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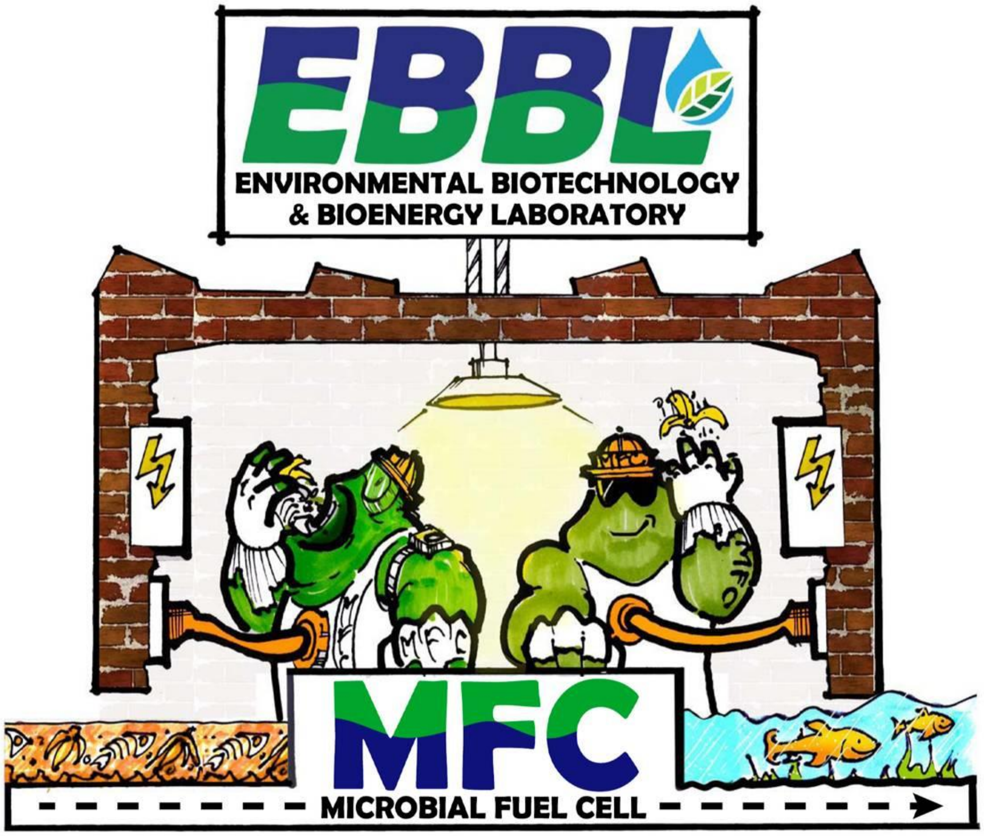


2018 Report

EBBL Director's Message 2018

Welcome to 2018 Annual Report of Environmental Biotechnology & Bioenergy Laboratory (EBBL).

It's hard to believe that we are entering the year of 2019. Time flies!

The easiest part to write for this annual report is probably about WaterJAM, because our members continued to have a great presence and performance at the 2018 WaterJAM, despite Hurricane Florence. For the third year in a row, the EBBL members have won the first place in poster competitions of both Water and Wastewater categories.

In 2018, we welcome two new PhD students, one MS student, and three visiting scholars. We also graduated two PhD students and four MS students. Several visiting scholars completed the visit and returned to their home institutions.

We have had a productive year with authoring/co-authoring 24 journal papers; one of them was featured as a Cover Article. Syeed and Shiqiang published two comprehensive review papers that critically evaluated UV quenching substances in landfill leachate and energy consumption of bioelectrochemical systems, both of which were published in *Water Research*.

I was appointed as a Co-Editor in Chief of *Environment International* (EI) and the new Editor in Chief of *Water Environment Research* (WER). EI is a high-profile multidisciplinary journal (2017 Impact Factor of 7.297) with an expanded scope and has been transformed to a fully open access mode. WER is among the oldest water/wastewater journal (established in 1928) and the only academic journal of Water Environment Federation (WEF). I was thrilled to be named a 2018 Highly Cited Researcher by Clarivate Analytics (one of only two at Virginia Tech) and grateful for a 2018 Walter L. Huber Civil Engineering Research Prize from American Society of Civil Engineer (ASCE).

I am excited about what we have accomplished in 2018 and look forward to working with all of you in 2019!

Zhen (Jason) He
Professor

2018 New Members and Alumni

Kyung-Sun (Jessie) Chung joined EBBL as a MS student after completing her BS in Civil Engineering at Arizona State University. She works on a project of using membrane distillation to recover high-quality water from landfill leachate.

Dr. Qingjie Hou joined EBBL as a Visiting Scholar from Shandong University. He is a research assistant in School of Environmental Science and Engineering at SDU. His research interest lies in BES and water treatment.

Xiao Li joined EBBL as a Visiting Student funded by CSC. She is currently a PhD student in Environmental Engineering at Sun Yat-sen University. Her interest is bioelectrochemical systems for wastewater treatment.

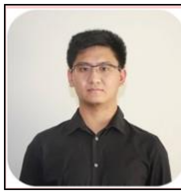
Xuejiao Ma joined EBBL as a Visiting Student funded by CSC. She is currently a PhD student at China University of Geosciences Beijing. Her interest is nutrient removal and recovery by using electrochemical technologies.

Zixuan Wang joined EBBL as a Direct-PhD student after completing his BS in Environmental Engineering at Xi'an Jiaotong University. He is working on a NSF project of integrated photo-bioelectrochemical systems (IPB).

Bing Xu joined EBBL as a PhD student. She completed her BS at Renmin University of China and MS at University of Illinois at Urbana-Champaign. She is working on Anammox decay, anaerobic digestion, and membrane technology.

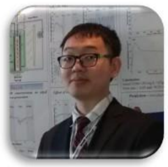
Daniele Cecconet has completed his visit and returned to University of Pavia (Italy) to complete his PhD study. During his EBBL stay, he published one first-author paper about energy consumption by BES-groundwater treatment in *STOTEN.*

Dylan Cowell has graduated with a MS degree and then joined Bowen Collins & Associates as an Environmental Engineer. Dylan has investigated the performance of biofiltration systems to deal with wet weather condition for WWTP.



Yu Dong has completed his MS study in EBBL. He has been a very active member of the lab and a dedicated photographer for every event. He was working on anammox treating wastewater and plans to become a consulting engineer.

Xiaojin (Jim) Li has completed his PhD study in EBBL and joined his wife in Boston. Jim helped start the anammox research in EBBL and published papers in premier journals such as *Water Research* and *Journal of Membrane Science*.



Shuai Luo has completed his PhD study in EBBL and joined Dr. Xia Huang's group at Tsinghua University as a Postdoctoral Research Associate. Shuai has been a very productive with 10 first-author journal publications from his PhD study.

Katherine Olso has completed her undergraduate study at Virginia Tech, and became a MS student at Nanjing University (China). She has been a very active undergraduate researcher in EBBL and a fast learner of Chinese.

Pranav Sai Shanker Sampara has completed his MS study in EBBL and moved to University of British Colombia as a PhD student. Pranav studied the use of forward osmosis to harvest algae from wastewater treatment.

Yishuang Wang has completed MS study. She started to work as an Environmental Engineer at Virginia Department of Health (VDH), Lexington Office. In EBBL, she performed literature analysis of membrane-based anammox treatment.

Siimao Wu has completed her visit and returned to Shanghai University to complete her PhD study. She was very productive to publish three journal papers and prepare two more manuscripts for submission.

Nan Zhao has finished her visit and returned to Jiangnan University to continue her MS study. Her research results from this visit have been published in a journal paper by *Environmental Science: Water Research & Technology*.

Dr. Zhizhong Su, a Professor of Chemical Engineering at Sanming University (China), has completed his one-year visit to EBBL.


JUST MARRIED
JUST MARRIED
JUST MARRIED


Alumni updates
Bojun Xu (MS '15) has relocated to Suez's office in Toronto, Canada.
Dr. Qingyun Ping (PhD '16) has joined the Journal of Visualized Experiments as a Science Writer.
Dr. Jian Li (PhD '16), joined Nebraska DEQ as an Environmental Engineer.
Sara Eghtessadi (REU'18) started her study abroad at DTU.
Christian White (REU'17) has joined UC Berkeley as a PhD student.
Dr. He had a reunion with Zhenyu Wu (MS'17) at University of Notre Dame
Dr. Zheng Ge (PhD '15) visited EBBL for research collaboration
Dr. Heyang Yuan (PhD '17) had his son born in Blacksburg.
Dr. Fei Zhang (PhD' 13) had his daughter born in Milwaukee.

Papers 2018

1. Pan, Y., Zhu, T.* and He, Z.* (2018) Enhanced removal of Azo dye by a bioelectrochemical system integrated with a membrane bofilm reactor. ***Industrial & Engineering Chemistry Research***. Vol 57, pp 16433 – 16441.
2. Madmanang, R., He, Z. and Sriwiriyarat, T.* (2018) Respirometric activities of unacclimatized Enterobacter aerogenes and mixed culture bacteria in sequencing batch reactor systems in response to acrylamide and its biodegradation products. ***RSC Advances***. Vol 8, pp 34911-34920.
3. Jain, A. and He, Z.* (2018) Cathodes-enhanced wastewater treatment in bioelectrochemical systems. ***npj Clean Water***. Vol 1, Article No. 23.
4. Iskander, S., Zhao, R.,* Pathak, A., Gupta, A., Pruden, A., Novak, J.T. and He, Z.* (2018) A review of landfill leachate induced ultraviolet quenching substances: sources, characteristics, and treatment. ***Water Research***. Vol 145, pp 297-311.
5. Zou, S., Guan, L., Taylor, D.P., Kuhn, D. and He, Z.* (2018) Nitrogen removal from water of recirculating aquaculture system by a microbial fuel cell. ***Aquaculture***. Vol 497, pp 74-81.
6. Zhang, J., Yuan, H., Deng, Y., Zha, Y., Abu-Reesh I.M., He, Z.* and Yuan, C.* (2018) Life cycle assessment of a microbial desalination cell for sustainable wastewater treatment and saline water desalination. ***Journal of Cleaner Production***. Vol 200, pp 900-910.
7. Ye, J., Hu, A., Cheng, X., Lin, W., Liu, X., Zhou, S.* and He, Z. (2018) Response of enhanced sludge methanogenesis by red mud to temperature: spectroscopic and electrochemical elucidation of endogenous redox mediators. ***Water Research***. Vol 143, pp 240-249.
8. Jain, A. and He, Z.* (2018) "NEW" resource recovery from wastewater using bioelectrochemical systems: moving forwards with functions. ***Frontiers of Environmental Science and Engineering***. Vol 12(4): 1. (Front Cover)

9. Wu. S., Zou, S., Yang. Y., Qian. G. and He, Z.* (2018) Enhancing the performance of an osmotic microbial fuel cell through self-buffering with reverse-fluxed sodium bicarbonate. ***Chemical Engineering Journal***. Vol 349, pp 241–248.
10. Yang, Y., Yang, X. and He, Z.* (2018) Bioelectrochemically-assisted mitigation of salinity buildup and recovery of reverse-fluxed draw solute in an osmotic membrane bioreactor. ***Water Research***. Vol 141, pp 259-267.
11. Cecconet, D., Zou, S., Capodaglio, A.G. and He, Z.* (2018) Evaluation of energy consumption of treating nitrate-contaminated groundwater by bioelectrochemical systems. ***Science of the Total Environment***. Vol 636, pp 881–890.
12. Zou, S., # Kanimba, E., # Diller, T.E., Tian, Z.* and He, Z.* (2018) Modeling assisted evaluation of direct electricity generation from waste heat of wastewater via a thermoelectric generator. ***Science of the Total Environment***. Vol 635, pp 1215-1224.
13. Li, X., Klaus, S., Bott, C. and He, Z.* (2018) Status, challenges and perspectives of mainstream nitritation-anammox for wastewater treatment. ***Water Environment Research***. Vol 90, pp 634-649.
14. Wu, Z., Zou, S., Zhang, B., Wang, L. and He, Z.* (2018) Forward osmosis promoted in-situ formation of struvite with simultaneous water recovery from digested swine wastewater. ***Chemical Engineering Journal***. Vol 342, pp 274-280.
15. Ye, J., Hu, A., Ren, G., Chen, M., Tang, J., Zhang, P., Zhou, S.* and He, Z. (2018) Enhancing sludge methanogenesis with improved redox activity of extracellular polymeric substances by hematite in red mud. ***Water Research***. Vol 134, pp 54-62.
16. Iskander, S., Novak, J.T. and He, Z.* (2018) Enhancing forward osmosis water recovery from landfill leachate by desalinating brine and recovering ammonia in a microbial desalination cell. ***Bioresource Technology***. Vol 255, pp 76-82.
17. Wang, W., Zhang, B.,* Liu, Q., Du, P., Liu, W. and He, Z.* (2018) Biosynthesis of palladium nanoparticles using Shewanella loihica PV-4 for excellent catalytic reduction of chromium (VI). ***Environmental Science: Nano***. Vol 5, pp 730-739.
18. Mohanakrishna, G., Abu-Reesh, I.M.,* Kondaveeti, S., Al-Raoush, R.I. and He, Z. (2018) Enhanced treatment of petroleum refinery wastewater by short-term applied voltage in a single chamber microbial fuel cell. ***Bioresource Technology***. Vol 253, pp 16-21.
19. Luo, S., Sampara, P.S.S. and He, Z.* (2018) Effective algal harvesting by using mesh membrane for enhanced energy recovery in an innovative integrated photobioelectrochemical system. ***Bioresource Technology***. Vol 253, pp 33-40.
20. Zou, S. and He, Z.* (2018) Efficiently "pumping Out" value-added resources from wastewater by bioelectrochemical systems: a review from energy perspectives. ***Water Research***. Vol 131, pp 62-73.
21. Qin, M., White, C., Zou, S. and He, Z.* (2018) Passive separation of recovered ammonia from catholyte for reduced energy consumption in microbial electrolysis cells. ***Chemical Engineering Journal***. Vol 334, pp 2303–2307.
22. Zhang, B.,* Zou, S., Cai, R., Li, M. and He, Z.* (2018) Highly-efficient photocatalytic disinfection of Escherichia coli under visible light using carbon supported vanadium tetrasulfide nanocomposites. ***Applied Catalysis B: Environmental***. Vol 224, pp 383-393.
23. Mohanakrishna, G., Abu-Reesh, I.M.,* Al-Raoush, R.I. and He, Z. (2018) Cylindrical graphite based microbial fuel cell for the treatment of industrial wastewaters and bioenergy generation. ***Bioresource Technology***. Vol 247, pp 753-758.
24. Wu. S., Zou, S., Liang, G., Qian. G. and He, Z.* (2018) Enhancing recovery of magnesium as struvite from landfill leachate by pretreatment of calcium with simultaneous reduction of liquid volume via forward osmosis. ***Science of the Total Environment***. Vol 610-611, pp 137-146.

Your paper:
before and after peer review

U-U Partnership

At 2018 WEFTEC, Dr. He was one of the invited speakers for a workshop of University – Utility Partnership, and discussed with both environmental academia and industry about how to better develop collaborative research partnership.

The newly established VT-CAWRI is a great example of such a partnership. We expect to involve more industrial members in 2019.

WER is planning a special issue on U-U partnership.

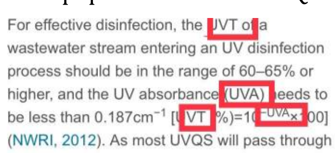
Editorships

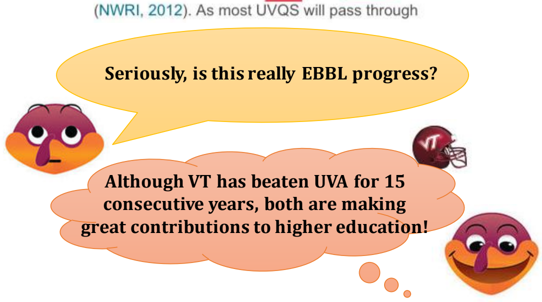
Dr. He has been appointed to be a Co-Editor in Chief of *Environment International* (EI). EI is a fully open access and multidisciplinary environmental journal, with a latest impact factor is 7.297. Dr. He is in charge of technology – related submissions.

Dr. He has also been selected to be next Editor in Chief of *Water Environment Research* (WER). WER is among the oldest water/wastewater journals (est. 1928) and the only academic journal of Water Environment Federation (WEF). Starting in 2019, WER is published through a partnership between WEF and Wiley.

VT and UVA together

We've had "VT" and "UVA" together in our *Water Research* review paper on leachate UVQS!


For effective disinfection, the UVT of a wastewater stream entering an UV disinfection process should be in the range of 60–65% or higher, and the UV absorbance (UVA) needs to be less than 0.187cm^{-1} [UVT (%)=10^{-UVA}×100] (NWRI, 2012). As most UVQS will pass through



Shiqiang Zou

Shiqiang gave three oral presentations and one poster presentation at 2018 AWWA ACE conference. His trip was fully funded by VA AWWA as a result of his 1st place in 2017 WaterJAM Poster Competition in Water Category.

He was also invited to visit Tampere University in Finland, and delivered two presentations about BES energy and reverse solute flux in Forward Osmosis.

Shiqiang has created a new lab record with publishing 4 papers in *Water Research*.

2018 CEE Annual Research Day

The EBBL members participated in the annual CEE Research Day and presented their research to CEE faculty and alumni.

THANKSGIVING FOOTBAL GAME

2018 WEFTEC

LAB PARTY IN DR. HE'S HOUSE

BIGEVENT

LAST GROUP MEETING

Both Mohan Qin and Heyang Yuan have been selected to receive 2017 Chinese Government Award for Outstanding Self-Financed Students Abroad (announced in 2018). Each received a cash award of $6,000. There were four awardees in total at Virginia Tech and half of them were from EBBL!!! Mohan attended the Award Ceremony at the Office of Educational Affairs of Chinese Embassy in Washington D.C.

EBBL's Winning Tradition Continued at WaterJAM 2018

The EBBL members have actively participated in 2018 WaterJAM. Despite the influence of Hurricane Florence and a shortened conference schedule, our members won the 1st places in both poster competitions, like what we did in past two years:

- Lu Guan, a EBBL MS graduate, won the poster competition in Wastewater category ($1,000);
- Shiqiang Zou, an EBBL PhD student, won the poster competition in Waste category ($1,000);
- Akshay Jain won the 1st place in Digital Knowledge Competition;
- Jessie Chung won the 2nd place in Digital Knowledge Competition.
- Shiqiang Zou received the 2018 VA AWWA Graduate Student Scholarship.

Dr. He was named a 2018 Highly Cited Researcher in the category of Cross-Field by Clarivate Analytics. This recognition places him among the top 1% of the world's researchers by citations. There are only two VT professors and a handful of Environmental Engineering professors nationwide on this year's HCR list.

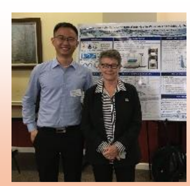
Dr. He has also received a 2018 Walter L. Huber Civil Engineering Research Prize from American Society of Civil Engineers.

For the second year in a row, Dr. He was named an Outstanding Reviewer by *Environmental Science: Water Research & Technology*.

Dr. He was invited to deliver seminars at Clemson University, University of Toronto, and University of Notre Dame.

Both Xiaojin Li and Shiqiang Zou were named "2017 Top Reviewers" by *Water Environment Research* (announced in 2018).

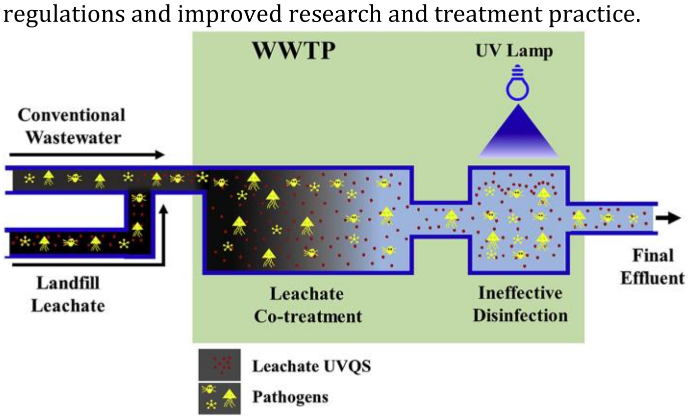
On the 34rd Virginia Tech GSA Research Symposium, Shiqiang Zou won the 2nd place in Interdisciplinary Scholar Award.



Syeed Md Iskander was named a Via Teaching Fellow and independently taught CEE 3104 Introduction to Environmental Engineering.

UV quenching substances in landfill leachate

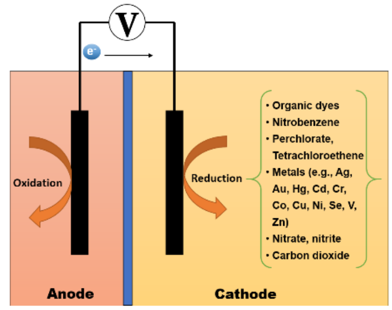
Landfill leachate contains extremely diverse mixtures of pollutants and thus requires appropriate treatment before discharge. Co-treatment of landfill leachate with sewage in wastewater treatment plants is a common approach because of low cost and convenience. However, some recalcitrant organic compounds in leachate can escape biological treatment processes, lower the UV transmittance of waste streams due to their UV-quenching properties, and interfere with the associated disinfection efficacy. Thus, the leachate UV quenching substances (UVQS) must be removed or reduced to a level that UV disinfection is not strongly affected. UVQS consist of three major fractions, humic acids, fulvic acids and hydrophilics, each of which has distinct characteristics and behaviors during treatment. The purpose of this review is to provide a synthesis of the state of the science regarding UVQS and possible treatment approaches. In general, chemical, electrochemical, and physical treatments are more effective than biological treatments, but also costlier. Integration of multiple treatment methods to target the removal of different fractions of UVQS can aid in optimizing treatment. The importance of UVQS effects on wastewater treatment should be better recognized and understood with implemented regulations and improved research and treatment practice.



Source: Iskander, S., Zhao, R.,* Pathak, A., Gupta, A., Pruden, A., Novak, J.T. and He, Z.* (2018) A review of landfill leachate induced ultraviolet quenching substances: sources, characteristics, and treatment. ***Water Research***. Vol 145, pp 297-311.

Cathode Enhanced Treatment in BES

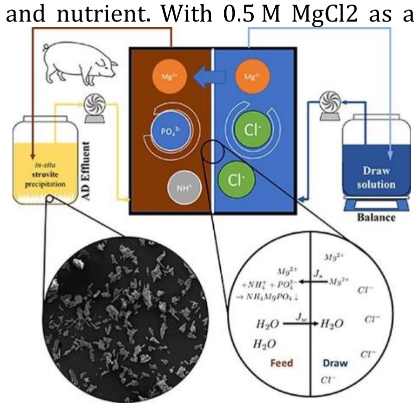
Bioelectrochemical systems (BES) have been intensively studied as a new technology for wastewater treatment. However, the treatment efficiency of BES anodes is limited and the anode effluent usually cannot be for direct discharge or reuse. To enhance the treatment, BES cathodes may be used for additional treatment of selected contaminants. This has been investigated in a number of approaches, which can be grouped into cathodes stimulated treatment and cathodes supported treatment. The former involves electron transfer directly to reduce contaminants like nitrate or dye compounds, while the latter can accomplish contaminant removal by aerobic oxidation, algal growth, production of strong oxidants for advanced oxidation, and/or membrane treatment. This paper aims to provide a concise view and discussion on the cathode-promoted wastewater treatment in BES, analyze challenges pertaining to the cathode treatment, and offer suggestions on the future development of BES for maximized treatment performance.



Source: Jain, A. and He, Z.* (2018) Cathodes-enhanced wastewater treatment in bioelectrochemical systems. ***npj Clean Water***. Vol 1, Article No. 23.

RSF-promoted Formation of Struvite in FO

Livestock wastewater contains a large amount of nutrients that are available for recovery. In this study, a proof of concept process based on forward osmosis (FO) was proposed and investigated for in situ formation of struvite from digested swine wastewater. This FO system took advantage of a drawback – reverse solute flux (RSF) and used the reverse-fluxed Mg^{2+} for struvite precipitation, thereby accomplishing recovery of both water and nutrient. With 0.5 M $MgCl_2$ as a draw solution, high-purity struvite formed spontaneously in the feed solution and the water flux through the FO membrane reached 3.12 LMH. The precipitated struvite was characterized and exhibited a similar composition to that of commercial struvite. The FO system achieve >50% water recovery and >93% ammonium nitrogen removal from the digested swine wastewater; in particular, it obtained >99% phosphate recovery, much higher than 60.7% removal via direct $MgCl_2$ addition (without FO treatment). The recovered products (both struvite and water) could potentially generate a value of 1.35 $\$\ m^{-3}$. The results of this study have demonstrated the feasibility of nutrient recovery from livestock wastewater promoted by FO treatment.



Source: Wu, Z., Zou, S., Zhang, B., Wang, L. and He, Z.* (2018) Forward osmosis promoted in-situ formation of struvite with simultaneous water recovery from digested swine wastewater. ***Chemical Engineering Journal***. Vol 342, pp 274-280.

Dr. Zhen (Jason) He
Durham Hall, RM 403
1145 Perry St.
Blacksburg, VA 24060
Office phone: 540-231-1346
Email: zhenhe@vt.edu

EBBL
Hancock Hall, RM 204 & 206
490 Old Turner St.
Blacksburg, VA 26040
Lab webpage: www.ebbl.cee.vt.edu