World Academy of Science, Engineering and Technology
International Journal of Chemical and Molecular Engineering
Vol:11, No:07, 2017

Separate Production of Hydrogen and Methane from Ethanol Wastewater Using Two-Stage UASB: Micronutrient Transportation

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Abstract : The objective of this study was to determine the effects of COD loading rate on hydrogen and methane production and micronutrient transportation using a two-stage upflow anaerobic sludge blanket (UASB) system under mesophilic temperature (37°C) with a constant recycle ratio of 1:1 (final effluent flow rate: feed flow rate). The first (hydrogen) UASB unit having 4 L liquid holding volume was controlled at pH 5.5 but the second (methane) UASB unit having 24 L liquid holding volume had no pH control. The two-stage UASB system operated at different COD loading rates from 8 to 20 kg/m³d based on total UASB working volume. The results showed that, at the optimum COD loading rate of 13 kg/m³d, the produced gas from the hydrogen UASB unit contained 1.5% H_2, 16.5% CH_4, and 82% CO_2 with H_2S of 252 ppm and also provided a hydrogen yield of 1.66 mL/g COD removed (or 0.56 mL/g COD applied) and a specific hydrogen production rate of 156.85 ml H_2/LRd (or 5.12 ml H_2/g MLVSS d). Under the optimum COD loading rate, the produced gas from the methane UASB unit mainly contained methane and carbon dioxide without hydrogen of 74 and 26%, respectively with hydrogen sulfide of 287 ppm and the system also provided a maximum methane yield of 407.00 mL/g COD removed (or 263.23 mL/g COD applied) and a specific methane production rate of 2081.44 ml CH_4/LRd (or 99.75 ml CH_4/g MLVSS d). Under the optimum COD loading rate, all micronutrients markedly dropped by the sulfide precipitation reactions. The reduction of micronutrients mostly appeared in the methane UASB unit. Under the studied conditions, both Co and Ni were found to be greatly precipitated out, causing the deficiency to microbial activity. It is hypothesized that an addition of both Co and Ni can improve the methanogenic activity.

Keywords : hydrogen and methane production, ethanol wastewater, a two-stage upflow anaerobic blanket (UASB) system, mesophillic temperature, microbial concentration (MLVSS), micronutrients
Conference Title : ICCBE 2017 : International Conference on Chemical and Biological Engineering
Conference Location : Zurich, Switzerland
Conference Dates : July 27-28, 2017