Anaerobic sludge blanket bioreactors for low-temperature domestic wastewater treatment: evaluation and modeling of organic removal, methane production, and energy recovery

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RESULTS AND DISCUSSION

FUTURE WORK AND PROJECTED PUBLICATION

References

• Wastewater conveyance and treatment accounts for ~3% of the total electrical energy used in the U.S.
• Current domestic wastewater treatment paradigm centers on aerobic wastewater treatment technologies.
• Though effective, approximately 50% of electrical energy used at wastewater treatment facilities is due to oxygenation of activated sludge.
• Anaerobic bioreactors for wastewater treatment have been the subject of research for > 40 years. They are very promising alternative because they need no oxygen input, use less energy, and create methane.
• While promising, the field requires a greater understanding of how organic removal rates relate to methane generation before applications of full-scale sludge blanket bioreactors can be implemented.

Research Question:
How do operational variables such as reactor size, temperature, and hydraulic residence time impact the bioenergy production potential of anaerobic sludge-blanket bioreactors treating domestic wastewater?

Investigation components:
• Literature review: After screening an initial pool of 200+ anaerobic bioreactor studies, over 247 lines of data were collected from 47 applicable studies and consolidated for further analysis.
• Binning: Once gathered, collected data configurations were organized in one of 24 unique “bins” based on the operational characteristics of reactor type (UASB or ABR), size, temperature, and hydraulic residence time.
• Modelling and Data Analysis: Established methods and assumed values were used to estimate the methane and energy generation rates for each “bin”. Palisade’s @RISK program was leveraged to conduct uncertainty analysis on the calculated results.

Power Generation Finding Example

Energy content may not vary much with temperature

Data Gaps and Observations

• Lack of standardization of units and variable nomenclature
  • Units for methane production varied widely
  • Conflicting COD subcomponent nomenclature
• Lack of BOD and VSS data provided
  • 92 of 247 initial configurations contained BOD data
  • 20 of 247 initial configurations contained VSS data
• Lack of UASB data from reactors with long HRTs
• Lack of ABR data
  • Data gap especially with full-scale volume reactors and reactors with long HRTs

METHODOLOGY

Study is a literature review of ~180 peer-reviewed manuscripts. More details regarding references are available upon request.

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