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Water Decontamination Using Ozone-Based Microreactor Technology

KWJ Engineering is currently developing ozone based water decontamination technology for the US Army for efficient water management in field operations of the mobile kitchen sanitation center. The technology will aid reduction of contaminant levels in the wash, rinse and discharge streams of the mobile kitchen sanitation center and allow recycle of effluent streams to reduce freshwater demand. The use of ozone, a powerful oxidizing gas capable of broadly neutralizing harmful species, provides an effective approach for decontamination in gaseous and aqueous phases. Microplasma-based ozone generation technology in particular, can be adapted for portable water-purification and the removal of toxic contaminants.

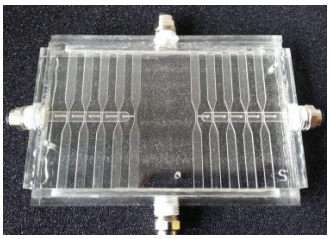

Figure 1. Scaled-up microreactor module used for greywater

The primary components of the decontamination system are a microplasma ozone generator and a multichannel gas-liquid microreactor for ozonolysis. The microplasma ozone generator has the potential for high conversion rates of air to ozone and the microreactor offers high mass transfer and reactivity for decontamination of wastewater with low power consumption in a compact and easily scalable modular design. Figure 1 shows the microreactor modules consisting of 10 individual microreactors with 2 gas ports and 2 liquid ports. The overall process schematic is shown in Figure 2.

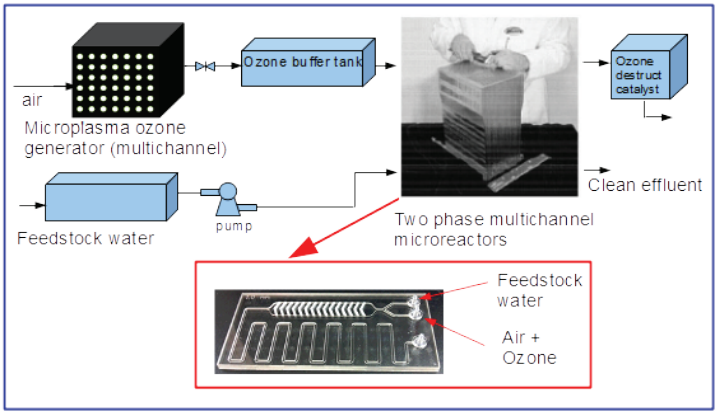

Figure 2. Conceptual schematic of overall process

Turbidity reduction (<50 NTU) and coliform destruction (NASA SBIR) has been achieved using KWJ's microreactor technology. Currently the technology is being scaled up to decontaminate up to 60 gallons of greywater using ozonation and further post-processing. Some of the turbidity reduction results achieved using microreactor modules are shown in Figure 3.

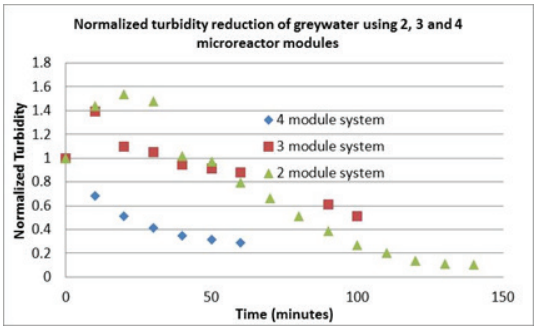

Figure 3. Comparison of 2, 3 and 4 microreactor module performance with normalized turbidity (each module has 10 microreactors)

The Army's field kitchen operations will be improved by reducing the need for fresh water supply and exit stream processing with the technology currently in development. In addition, the integrated system will be portable, compact (multiple microreactors in a module) and low weight with low power requirements. This will enable rapid assembly, disassembly and easy transport for field deployment. The system uses ambient air for in-situ ozone generation and does not deploy consumables such as filters, making it virtually maintenance-free for long term operation. Turn-key features for ease of use, low cost, and scalability for adaptable processed water throughput are additional benefits to reduce sustainment costs. The adaptability of the system and the powerful disinfecting characteristics of ozone facilitate deployment for soil remediation (oil spills), emergency disaster relief (water purification), and also for neutralizing warfare agents such as sulfur mustard (gaseous ozone).