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Advocating circular economy in wastewater treatment: Struvite formation and drinking water reclamation from real municipal effluents

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Abstract

In this pilot study, the circular economy concept in wastewater treatment was examined, through a zero liquid discharge (ZLD) process where struvite was recovered and drinking water was reclaimed. A stage wise approach was followed for struvite formation and the subsequent reclamation of drinking water. Specifically, the early stages of treatment entail the synthesis of struvite via the chemical precipitation of nutrients (phosphate and ammonia), using thermally activated cryptocrystalline magnesite. Thence, reverse osmosis (RO) was employed for drinking water reclamation. With this dual approach, 3.5m3 of municipal wastewater were successfully treated at a pilot plant in South Africa, producing ~52.5 kg of struvite and ~3.4 m3 of drinking water. The operating parameters were 30 min of residence time, 0.5 g : 500 mL solid to liquid (S/L) ratio, using ambient temperature and pH. X-ray diffraction (XRD) and High Resolution Scanning Electron Microscopy (HR-SEM) coupled with electron dispersion spectroscopy (EDS) confirmed the synthesis of struvite and the presence of notable Mg/P ratios. Fourier Transform Infrared Spectrometer (FTIR) further ascertained the obtained results. Moreover, it was identified that the reclaimed water meets the South African National Standard (SANS) 241:2015 and the world health organisation (WHO) standards for drinking water. An economic analysis revealed the viability of the process, suggesting that the system could be self-sustainable. Therefore, the results of his work indicate that introducing the concept of circular economy in wastewater treatment can promote the sustainable management of the ever-increasing quantities of municipal wastewater and at the same time address problems of emerging concern, such as water scarcity and phosphate shortage.