

## Nitrogen removal and effect of chemical oxygen demand on removal of nitrogen in Coir Fiber Biofilm Treatment System

DHARMARATHNE, Nirmala kumuduni<sup>1\*</sup> ; SATO, Naofumi<sup>3</sup> ; KAWAMOTO, Ken<sup>1</sup> ; TAKAHIRO, Koide<sup>2</sup> ; SATO, Hiroyasu<sup>4</sup> ; TANAKA, Norio<sup>1</sup>

<sup>1</sup>Graduate School of Science and Engineering, Saitama University, Japan, <sup>2</sup>Institute of Environmental science and Technology, Saitama University, Japan, <sup>3</sup>Kokusai Kogyo Co., Ltd, <sup>4</sup>Graduate School of Frontier Sciences, University of Tokyo, Japan

Biological treatment is the most useful process to remove nitrogen from water and wastewater. In this process, ammonium is first oxidized to nitrate by aerobic autotrophic nitrifying microorganisms. Nitrate is then reduced to nitrogen gas by heterotrophic denitrifying bacteria under anoxic conditions. Oxygen and organic carbon must be supplied to act as electron acceptor in nitrification and electron donor in denitrification. This study has carried out microcosm experiments in the laboratory for evaluating wastewater treatment mechanism and efficiency in the Coir Fiber Biofilm Treatment System (COTS). Coconut fiber was used to encourage the development of contaminant-degrading biofilms. A string of coconut-fiber (0.2-m length) was used as a biofilm support media and experiments were carried out using synthetic wastewater. The string of coconut-fiber was put inside the treatment container (0.012-m<sup>3</sup> volume) with two conditions: low fiber density (LFD; single string per a container) and high fiber density (HFD; two strings per a container). As a control condition, a blank container without a coconut-fiber string was also used in the experiment. The flow rate is about 870 cm<sup>3</sup>/day (two-weeks retention time)

The inflow ammonium nitrogen concentration was 500 mg/l- 640 mg/l and the average nitrate nitrogen concentration in influent was 5.9 mg/l- 6.5 mg/l (low nitrate nitrogen loading rate). Dissolved Oxygen (DO) value of the treatment tanks were range between 0-0.3 mg/l. DO concentration in LFD and HFD treatment tanks were slightly lower than the inflow and blank tank during the whole experimental period. The maximum ammonium nitrogen removal efficiency was recorded in the 14 days of startup. It was approximately 45% and 30% in HFD and LFD treatment tank respectively. After that, ammonium nitrogen removal efficiency shows the slightly decreasing trend over the time. The maximum nitrate nitrogen removal was observed for 70 days of operation. It was around 90% and 72% in HFD and LFD tank respectively. Over the duration of the experiment, very low concentrations of Nitrite Nitrogen were observed and it was below 1 mg/l. low nitrite nitrogen is evident that the oxygen limited anaerobic nitrification-denitrification process leads to removal of ammonium nitrogen in this system. This process involves two-step as partial nitrification and Anammox. One of the most critical parameters of the nitrification process is the influent chemical oxygen demand (COD), because it directly influences the growth competition between autotrophic and heterotrophic microorganism population. The average inflow COD concentration in influent was 18300 mg/l- 19800 mg/l. Ammonium nitrogen removal efficiency decreased with the increasing of COD removal efficiency in both LFD and HFD treatment tanks. So there is a negative relationship between organic carbon concentration and biological ammonia removal. High organic loading can result in decreased nitrification due to faster growing heterotrophic bacteria dominating the surface of the biofilm, and leads to oxygen limitations for the nitrifying bacteria growing deeper inside the biofilm. As considering the results obtained from the microcosm system it can be conclude that partial nitrification and the subsequent anaerobic ammonium oxidation (Anammox) are the major process associated with the removal of ammonium nitrogen. This process is a shortcut biological nitrogen removal without increasing nitrite and nitrate concentration in the system. At the same time treatment tank with HFD always tend to eliminate significant amount of ammonium nitrogen than the LFD tank. Difference between results in HFD and LFD treatment tank indicating that surface provided for growth of biofilms is a major factor for improving biodegradation rates. COTS has effect on remove nitrate nitrogen effectively at low nitrate loading rate from the wastewater.

Keywords: Coir Fiber, Biofilm, Nitrogen removal, Chemical Oxygen Demand