Dissolved Methane: A Hurdle for Anaerobic Treatment of Municipal Wastewater

ARTICLE *in* ENVIRONMENTAL SCIENCE & TECHNOLOGY · DECEMBER 2013

Impact Factor: 5.33 · DOI: 10.1021/es405553j · Source: PubMed

4 AUTHORS, INCLUDING:

ZeHua Liu
South China University of Technology
30 PUBLICATIONS **549** CITATIONS
SEE PROFILE

Hua Yin
South China University of Technology
66 PUBLICATIONS **449** CITATIONS
SEE PROFILE

Yu Liu
Nanyang Technological University
198 PUBLICATIONS **7,319** CITATIONS
SEE PROFILE

Environmental Science & Technology

Viewpoint

pubs.acs.org/est

Dissolved Methane: A Hurdle for Anaerobic Treatment of Municipal Wastewater

Ze-hua Liu,[†,‡,*] Hua Yin,[†,‡] Zhi Dang,[†,‡] and Yu Liu[§,∥]

[†]College of Environment and Energy, South China University of Technology, Guangzhou 510006, China

[‡]Key Lab Pollution Control & Ecosystem Restoration in Industry Cluster, Ministry of Education, Guangzhou 510006, Guangdong, China

[§]Advanced Environmental Biotechnology Center, Nanyang Environment and Water Research Institute, Nanyang Technological University, CleanTech one, Singapore 637141

[∥]School of Civil and Environmental Engineering, Nanyang Technological University, Singapore 639798

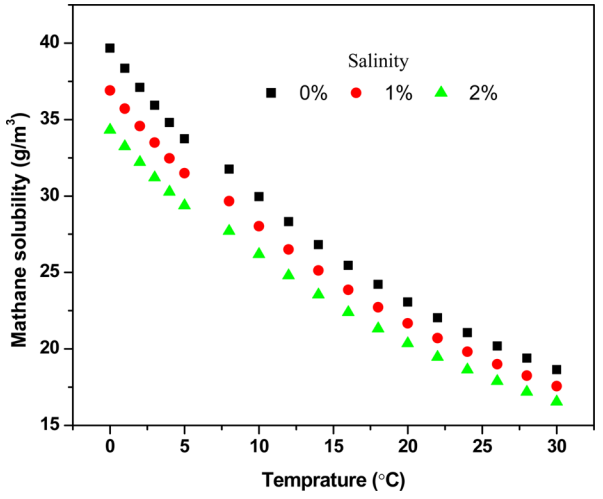

Figure 1. Methane solubility in water at different temperature and salinity (derived from Yamamoto et al.[4]).

Increasing interest has been given to the wastewater treatment−energy nexus due to the concern on global climate change. As such, various anaerobic processes have been investigated for energy recovery from municipal wastewater in the form of biogas.[1,2] In this viewpoint, we argue that biogas recovery from municipal wastewater through anaerobic processes might not be economically practical and environmentally friendly due to the fact that substantial amount methane is dissolved into treated effluent.

Soluble COD in municipal wastewaters often ranges from 100−300 mg/L with an average of 200 mg/L. Theoretically, 0.35 L of methane can be produced from 1 g of bCOD removed.[3] Prvoided the COD removal efficiency is as high as 90%, methane produced is about 63 L/m^3 wastewater, equivalent to about 41 g/m^3 at 30 °C. As shown in Figure 1, the solubility of methane at 30 °C is about 18.6 g/m^3. These mean that for anaerobic systems operated at 30 °C, theoretically about 45% of methane produced would be present in its dissolved form, which will be higher at lower temperature (Figure 1). It had been reported that dissolved methane accounted for 50% of total methane generated in an anaerobic MBR operated at 15 °C feeding with synthetic wastewater at COD of 440 mg/L.[2] Dissolved methane would lead to reduced energy efficiency of anaerobic process for municipal wastewater treatment, and increasing risk of its release into the environment.

Methane is known to be 25 times more powerful than carbon dioxide in terms of the greenhouse effect.[1] Therefore, methods for recovering dissolved methane from treated effluent are urgently needed, otherwise anaerobic processes for municipal wastwater tretament would be in question. For example, if 1 m^3 above municipal wastewater is treated with activated sludge process (AS), the amount of CO_2 produced is about 275 g (1 mol COD equals 1 mol CO_2) with 100% COD removal, and equivalent CO_2 from electric consumption of pump for aeration is about 68 g when it is calculated as 20% oxygen utilization efficiency and one kwh electricity produced from coals emits 880 g CO_2,[5] thus the total amount of CO_2 produced from AS is about 343 g/m^3. However, the dissolved methane only in anaerobic process would result in 465 g equivalent CO_2/m^3(dissolved methane multiple greenhouse gas factor), which is instead larger than that of AS.

Although some technical approches for recovery of dissolved methane from treated effluent have been proposed, for example,

Received: December 12, 2013
Accepted: December 20, 2013
Published: December 27, 2013

membrane separation, air stripping etc., their feasibility has not yet been fully evaluated in terms of economic viability and process safety. Without proper technical solutions, dissolved methane would be a technical hurdle for broad application of anaerobic processes for treatment of municiapl wastwater that contains only low organic constituents.

AUTHOR INFORMATION

Corresponding Author

*Phone/fax: +86-20-39380507; e-mail: zehualiu@scut.edu.cn.

Notes

The authors declare no competing financial interest.

REFERENCES

(1) MaCarty, P. L.; Bae, J.; Kim, J. Domestic wastewater treatment as a net energy producer-can this be achieved? *Environ. Sci. Technol.* **2011**, *45* (17), 7100−7106.

(2) Smith, A. L.; Skerlos, S. L.; Raskin, L. Psychrophilic anaerobic membrane bioreactor treatment of domestic wastewater. *Water Res.* **2013**, *47* (4), 1655−1665.

(3) Lawrence, A. W.; McCarty, P. L. Kinetics of methane fermentation in anaerobic treatment. *J. Water Pollut. Control Fed* **1969**, *41* (2), R1−R17.

(4) Yamamoto, S.; Alcauskas, J. B.; Crozler, T. E. Solubility of methane in distilled water and seawater. *J. Chem. Eng. Data* **1976**, *21* (1), 78−80.

(5) Skeer, J.; Wang, Y. Carbon charges and natural gas use in China. *Energy Policy* **2006**, *34* (15), 2251−2262.