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Optimisation of a Water Treatment Plant Based on Turbidity Removal Efficiency: A Case Study

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Abstract

Optimisation of a water treatment plant (WTP) will be immensely assist in reducing chemical and operational cost. In this study, a conventional WTP with an average raw water inflow of 12 MLD has been considered to evaluate its performance efficiency, with respect to turbidity removal. As the initial phase of optimisation, each unit processes were evaluated by collecting water samples at the different stages and analysed for the major water quality parameters; turbidity, pH, conductivity, dissolved oxygen, alkalinity, trihalomethanes and hardness. It was found that the coagulation and flocculation processes were inefficient since the coagulant was not uniformly mixed with the water in the two channels of the existing flocculator. As a solution to this issue, a rapid mixing chamber was designed considering the design and operational parameters, in order to optimise coagulation and flocculation processes by promoting uniform mixing of coagulant in water. The design was experimented in the laboratory scale to see the effect of the rapid mixing chamber on overall turbidity removal. Further, "Extended Flocculation method" (adopted from literature), which can be performed where the flocculation process does not satisfy the requirement, was examined by conducting three lab scale experiments as to improve the turbidity removal. The results of water quality analysis showed that, except for turbidity the other parameters satisfy the drinking water quality standards (SLS 614:2013). Therefore a target turbidity value of 1.24 NTU (75^{th} percentile) was set. The turbidity values obtained from the experiment using the rapid mixing chamber were found to be uniform when comparing to the actual values obtained by water quality analysis. This indicates that the coagulation and flocculation processes were improved, which means the coagulant was uniformly mixed with the water in both channels of the flocculator. The results obtained in the experiments conducted to examine the effect of extended flocculation method on turbidity removal were, 89.5±0.2%, 99.5±0.2% and 96.6±1.6% respectively. It is recommended to include the rapid mixing chamber into the existing WTP since it will improve the overall turbidity. Among the experiments onextended flocculation method, it was decided that, it should be carried out by applying both rapid and slow mixing with no additional dose of coagulant into the settled water. The obtained results were useful in identification and rectification of operational and maintenance problems as well as the future expansion to be carried out in the plant.

Keywords: Extended flocculation, Performance evaluation, Rapid mixing chamber, Turbidity removal efficiency, Water treatment plant (WTP)