Efficiency comparison of conventional wastewater treatment systems in removing emerging pollutants

Abstract:

Wastewater is among the most important reservoirs of emerging pollutants (EPs) such as pharmaceutical and personal care products (PPCPs), antibiotic resistant bacteria (ABR) and associated antibiotic resistance genes (ARGs) in urban environments. Due to the limited capability of existing sewage treatment plants (STPs) in removing EPs, the occurrence of these pollutants in the aquatic environment has become a global problem.

The present study aims to estimate the abundances of ARB, ARGs and PPCPs in the different treatment stages of STPs. Water and sludge samples were collected from the STPs and they were analyzed to estimate the abundance of coliform, ARB against the antibiotics such as, amoxicillin, ciprofloxacin, erythromycin, ESBL (Extended spectrum β-lactam), *Klebsiella pneumonia* carbapenemase (KPC), meropenem and tetracycline. Also, the abundance of 20 clinically significant ARGs from each group of antibiotics, 3 mobile genetic elements (MGEs), a gene for faecal indicator BtH and 17 different PPCPs were estimated in the collected samples. All the targeted EPs were detected in the raw sewage, in the treated effluent and in the sludge, samples collected from STPs. The abundance of EPs in treated effluent and sludge indicates the inability of existing STPs in removing EPs. However, a slight reduction in the absolute abundance of ARB and ARGs was observed in the treated wastewater, whereas the relative abundance of most of the ARGs and MGEs was increased during the wastewater treatment. The strong positive correlation between MGEs and most of the ARGs, thereby indicating the dominant role of integrons genes in the proliferation of antimicrobial resistance (AMR) in the environment.

The treatment studies with activated sludge process (ASP), hybrid anaerobic reactor (HAR) and modified trickling filter (MTF) showed that MTF was superior to ASP and HAR in removing both conventional and EPs. The diverse microbial community inside the MTF improves the overall efficiency of the system in removing conventional and EPs from urban sewage. Biodegradation was the key factor controlling the removal of most of the PPCPs during MTF operation. Moreover, among the tertiary treatment systems (UV and ozone), ozonation provides better removal of targeted EPs due to the strong oxidation potential. Though the combination of MTF and ozone provides significant reduction in the abundance of EPs but none of the tertiary systems was capable in the complete elimination of ARGs and PPCPs. Therefore, alternate advanced and effective treatment technology needs to be developed and evaluated for the complete removal of EPs.