical Detention time = 181718 *60 / 379295 = 28.70 mins = T_1'

Efficiency (%) = $T_1 * 100 / T_1' = 21.31 * 100 / 28.70 = 74.25$

Clarifier :- Flow through period = $\sum dc_2 * t_2 / \sum dc_2 - T_1 - t/2$

Where, $\sum dc_2$ = total concentration of chloride (mg/l)

t_2 = cumulative time (mins)

T_1 = flow through time (flocculator) (mins)

t = time taken for salt addition (mins)

flow through period = $35485/237 - 21.31 - 4.67/2 = 126.09$ mins $= T_2$

Raw water flow in each clarifier=379295 gph. Capacity of clarifier=4950 m^3

Theoretical Detention time = $1090308 * 60 / 379295 = 172.50$ mins $= T_2'$

Efficiency (%) $T_2 * 100 / T_2' = 73.10$

TABLE-2

Efficiency of Clarifier

Baranagar-Kamarhati Water Treatment Plant

date	Av. Flow m^3/hr	Av. Plant run hrs	No of units in Operatn.	Flow in each unit m^3/d	Surface loading Rate $m3/m^2.d$	Weir loading rate $m^3/m.d$	Design value			
							CMDA		CPHEEO	
							Surface loading rate $m3/m^2.d$	Weir loading rate m3/m.d	Surface loading rate $m3/m^2.d$	Weir loading rate m3/m.d
6.10.99	6456	14.25	3	30666	24.0	689.0	35		30.4	300-1500
9.12.99	5831	15.25	3	29641	23.2	666.0				
2.2.00	5852	16.00	3	31211	24.4	701.4				
12.6.00	5803	14.90	3	28822	22.5	647.7				
9.8.00	5865	15.75	3	30791	24.1	692.0				

- Surface loading rate ranges between 22.5 and 24.4m^3/m^2.d.

- Data reveals that UC&ES varies between 1.30 - 2.00 and 0.50 - 0.71 mm respectively. For ES all the values are within limits as per CPHE&EO norms. For UC, all the values satisfies norms barring a minimum value.

- Survey reveals that quantity of backwash water varies between 200 & 336m3, duration of backwashing ranges between 5.25 & 8.50 mins and sand expansion ranges between 15mm & 25mm. Water depth of filter beds ranges between 0.93m and 1.12m in comparison to design value of 0.90m to 1.20m.

Conclusions

— Finished water is conforming to Indian Standard for Drinking water (IS:10500, 1991) in the entire study period.

— UC & ES of sand samples are as per CPHE & EO manual.

— More attention need be given while setting the wash water rate and length of filter washing period.

— Performance of clariflocculators and filter beds are satisfactory.

References

1. CPHE & EO March 1991, Manual of Water Supply & Treatment, Ministry of Urban Development, Govt. of India.

2. APHA, AWWA, WPCF, 1989, Standard Methods for Examination of Water & Waste Water, 17th edition.

3. NEERI, 2001. Performance Evaluation of Baranagar - Kamarhati Water Treatment Plant - perpared for Kolkata Metropolitan Development Authority (KMDA).

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