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Design and development of landfill leachate treatment with bio-reactors and leachate barricades

S.M.R. Joseph,¹ B. Dilsharan,¹ N. D. Punchihewa,¹ M. Vithanage,² and B.C.L. Athapattu^{1*}

¹The Open University of Sri Lanka

²University of Sri Jayewardenepura

Leachate generated from municipal landfills has become a great threat to the surroundings as it contains high concentrations of organics, ammonia, and other toxic pollutants. However, landfill leachate treatment is a major engineering challenge due to high ammonia, phosphate, nitrate, and heavy metals, and it usually exceeds the allowable limits of COD, BOD, and colour. In recent years, new technologies have been developed on leachate treatment but most of them were quite expensive depending on their methodology. This study was mainly focused on a treatment train comprised of an Anammox microbial reaction, biochar barricades and a subsurface constructed wetland to treat MSW leachate. Anammox bacteria were incubated in the laboratory to populate the anammox reactor with anammox bacteria. Municipal wastewater from a treatment plant was used as a medium to grow these bacteria. This wastewater was stored in the anaerobic digester and fed continuously with a synthetic medium at a temperature of 35°C. The synthetic medium contained NaNO₂ (30 mg N/L), NH₄Cl (30 mg N/L), NaNO₃ (0–14 mg N/L), KHCO₃ (0.4 g/L), KH₂PO₄ (0.040 g/L), MgSO₄·7H₂O (0.25 g/L) and CaCl₂ (0.30 g/L) dissolved in demi water. Biochar were produced using organic waste in a dumpsite by a bone char pyrolysis system. Initially dried organic waste was packed into the small steel drum retort and closed. The retort was placed lidded end down over a steel drum containing wood pieces. Another steel drum with a chimney pipe was placed over the retort. The biochar yield of this method was 30%. Furthermore, BC was characterized for its properties. Two reactors were used for the experiment were filled with both wood and MSW biochar. Both reactors were fed with leachate taken from the dump site. Effluent samples were taken after every pore volume pass through the reactors. However, the removal efficiency continued to drop over the time. Wood biochar is more efficient in removing COD and ammonia while MSW biochar is more effective in removing nitrate. The efficiency of wood biochar is 10.78 g/kg for COD, 1.17g/kg for ammonia, and 0.104 g/kg for nitrate while the efficiency of MSW biochar is 10.05 g/kg for COD, 1.08g/kg for ammonia, and 0.35 g/kg for nitrate. The discharge of leachate was measured using a v-notch to determine parameters of the basin. The results showed that the nitrate concentration varied from 4.72 – 6.52 mg/L and chromium, cadmium, lead, and nickel varied from 1000.88 – 225.87 µg/L, 17.29 – 4.66 µg/L, 701.15 – 53.49 µg/L, and 497.27 – 263.28 µg/L respectively for the above leachate. Accordingly, a combination of anammox reactor followed by biochar barricades and constructed wetland was proposed with proven results.

E-mail: bcliy@ou.ac.lk