Abstract

Reuse of treated sewage for irrigation is widely practiced to meet the ever growing demand for water across the globe. Sewage contains a range of pathogenic microorganisms and conventional treatment processes are insufficient to meet the existing WHO norms for wastewater discharge or reuse (1000 CFU/100 mL for TCs). Therefore disinfection is required.

The present study assesses the effectiveness of all the three conventional disinfectants such as chlorine, ozone and Ultraviolet (UV) radiations against dominant coliform species in the secondary treated sewage collected from rotating biological contactor of Malaviya National Institute of Technology (MNIT), Jaipur. Resistance to low chlorine dose was observed among *Serratia/Hafnia* and *Enterobacter*, which resulted in its excessive doses up to 80 mg-min/L for meeting the WHO standards, which leads to the formation of high concentrations of disinfection byproducts causing negative environmental consequences. Ozone was considered as an alternative to chlorine, which is highly effective disinfectant having lower concentration time for TCs (30 mg/L compared to 80 mg-min/L for chlorine) and reduced formation of total trihalomethanes (TTHMs). After ozone disinfection, reduction in TTHMs was by 80% as compared to chlorination. Thereafter, for disinfection using UV radiations, a dose of 150 mJ/cm^2 was found sufficient for meeting the norms as a standalone measure with reduction in TTHMs by 91%. Both ozone and UV have a further benefit that no residuals are left after treatment, hence do not pose any toxic risk to aquatic organisms of the receiving waters. However, due to their relatively higher cost as compared to chlorine, the process needs optimization, where low doses of disinfectant were used to achieve WHO standard. Different design methods of response surface methodology (RSM) was used for statistically obtaining optimum ozone dose.

Based on these observations, a hybrid disinfection strategy was evolved to avoid high doses of chlorine by adopting a two-step treatment. The first step brought down all chlorine susceptible bacteria to a low value with an optimum dose for its efficacy, while the second step employed ozone or UV in series to meet the TC norms. This resulted in substantial reduction in CD (about 47% reduction) and much lower CT values for the subsequent disinfectant (8 mg/L for ozone and 75 mJ/cm^2 for UV) compared to their standalone values. This could bring the overall cost of disinfection comparable, despite of using a costlier disinfectant in series and yields additional benefits in terms of reduction in THMs. Where hybrid disinfection strategy 'A' (Cl_2/O_3) reduced TTHMs by 37% and Strategy 'B' (Cl_2/UV) reduced TTHMs by 44%. The novelty of the present research is the adoption of a reverse sequence of disinfectant such as Cl_2/O_3 and Cl_2/UV for wastewater to optimize the overall process in terms of cost as well as

THM concentrations in the treated water. The hybrid doses reduced TTHMs formation by 37% and 44% when compared to chlorination alone exemplifying the overall superiority of the modified process.