XIII Taller y Simposio Latinoamericano de Digestión Anaerobia
Octubre 21 al 24, 2018
Medellín - Colombia

Cincuenta Aniversario 1968_2018 UAM

IWA the international water association

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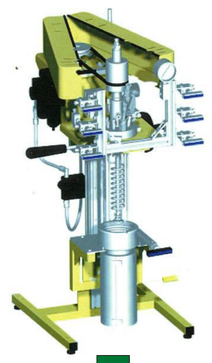
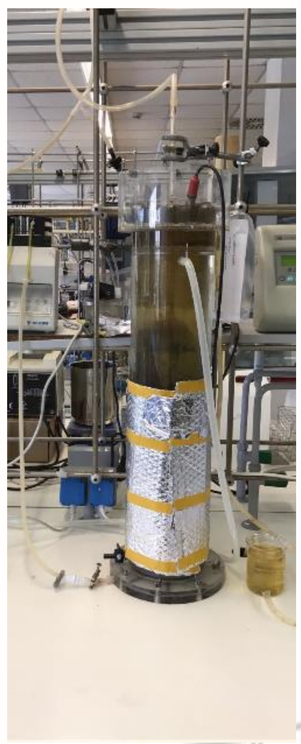
Biomethanization of the liquid fraction from hydrothermal carbonization of sewage sludge by UASB reactor

Abstract

The combination of hydrothermal carbonization (HTC) with anaerobic digestion opens an alternative to sewage sludge management and valorization, having the possibility to generate a energy-rich solid (hydrochar) and a liquid by-product with biogas production potential. In the present work, the anaerobic biodegradability of the liquid fraction from hydrothermal carbonization (LFHTC) of dewatered sewage sludge in an upflow anaerobic sludge blanket (UASB) reactor has been studied. The reactor was fed with a substrate composed by LFHTC + glucose (1:1 on a COD basis). Organic loading rates from 0.3 to 4.6 g COD L^{-1} d^{-1} were tested to evaluate the performance of the anaerobic reactor. Overall, the start-up period was successful, the biomass showed stable behavior and great adaptability to increasing organic loads, with COD and TOC removal efficiencies average of 65% and 40%, respectively, and a biogas with 70% of methane.

METHODS





BIOGAS

Hydrochar

RESULTS AND DISCUSSION

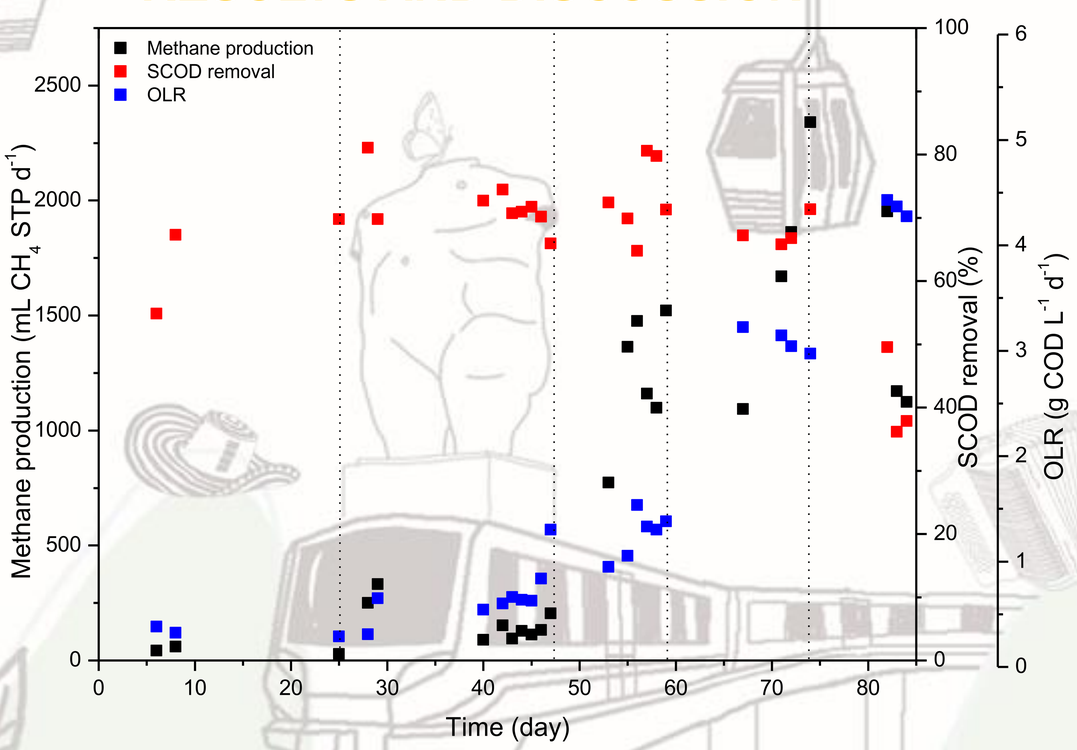


Figure shows the reactor performance working at different organic load rates (mean for each period): 0.3, 0.65, 1.25, 1.77 and 4.6 g COD L^{-1} d^{-1}, respectively. Along the long-term experiment accumulation of VFA (< 200 mg COD L^{-1}) was not detected, which is consistent with the alkalinity and pH values measured and the N-NH_3 concentration, which was kept below 50 mg L^{-1}. COD and TOC removal efficiencies were about 60-70% and 25-50%, respectively, quite similar to those obtained by Qiao et al. (2011) on the digestion of low concentrated LFHTC from sewage sludge. During the acclimation period, working at OLR of 0.3 g COD L^{-1} d^{-1}, biogas production was below than the expected (209 mL d^{-1}; 18.4% CH_4) indicating that COD removal was due mainly to the synthesis of new micro-organisms rather than for CH_4 production. The production of biogas increases with the increase of OLR and the percentage of CH_4 was stabilized between 62 and 70%, growing in proportion to the organic matter concentration. The highest OLR tested showed a noticeable impact on the biogas production and COD removal, evidencing an inhibitory effect of the LFHTC of DSS.

LFHTC of DSS could be valorized by anaerobic digestion in an UASB reactor working at OLR lower than 4 g COD L^{-1} d^{-1}.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Spanish MINECO (CTM2016-76564-R) for providing financial support. M.A. de la Rubia acknowledges financial support from the Spanish MINECO (RYC-2013-12549)