

Nitrification and Denitrification Kinetic Parameters of a Mature Sanitary Landfill Leachate

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Abstract : Sanitary landfill leachates are characterized as a complex mixture of diverse organic and inorganic contaminants, which are usually removed by combining different treatment processes. Due to its simplicity, reliability, high cost-effectiveness and high nitrogen content (mostly under the ammonium form) inherent in this type of effluent, the activated sludge biological process is almost always applied in leachate treatment plants (LTPs). The purpose of this work is to assess the effect of the main nitrification and denitrification variables on the nitrogen's biological removal, from mature leachates. The leachate samples were collected after an aerated lagoon, at a LTP nearby Porto, presenting a high amount of dissolved organic carbon (1.0-1.3 g DOC/L) and ammonium nitrogen (1.1-1.7 g NH₄⁺-N/L). The experiments were carried out in a 1-L lab-scale batch reactor, equipped with a pH, temperature and dissolved oxygen (DO) control system, in order to determine the reaction kinetic constants at unchanging conditions. The nitrification reaction rate was evaluated while varying the (i) operating temperature (15, 20, 25 and 30°C), (ii) DO concentration interval (0.5-1.0, 1.0-2.0 and 2.0-4.0 mg/L) and (iii) solution pH (not controlled, 7.5-8.5 and 6.5-7.5). At the beginning of most assays, it was verified that the ammonium stripping occurred simultaneously to the nitrification, reaching up to 37% removal of total dissolved nitrogen. The denitrification kinetic constants and the methanol consumptions were calculated for different values of (i) volatile suspended solids (VSS) content (25, 50 and 100 mL of centrifuged sludge in 1 L solution), (ii) pH interval (6.5-7.0, 7.5-8.0 and 8.5-9.0) and (iii) temperature (15, 20, 25 and 30°C), using effluent previously nitrified. The maximum nitrification rate obtained was 38±2 mg NH₄⁺-N/h/g VSS (25°C, 0.5-1.0 mg O₂/L, pH not controlled), consuming 4.4±0.3 mg CaCO₃/mg NH₄⁺-N. The highest denitrification rate achieved was 19±1 mg (NO₂⁻-N+NO₃⁻-N)/h/g VSS (30°C, 50 mL of sludge and pH between 7.5 and 8.0), with a C/N consumption ratio of 1.1±0.1 mg CH₃OH/mg (NO₂⁻-N+NO₃⁻-N) and an overall alkalinity production of 3.7±0.3 mg CaCO₃/mg (NO₂⁻-N+NO₃⁻-N). The denitrification process showed to be sensitive to all studied parameters, while the nitrification reaction did not suffered significant change when DO content was changed.

Keywords : mature sanitary landfill leachate, nitrogen removal, nitrification and denitrification parameters, lab-scale activated sludge biological reactor

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