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Supercritical Water Oxidation Of Chemical Warfare Agents And Surrogates

Igor Novosselov University of Washington **Stuart Moore** The University of Washington **Anmol Purohit** The University of Washington **Brian Pinkard** The University of Washington

Supercritical water was first explored as a reaction medium in the 1970s for the hydrothermal refining of organic compounds to gaseous products. Supercritical water oxidation (SCWO) is primarily used for neutralizing toxic waste. Under supercritical conditions, organic compounds and oxygen become fully miscible in water, allowing oxidation to occur in a single fluid phase with excellent transport properties. This work demonstrates the mineralization of CWA and CWA surrogates in a lab-scale SCWO reactor. This continuous process offers several advantages over the current batch NaOH hydrolysis process: the fast decomposition rates enable a dramatic reduction of the system's Size, Weight, and Power (SWAP) requirements, and a single-step, continuous process reduces the direct involvement of the plant operator. The first point envisions a portable, skid-mounted system, while the latter focuses on reducing manpower requirements, training, and opportunities for error. Basic research is, however, required to advance this concept to the practical application of CWA neutralization. Specifically, this work addresses: (1) the fundamental chemical kinetic rates for agent decomposition over the range of operating conditions, (2) the fate of potentially toxic intermediates, (3) the strategies for corrosion control, and (4) the automated process control. Several basic and applied research topics were investigated, leading to the development of a small footprint (mobile), flexible, low-cost CWA neutralization platform. The platform was operated for several months and was tuned for the destruction of CWA surrogate (DMMP) and then was evaluated for the destruction of GB and HD agents at the U.S. Army DEVCOM Chemical Biological Center. Complete mineralization (99.99+%) of DMMP, GB, and HD (no detection, based limit of detection of the analytical methods) was achieved for all targets.

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