Environmental Research, Technology Demonstration and Conference Project

ECF Project:	ECF 2018-49
Project Title:	A dye-assisted paper-based assay for fast and reliable detection of biotoxicity for anaerobic digestion
Principal Investigator:	Dr Chen Jianlin, School of Science and Technology, Hong Kong Metropolitan University
Total Approved Grant:	$499,500
Duration:	1/6/2019 to 31/1/2022
Project Status/Remarks:	Completed
Project Scope:	This programme was to develop a low-cost paper-based assay, assisted by a dye (resazurin), to diagnose the health of anaerobic microbial consortium within minutes and to monitor their response to toxicants present in the feedstream based on the kinetics of resazurin reduction. Fabricating microfluidic paper-based analytical device (μPAD), functionalising surface of μPAD with resazurin, and applying μPAD for different type of toxicants in anaerobic digestion system were involved in this research plan. The μPADs were fabricated by using a wax printer and a wax patterning technique, known as "screen patterning". The sealed μPAD channel full of fibers was functionalised by directly depositing resazurin, which was free and available to be reduced by healthy microorganisms' cells. By controlling the size and surface properties of μPAD channel, and the concentration of deposited resazurin, it enabled us not only to make early warning for toxicant / inhibitor loads in the feedstream to an anaerobic digestion system, but also to exploit the mechanism of resazurin reduction by living cells, as well as by mixed anaerobic sludge. This low-cost green chemistry process might also be extended to food safety and drinking water contamination.
Summary of the Findings/Outcomes:	In this study, the project team took advantage of the properties of paper to construct an analytical device that does not require external power to drive the liquid flow. By this analytical device with the assistance of a dye (resazurin), the cytotoxicity of two chlorophenols (pentachlorophenol, 4-chlorophenol) was successfully detected and identified within 30 minutes by analyzing the color change. At the same time, using this paper-based analytical device with the assistance of the same dye, the effects of three chlorophenols (pentachlorophenol, 2,4-dichlorophenol, 4-chlorophenol) on anaerobic digestion were predicted within one hour. This technique greatly improves the corresponding sensitivity of anaerobic digestion to toxic substances. This will provide real-time monitoring technology for anaerobic digestion systems in the face of ramp/shock loads and toxin addition.