**Abstract**

In recent decades, high socio-economic development has led to an increase in water consumption, which, in turn, generates large volumes of wastewater. The centralized wastewater treatment facilities are not foreseen as a sustainable solution to manage the water and wastewater resources due to associated issues like high capital investments, high maintenance costs, upgradation challenges, and operational difficulties in scarcely populated or unsuitable terrain regions. Nowadays, wastewater is increasingly regarded as the non-conventional water source to meet increasing water demands for different purposes. The processes used in the treatment plants determine the quality of treated effluent. In recent times, decentralised treatment processes capable of resource recovery are highly encouraged over the globe. In particular, integrated technologies that can help manage the wastewater at the point sources are emerging as promising alternatives to the existing approaches. In this context, our lab tested the idea of iHydroMET with the aim of developing sustainable decentralised technology. iHydroMET stands for Integrated Hydroponics Microbial Electrochemical Technology. It is based on the integration of physicochemical, biological, and bioelectrochemical processes in a single reactor system to remove different pollutants present in domestic wastewater. In a proof-of-concept design study, it worked in principle and proved its potential for wastewater treatment along with simultaneous resource recovery. As a logical continuation of the work, my thesis focussed mainly on optimising the reactor components of iHydroMET to improve the system performance. We tested three major components; namely, i) support bed matrix, ii) cathode placement and iii) plant selection for better nutrient removal. Different granular activated charcoal (GAC) and cocopeat (CP) ratios were tested as the bed matrix component. GAC:CP in 20:80 combination showed removal of around 70% of COD, 69% ammonia, and 80% orthophosphate. The configuration of 3⁄4 immersed cathode in effluent showed higher closed circuit voltage (by a margin of 34±4 mV) compared to the cathode placement at the top of the bed matrix. Among different locally available plants, namely Vinca, Pothos, Peppermint, Lemongrass, and Brahmi, the Vinca plant outcomepted others in nutrient removal capabilities (total nitrogen; TN: 44 mg/L and total phosphorous; TP: 2.1 mg/L 1within 48h). It offers additional benefits like perennial flowering and phytoremediation of heavy metals. The semi-pilot scale iHydroMET with the selected reactor unit components was then evaluated for domestic wastewater treatment and resource recovery. The upgraded system achieved 79±6.7 %, 20±8.4 %, 10±2.7 % removal efficiencies for COD, TP, and TN after 3h of operation in the fed-batch tests. The removal efficiencies enhanced to 91±3.3 %, 32±1.1 %, 34±5.7 % after 24h. The maximum power densities were recorded at low levels of 1.2 mW/m 2 in series and 11.7 mW/m 2 in parallel connections. The UV treatment of the secondary effluent of iHydroMET resulted in complete disinfection. As per the standards of ‘The Food and Agriculture Organization, United Nations’, the treated effluent quality is fit for reuse in gardening purposes. To summarize, the selected reactor components contributed to the improved COD removal performance by iHydroMET. However, the system could not substantially remove TN and TP and produced low electric power. It was most likely due to the lack of anoxic conditions in the lower part of the reactors. Hence, further modifications in system operation like creating a saturation zone in the lower part of the reactor units are needed to address the inefficient removal of nutrients from domestic wastewater and improve the electric output of the iHydroMET technology.