PhytoPower: Safely transforming mercury phytoremediation crops into bioenergy

Tanja Radu, PhD, Loughborough University, UK
Jeffrey Beyer, Yuyun Ismawati, Terra Power Ltd, UK

Abstract

Statement of the Problem: The Minamata Convention on Mercury entered into force in August 2017 and seeks to redress mercury contamination across its 128 signatories and 84 ratified Parties. Some 5,500-8,900 tonnes of mercury are released into the biosphere annually negatively affecting the health of hundreds of thousands of people worldwide. Cleaning up contaminated site using standard methods is expensive and unrealistic in many affected areas, primarily in developing countries. Developing a more cost-effective method that includes co-benefits is needed.

Methodology & Theoretical Orientation: The research team worked with an industry partner to test its patented method for site decontamination. The method uses plants to take up heavy metal pollution (called phytoremediation), decontaminates phytoremediation biomass, and uses treated biomass as a feedstock for anaerobic digestion. This is a novel method of coupling land remediation with renewable energy generation using plants. Mercury distribution throughout this system is monitored with the special emphasis on efficiency of its removal from every step of the cycle using a novel polymer (adsorbent). Systematic analysis of soil, plant, and AD digester samples indicates sinks of mercury and the optimal conditions for its adsorption. The experimental work includes using real soil and plant samples from mercury contaminated sites in Indonesia. Several types of plants are studied to provide maximal mercury uptake and biogas yield.

Conclusion & Significance: The research shows the efficacy of the method to remove mercury from contaminated biomass, and the efficiency of treated biomass when used as an AD feedstock (typically mercury interferes with the AD process). It is significant because the method could be applied to vast tracts of contaminated land to support site remediation whilst creating a bioenergy value stream from currently poisoned land. The method complies with Minamata Convention provisions and could significantly improve the health and welfare of people especially in developing countries.

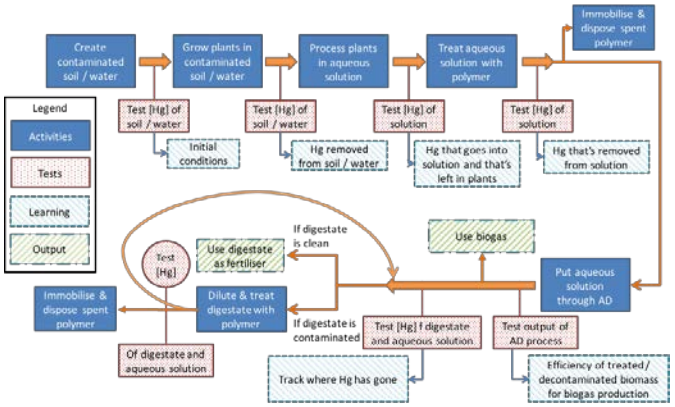

Figure 1: Experimental design process diagram

Recent Publications

1. Radu T, Blanchard R, and Wheatley A (2017) Biogas for sustainable rural communities: Case studies, in Moving to Cleaner Energy in a Resource-Rich Country: The Case of Kazakhstan, edited by Yelena Kalyuzhnova and Richard Pomfret, 189-208, Routledge, Taylor and Francis Group, Oxford, UK
2. Rothenberg S, Yin R, Hurley JP, Krabbenhoft DP, Ismawati Y, Hong C, and Donohue A (2017) Stable Mercury Isotopes in Polished Rice (Oryza sativa L.) and Hair from Rice Consumers, Environ. Sci. Technol., 51 (11), 6480–6488
3. Bose-O'Reilly S, Schierl R, Nowak D, Siebert U, William J, Owi FT, Ismawati Y (2016) A preliminary study on health effects in villagers exposed to mercury in a small-scale artisanal gold mining area in Indonesia, Environmental Research, Volume 149, 274-281
4. Radu T, Blanchard R, Smedley V, Theaker H, and Wheatley A, (2014) Anaerobic Digestion of Brewery Effluent- 2 Year Operating Experiences and Key Effects on Performance, Journal of Environmental Engineering and Science, 9 (4), 207 – 213
5. Radu T, Smedley V, Wheatley A and Blanchard R (2014), Operational experiences of industrial scale AD: Lessons for the future, Proceedings of the 1st International Conference on Non-Conventional Energy (ICONCE 2014), 131-135

Biography

Dr Tanja Radu is a lecturer in International Relief, Water Supply and Sanitation Engineering at Loughborough University, UK. She has more than 15 years of international experience in water and environmental engineering. Her main research interests include waste water treatment, renewable energy from waste and supplying energy for rural communities in developing countries. Currently, she is focusing on the process of biogas generation from waste using the technology of anaerobic digestion. She is involved in a range of international projects providing small-scale, decentralized sustainable energy generation. This includes collaborative effort with Universities of India, Thailand and Bahrain.

Email: t.radu@lboro.ac.uk

Notes/Comments: