Drinking Water Treatment Process Review on Optimization

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Abstract

In the drinking water treatment processes, the optimization of the treatment is an issue of particular concern. In general, the process consists of many units as settling, coagulation, flocculation, sedimentation, filtration and disinfection. The optimization of the process consists of some measures to decrease the managing and monitoring expenses and improve the quality of the produced water. This paper proposes a review on optimization of drinking water treatment process by analyzing all of the water treatment units and gives some solutions in order to maximize the water treatment performances without compromising the water quality standards. Some practical solutions and methods are performed in the water treatment plant located in the middle of India

Keywords :- *Optimization, Coagulation Process, Turbidity Removal, Water Treatment*

1. Introduction

The demand on water supply is increasing over the last century due to improved lifestyle, industrial develop- ment and population growth. This increased demand is facing a paradox to produce treated water with high quality at lower cost. In order to reduce the water cost, it is very important to optimize the operating expenses in the water treatment plant (power, chemicals, operator's expenses…) and many measures should be performed in this vision.

The optimization of water treatment plant is not a disciplinary to maximize the treatment objective and mi- Nimitz the cost of the water produced. But it consists of understanding the functioning of the treatment plant and treasure the experience of the operators in dealing with all treatment process related to different aspects.

This paper addresses the problem of optimizing of the conventional drinking water plant and proposes some practical to reach this goal. This paper is organized as fellows. After an introduction of the objective of this study, the water treatment operation is described in Section 2. Review on optimization of conventional drinking water treatment plant is discussed in Section 3. In Section 4, some practical methods are explained.

2. Water Treatment

2. Operation Water Treatment

India region is located in the middle of Bombay, has a Mediterranean climate with continental in- fluences. The temperature shifts from cool and cold in winter to hot days in the summer months of June - Sep- tember. The agriculture and industry are the mean activities in the region.

This study was developed in a water treatment plant located in Bombay, The quality of water, produced by the spring, changes according to the rainfall in the region. Sometimes, it can be affected by the warm in the sahyadri rock. The treatment water plant, as part of other water resources, water to more than 2000,000 inhabitants of Bombay city, and it has a nominal capacity of 16000 l/s of treated water. This water treatment plant is chosen regarding to the variation of the raw water tur- bidity and because of the availability of data.

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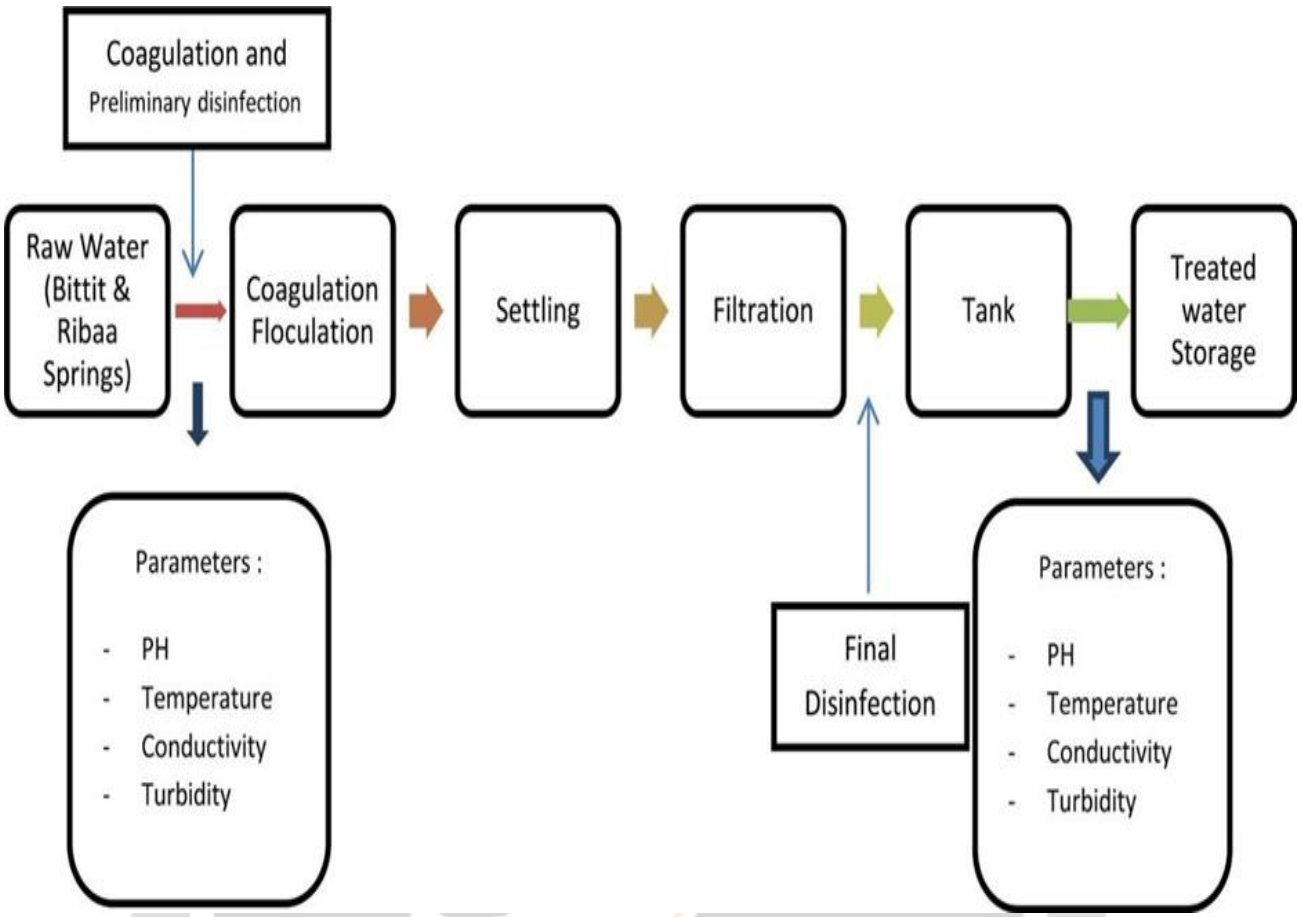
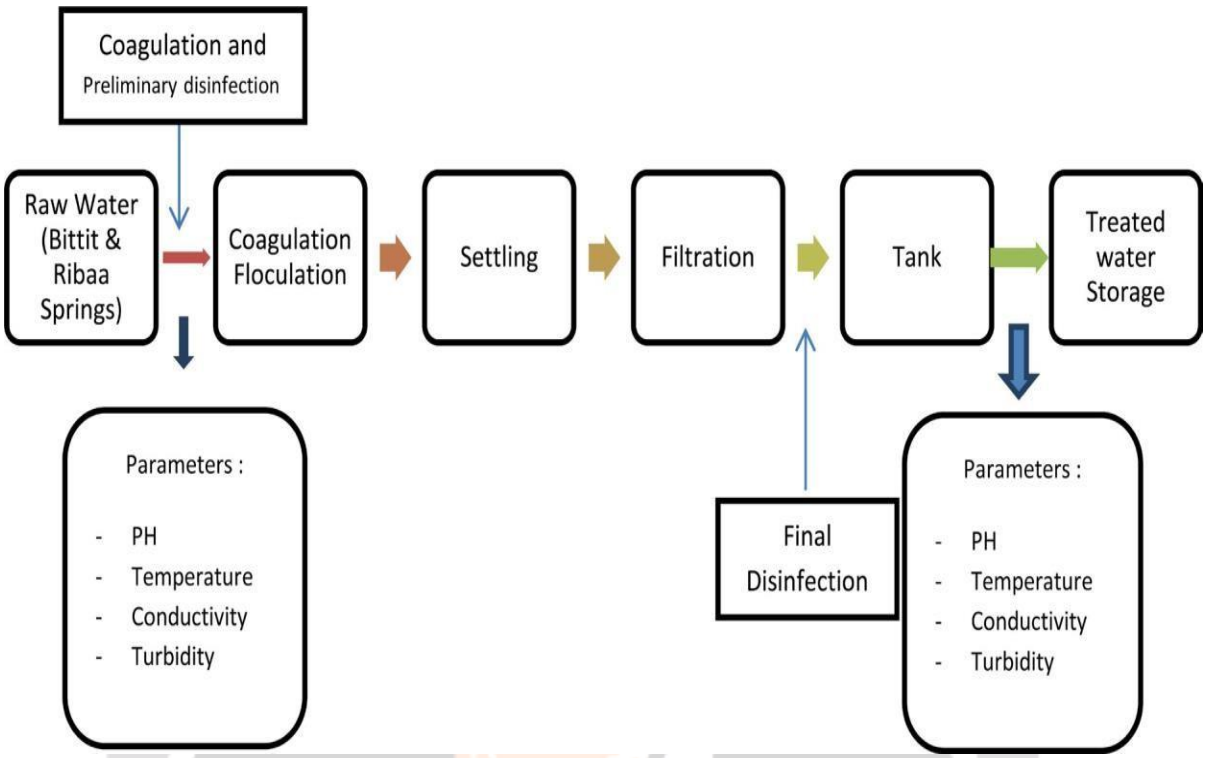
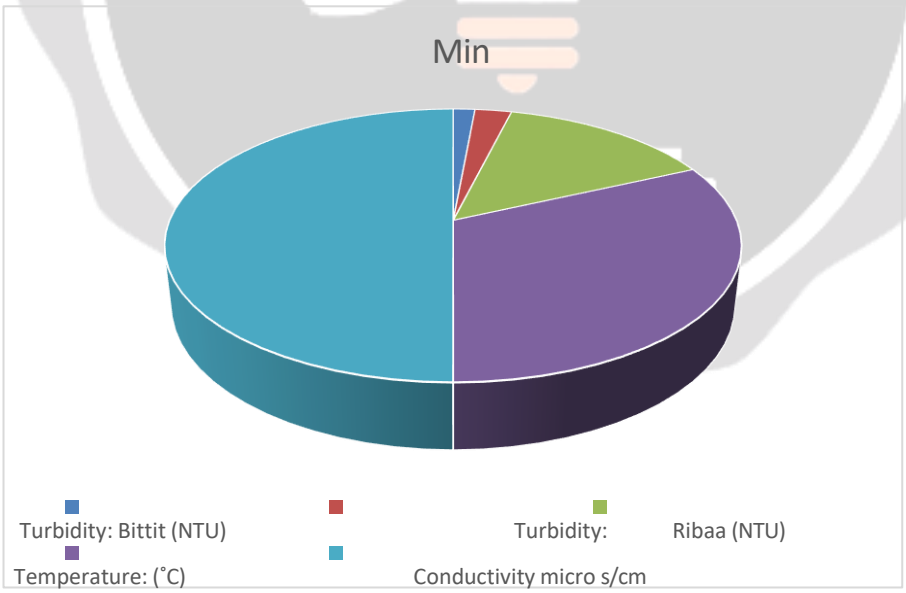

Coagulation and
Preliminary disinfection
Raw Water (Bittit & Ribaa Springs)
Coagulation Floculation
Settling
Filtration
Tank
Treated water Storage
Parameters :
- PH
- Temperature
- Conductivity
- Turbidity
Final Disinfection
Parameters :
- PH
- Temperature
- Conductivity
- Turbidity



The variation of PH, conductivity and temperature from 01/01/2023 to 31/12/2024 is given by **Figures 2(a)-(c)**.

In the rainfall period, the turbidity of raw water changes from time to time as shown in the graph below, the turbidity of the raw water can increase to reach levels more than 1500 NTU as shown in **Figure 3**.



2016	245	160	101	34	23
2017	0	0	113	148	104
2018	0	163	144	59	30
2019	515	45	17	5	5
2020	320	100	23	8	0
2021	417	78	32	20	4
2022	184	256	34	10	5

However, the turbidity level is less than 10 NTU this three last years (2013, 2014 and 2015) for more than 88% of the year and more than 64% of the year (1637/2556 days); the turbidity is less than 10 NTU for the six last years as shown by Table 2.

Review on Optimization of Drinking Water Treatment Plant

In order to remove turbidity and contaminants from raw water, the treatment comprises many steps as the set tling, aeration, coagulation, sedimentation, filtration and disinfection. The optimization of water treatment plant

Year: 2016

March	4.95	98.40	4.50	136.66
April	6.40	21.95	4.90	32.77
May	3.93	6.30	3.80	5.30
June	3.72	4.40	3.34	4.89
July	3.30	4.33	2.92	3.62
August	3.00	3.80	2.70	3.46
September	3.10	4.64	2.68	4.15
October	2.90	3.99	2.46	3.62
November	2.70	7.44	2.90	10.00
December	3.07	4.23	2.60	3.95

practice, aluminum sulfate is applied according to the jars test results. The problem is to deter- mine the optimal dose of aluminum sulfate related to raw water characteristics. Both manual and automatic me- thods are used to predict optimum coagulant dose [14] [15]. Automatic method is ensured by streaming current detectors [16]. However, manual method is consisting to determine the quantity of the coagulant to apply expe- RI mentally and based on the jar test results. Jar test involves taking a raw water samples and applying different quantities of coagulant to each sample [15]. After a short period of time, each sample is assessed for water qual- it and the dosage that produces the optimal result used a set point. This operation should be repeated by the op- erators each time when the quality of raw water changes. The aluminum sulfate is the compound likely to be mathematically modeled and therefore its value can be estimated according to the data available in the treatment plant. The optimization of using the coagulant is very interesting approach because under dosing of coagulant can lead to poor quality drinking water while too much coagulant leads to many operating problems (less efficient filtration and sedimentation, PH), healthy problems and can increase the cost of treated water. Some attempts have been made to model the relationships between raw water quality characteristics and the optima coagulant dosage rate Practical Methods of Water Treatment Plant Optimization Understanding of the Water Treatment Process The understanding of the water treatment functioning is a very important step on the performances optimization program. A systematic gathering of information about plant performances are need such as:

•Data trending and analysis.
•Check plant design criteria against actual and the controlling operations to improve the plant performances.
•Track chemical dosing and use indicators.
•Field measurements and visual observation.
•Collaboration of operators (quality water operators, maintenance team and managing operator).
•Plant specific operating guidelines and procedures.
•Accuracy and control of the on-line measurement devices.

The Aluminum Sulfate Consumption The sludge produced in the settling step of the treatment process is used not only to reduce the aluminum sulfate dose and the sludge volume but also in order to improve the water quality. A standard jar test apparatus equipped with six paddles rotating in a set of six beakers is used to simulate coagulation, flocculation and sedimentation processes At the first, Control experiments for coagulation tests are performed in order to determine the optimal dose of the aluminum sulfate in normal conditions

The selected level of turbid water (1 L) is filled into the beakers and various doses in the range from 10 to 100 mg/l of sludge and the aluminum sulfate according to the results of the first jar test determining the optimal dose of the inorganic coagulant in normal conditions are separately added in the beakers and mixed rapidly (300

rpm) for one minute. The mixing speed was then reduced to 40 rpm for 20 minutes. Then the stirrer is turned off and the sus- pensions are allowed to settle for different periods of time ranging from 30 to 120 minutes under quiescent conditions. After each period of settling time, supernatant samples of each beaker in the jar test is withdrawn from located 10 cm below the water level and residual turbidity is measured. Standard Jar test experiments were performed to determine the optimal dose of aluminum sulfate. A set of experiments were performed using jar test to investigate the optimal dose of sludge to add in order to improv the quality of water. The sludge produced by the treatment plant and used with the aluminum sulfate improves the turbidity re- Table 4 gives the results of turbidity removal percentage using aluminum sulfate only, optimal dose of AS and sludge and the optimal dose of sludge and the proposed dose of AS The results show

This paper has presented some results concerning many practical methods used in the management of the water treatment plant, the use of sludge as coagulant aid with the aluminum sulfate in the water treatment plant. The sludge improves the quality of the produced water by increasing the coagulation efficiency and the aluminum sulfate dosage is decreased. The sludge volume is reduced and subsequently sludge management costs. The coagulation process is optimizing and this approach offers several significant economics and operational bene- fits such as it minimizes the aluminum dose required to 40%, reduces the sludge volume produced by the treat- ment plant and decreases the residual turbidity of the water. These advantages are very important not only for process economy through reducing the cost of treatment but also in the management of the sludge volume. Therefore, it is reasonable to consider this approach to be applied in the treatment plant for water with similar turbidity level. Also, the chlorine and energy consumption can be reduced in order to optimize the water treat- ment plant performances.

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