Development of Integrated Reactor Systems for the PV-Powered Treatment of Domestic Wastewater without Discharge to the Environment

Michael R. Hoffmann
Division of Engineering & Applied Science
Environmental Science & Engineering
The Linde+Robinson Center for Global Environmental Science
California Institute of Technology
Pasadena, California 91125

Abstract

The Hoffmann research group (Clement Cid, Justin Jasper, Yang Yang, Cody Finke has developed transportable prototypes designed for the onsite treatment of domestic wastewater. After pre-treatment with a mixed anaerobic/aerobic baffled bioreactor, the effluent is processed sequentially through electrochemical arrays and a micro-filter before recycling of the treated black water into a flush water reservoir without discharge to the surrounding environment. Human wastewater can be clarified with the elimination of suspended particles along with > 90% reduction in chemical oxygen demand (COD). In addition, total enteric organism disinfection is achieved for bacteria and viruses via anodic chlorine generation coupled with cathodic hydrogen generation. The biochemical and electrochemically treated wastewater is recycled internally as toilet and urinal flushing water. Improvement of the performance and durability of the core semiconductor anodes along with materials modifications to lower their production costs is a continuing objective. Second-and third-generation prototypes are undergoing field-testing in several locations that lack conventional urban infrastructure for wastewater discharge and treatment; the system can operate without an external source of electricity or fresh water. Extensive field-testing in India and China is underway. A joint-venture company, EcoSan has been established in Yixing, China to manufacture units for the developing world, while at the same time industrial collaborations have been established in India with ERAM Scientific and the Kohler Company (USA/India) for production of units to be used in urban environments in India. The latest basic research results, field-testing results, and plans for future development and manufacturing will be presented. At the current time larger-scale units are being constructed for use in South Africa and the Philippines.

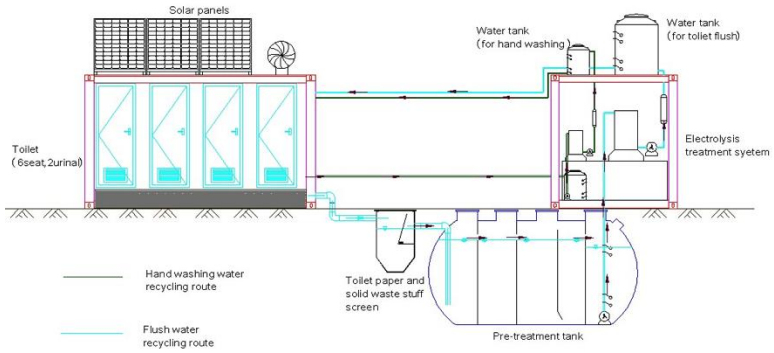

Figure 1. Beta prototype of the PV-powered solar toilet system; elevation view and configuration.

Figure 2 Beta prototype PV-powered solar toilet system used at an elementary school in Yixing, China.

Figure 2 Left Panel: Alpha prototype showing the electrochemical reactor arrays, the baffled anaerobic reactor, flushwater tank, and the biochemical reactor effluent holding tank. Right: Smartphone monitoring and control systems for operational control, maintenance, and repair directions.

Keywords: Electrochemistry; Chlorine; Disinfection

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