A study on analytical techniques and statistical design for tertiary treatment of secondary wastewater using Zetag-4120 coagulant

Priya Singh, Mahendra Kumar Pal*, Prabhat Kumar Singh Dikshit and Goutham Banerjee

Department of Civil Engineering, Indian Institute of Technology, Banaras Hindu University, Varanasi 221 005, India

The primary and secondary wastewater treatments from different sewage treatment plants are of great importance not only for removing pollutants but also for using treated water for different purposes. The latter involves using suitable coagulants and their optimal dosages for the treatment. Given this, the present study identified the most suitable coagulant for tertiary treatment and its optimal dosage to achieve the maximum total suspended solids (TSS) and biological oxygen demand (BOD) removal. We used six coagulants (alum, ferric chloride, polyaluminium chloride (PAC), Zetag-4120, Mecafloc-25 and Rothfloc-27) and found that Zetag-4120 is the cost-efficient coagulant at varying coagulant dosage. We arrived at this conclusion based on several experiments using varying coagulant dosages. Furthermore, the regression prediction models for BOD and TSS removal for coagulant Zetag-4120 have been generated using statistical models and validated by calculating R^2 value, F-test and Lack-of-fit test using ANOVA. Optimization analysis suggests the optimal dosage, initial wastewater pH and settling time to be 1.86 mg/l, 6.73 and 89.12 min respectively. Furthermore, BOD and TSS removal efficiency values are 50.0% and 92.4% respectively. The treated wastewater has BOD and TSS equal to 12.27 and 5.66 mg/l respectively, conforming to the standard for re-usability of treated water for unrestricted irrigation.

Keywords: Polyelectrolytes, regression prediction model, response surface methodology, tertiary wastewater treatment, Zetag-4120.

contaminated water can cause pathogens to spread in the environment and pose a risk to public health[8]. Dickin *et al.*[9] have reviewed the health hazards connected with agricultural wastewater reuse, considering multiple exposure routes, long-term health implications and increased contamination. These studies encourage the reuse of contaminated water for irrigation, watering plants and industry purposes after primary and secondary treatments.

Generally, primary and secondary treatment treat wastewater to the extent that it meets the municipality guidelines and can hence be discharged into the streams. Many municipalities have stringent effluent limits for waste water treatment plants (WWTPs) to protect the water quality of the receiving streams. However, regulators have set the effluent limitations but have not specified the control technology. Consequently, effluent coming from WWTPs often fails to comply with standards necessary for reuse as effluent quality is technology-dependent. Therefore, tertiary treatment of secondary effluent is essential to make wastewater reuse feasible.

Prakash *et al.*[10] studied the possibility of coagulation and flocculation as a post-treatment option for the effluent of up-flow anaerobic sludge bed (UASB) reactor treating domestic sewage using common coagulants, namely alum, polyaluminium chloride (PAC), ferric chloride and ferric sulphate. They calculated faecal coliform concentration post-treatment and found that treated water did not meet the coliform criterion. Diamadopoulos *et al.*[11] studied alum, aluminium chloride, ferric chloride, PAC and poly ferric chloride in municipal treated wastewater. Researchers reported that removal of chemical oxygen demand (COD)