Technical University of Denmark

Life cycle assessment as decision support tool in early stage development of a new technology for wastewater resource recovery

Fang, Linda L.; Valverde Pérez, Borja; Damgaard, Anders; Plósz, Benedek G.; Rygaard, Martin

Published in:
ISIE Conference 2015

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Life cycle assessment as decision support tool in early stage development of a new technology for wastewater resource recovery

Friday, 10th July 11.00 - ISIE 2015

Linda Fang[1], Borja Valverde-Pérez[1], Anders Damgaard[1], Benedek Gy. Plósz[1], Martin Rygaard[1]

[1]Department of Environmental Engineering, Technical University of Denmark

Life cycle assessment (LCA) has been increasingly used in the field of wastewater treatment where the focus has been to identify environmental trade-offs of current technologies. In a novel approach, we use LCA to support early stage research and development of a biochemical system for wastewater resource recovery. The freshwater and nutrient content of wastewater are to a large extent recognized as potential valuable resources that can be recovered for beneficial reuse. Both recovery and reuse are intended to address existing environmental concerns, for example water scarcity and use of non-renewable phosphorus. However, the resource recovery may come at the cost of unintended environmental impacts.

One promising recovery system, referred to as TRENS, consists of an enhanced biological phosphorus removal and recovery system (EBP2R) connected to a photobioreactor. We present the environmental impact results of the first simulated full-scale TRENS system in its potential operating environment as a side-stream process to an existing Copenhagen wastewater treatment plant. The system recovers water and nutrients that can be used in scenarios of agricultural irrigation-fertilization and aquifer recharge. The environmental performance of the system has been evaluated through life cycle assessment using EASETECH software.

For the chosen scenarios, TRENS reduces global warming up to 15% and marine eutrophication impacts up to 9% compared to conventional treatment. This is due to the TRENS system's lower aeration demands, and thus energy consumption, as well as recovery of nitrogen. The key environmental concerns obtained through the LCA are linked to increased human toxicity impacts from the chosen end use of TRENS products. The toxicity impacts are from both heavy metals release associated with land application of recovered wastewater nutrients and production of AlCl3, which is required for advanced treatment prior to aquifer recharge.

Pertubation analysis of the LCA model in EASETECH pinpointed nutrient substitution and heavy metals content of algae biofertilizer as critical areas for further research if TRENS performance is to be better characterized. These findings provided the first iteration in addressing the environmental performance of TRENS as it progresses from concept to commercial implementation. In conclusion, our study provided valuable feedback to the TRENS developers and identified the importance of system expansion to include impacts outside the immediate biological system of TRENS itself. Also the study showed for the first time the successful evaluation of urban-to-agricultural water systems in EASETECH.