National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Construction of integrated (bio) degradation and adsorption-based approach for treatment of diversified pharmaceutical compounds
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Venue	: Seminar Room (BM) (Hybrid)
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Abstract : A wide range of pharmaceutically active compounds (PhACs) have been recently detected in different types of ground and surface waters all over the world. Among these compounds, non-steroidal anti-inflammatory drugs (NSAID) and antibiotics were found most abundantly due to their unrestricted and unmonitored use and disposal. The conventional water treatment techniques were found inefficient in managing these contaminants, raising the need for specialized techniques to treat such micropollutants. The current study initially addressed diverse PhACs including NSAIDs, antibiotics, and dyes. Six different bacterial strains were isolated from the pharmaceutical wastewater, specialized to degrade particular PhACs which include five different pharmaceutical azo dyes (indigo carmine (IC), tartrazine (TAR), quinoline yellow (QY), sunset yellow (SY), and amaranth (AM)) and two NSAIDs (paracetamol and diclofenac (DCF)). The underlying process of biodegradations for each PhAC was studied and optimized to obtain the best degradation efficiencies. The degradation efficiency of the azo dyes was 99.91%, 99.87%, 96.89%, 93.98%, and 99.71% for IC, SY, TAR, QY, and AM, respectively. After optimization, the degradation efficiency for paracetamol was 92.35% (C_i = 3 g/L), whereas for DCF, the same was 99.82% (initial concentration, C_i = 500 mg/L). Moreover, the presence of antibiotics could interrupt the biodegradation of PhACs and spread antibiotic resistance. Hence, this current study resolved this issue by implementing an adsorption strategy for the removal of antibiotics from the wastewater. Two different bio-adsorbents, 700 °C rice straw biochar, and 200 °C torrefied coco peat developed for the removal of two different antibiotics doxycycline (Dox) and norfloxacin (NFX), respectively, representative of the two most used antibiotic family, tetracycline and fluoroquinolone, respectively. The removal efficiency of the mentioned antibiotics was found to be 99.82% (C_i = 500 mg/L) and 99.52% (C_i = 500 mg/L), respectively. The adsorption mechanism, kinetics, and isotherm studies were also performed. The desorption study revealed that for both bio-adsorbents, 90% ethanol was found to regenerate the adsorbent. Further, all of the individual processes were integrated to demonstrate the successful PhAC removal from synthetic wastewater formulated by mixing azo-dyes, paracetamol, DCF, Dox, and NFX. The primary step of the designed integrated process was the single-step adsorption of the antibiotics using biochar. The antibiotic removal from the wastewater was monitored by a minimum inhibitory concentration test using the *Escherichia coli* DH5&alpha strain. Untreated wastewater exhibited almost 100% growth inhibition at 1% concentration. However, significant growth of *E. coli* was observed up to 4% concentration of treated wastewater. Moreover, the FITR spectra of the adsorbents confirmed the antibiotic removal. Biodegradation of the residual PhACs was performed in an aerated reactor which was confirmed by monitoring different water quality parameters. The COD and TOC of the synthetic wastewater was reduced by92.32% and 87.47%, respectively. The ecotoxicological study using *Aliivibrio fischeri* (ATCC 7744) confirmed notable depletion in the ecotoxic load (97.71%) of the wastewater signifying the success of the integrated process. The techno-economic analysis estimated an expense of $0.03/L of wastewater for a plant with a capacity of 100 kL for each batch. Hence, this current work has successfully demonstrated the implementation of an integrated wastewater treatment policy using bioadsorption and biodegradation technologies for the cost-effective removal of PhACs from wastewater with appreciable efficiencies. The constructed design can be further improved for industrial application by improving water flow, bioreactor, and plant design. Enhancing detection methods would open opportunities for exploring more compounds and applying the integrated design to address broader wastewater remediation challenges.

Keywords: Pharmaceutical pollution Antibiotics Adsorption Biodegradation Biochar Cost analysis.