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Elimination of water pathogens with solar radiation using an automated sequential batch CPC reactor

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ABSTRACT

Solar disinfection (SODIS) of water is a well-known, effective treatment process which is practiced at household level in many developing countries. However, this process is limited by the small volume treated and there is no indication of treatment efficacy for the user. Low cost glass tube reactors, together with compound parabolic collector (CPC) technology, have been shown to significantly increase the efficiency of solar disinfection. However, these reactors still require user input to control each batch SODIS process and there is no feedback that the process is complete. Automatic operation of the batch SODIS process, controlled by UVA-radiation sensors, can provide information on the status of the process, can ensure the required UVA dose to achieve complete disinfection is received and reduces user work-load through automatic sequential batch processing. In this work, an enhanced CPC photo-reactor with a concentration factor of 1.89 was developed. The apparatus was automated to achieve exposure to a predetermined UVA dose. Treated water was automatically dispensed into a reservoir tank. The reactor was tested using Escherichia coli as a model pathogen in natural well water. A 6-log inactivation of E. Coli was achieved following exposure to the minimum uninterrupted lethal UVA dose. The enhanced reactor decreased the exposure time required to achieve the lethal UVA dose, in comparison to a CPC system with a concentration factor of 1.0. Doubling the lethal UVA dose prevented the need for a period of post-exposure dark inactivation and reduced the overall treatment time. Using this reactor, SODIS can be automatically carried out at an affordable cost, with reduced exposure time and minimal user input.