DECENTRALIZED WASTEWATER TREATMENT PLANTS AS A SUSTAINABLE IMPACT MITIGATION SYSTEM

Abstract of the Thesis

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ABSTRACT

A review of the existing wastewater treatment technologies and reinvention of them is very timely in order to achieve complete sewage treatment with organic matter, solids, nutrients and pathogen removal which was aimed to do in the current study to facilitate reuse of treated water. Five decentralized and one centralized treatment plants were monitored extensively after studying the qualitative performance of thirteen treatment plants as a case study in West Bengal. Proper emphasis ought to be placed on sludge management, tariff of water and training of staff for improving performance of these plants. Decentralized treatment plants fared well in terms of these aspects, with the anaerobic technologies using 15 fold less energy and producing 5 times less sludge than the aerobic technologies.

Possibility of methane generation from septic tank sludge was explored in laboratory scale anaerobic digesters with and without sonication pre-treatment. Biogas production rate was predicted best with first order kinetic model which was validated in a 2000 L pilot digester. The pilot digester could produce biogas of 280 ± 22 L/kg VS destroyed per day. Arrhenius temperature correction factor was worked out to be 1.12. Sonication of septic tank sludge resulted in higher methane recovery and a net energy gain of 1.67 W-h/L of sludge digested.

The problems of up flow anaerobic sludge blanket (UASB) reactor while treating low-strength sewage, namely sludge washout, improper mixing and no granular sludge was solved by the novel reactor configuration of UASB-moving bed biofilm (MBB)-rope bed biofilm (RBB) reactor, which was operated for 640 days on synthetic wastewater and 90 days on raw sewage. A 99% chemical oxygen demand (COD) removal efficiency and 89% nitrogen removal efficiency via anammox process could be achieved in the hybrid reactor when operated with synthetic sewage. COD removal efficiency of 95% with final effluent COD less than 10 mg/L was achieved when the reactor was operated on raw sewage. 83% sludge granulation could be observed in the laboratory hybrid reactor. 73% of sulphur recovery from sulphate rich raw municipal wastewater could be achieved in a microbial fuel cell (MFC), which could harvest power of 54.4 mW/m^2, at a Coulombic efficiency of 14%, with respective COD and sulphate removals of 90% and 95%. 2-3 log scale pathogen removal producing effluent with MPN less than 1000/100 mL was achieved using novel ZnO-Ag coated chitosan beads.

The UASB-MBB reactor piloted and operated for a year to treat up to 500 m^3/day of sewage generated in IIT Kharagpur campus. COD removal efficiency increased from 73% to 83% upon addition of moving media in the UASB reactor. A 67% granulation of sludge could be observed, which has never been reported earlier in a full scale UASB reactor treating low strength sewage. For post treatment of UASB effluent a HRAP was operated which could achieve a total nitrogen removal of 85%, phosphate removal of 91% and 2-3 log scale pathogen removal. The research thus provided a solution for sustainable decentralized sewage treatment.

Keywords: Decentralized wastewater treatment, Disinfection, Granulation, Hybrid reactor, UASB-MBB-RBB, ZnO-Ag-Chitosan beads