

## Development of an Integrated System for the Treatment of Rural Domestic Wastewater: Emphasis on Nutrient Removal

**Authors :** Prangya Ranjan Rout, Puspendu Bhunia, Rajesh Roshan Dash

**Abstract :** In a developing country like India, providing reliable and affordable wastewater treatment facilities in rural areas is a huge challenge. With the aim of enhancing the nutrient removal from rural domestic wastewater while reducing the cost of treatment process, a novel, integrated treatment system consisting of a multistage bio-filter with drop aeration and a post positioned attached growth carbonaceous denitrifying-bioreactor was designed and developed in this work. The bio-filter was packed with 'dolochar', a sponge iron industry waste, as an adsorbent mainly for phosphate removal through physiochemical approach. The Denitrifying bio-reactor was packed with many waste organic solid substances (WOSS) as carbon sources and substrates for biomass attachment, mainly to remove nitrate in biological denitrification process. The performance of the modular system, treating real domestic wastewater was monitored for a period of about 60 days and the average removal efficiencies during the period were as follows: phosphate, 97.37%; nitrate, 85.91%, ammonia, 87.85%, with mean final effluent concentration of 0.73, 9.86, and 9.46 mg/L, respectively. The multistage bio-filter played an important role in ammonium oxidation and phosphate adsorption. The multilevel drop aeration with increasing oxygenation, and the special media used, consisting of certain oxides were likely beneficial for nitrification and phosphorus removal, respectively, whereas the nitrate was effectively reduced by biological denitrification in the carbonaceous bioreactor. This treatment system would allow multipurpose reuse of the final effluent. Moreover, the saturated dolochar can be used as nutrient suppliers in agricultural practices and the partially degraded carbonaceous substances can be subjected to composting, and subsequently used as an organic fertilizer. Thus, the system displays immense potential for treating domestic wastewater significantly decreasing the concentrations of nutrients and more importantly, facilitating the conversion of the waste materials into usable ones.

**Keywords :** nutrient removal, denitrifying bioreactor, multi-stage bio-filter, dolochar, waste organic solid substances

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