

MITIGATION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL HAZARD MITIGATION

Autonomous Surface And Airborne Chemical And Biological Decontamination Via Peroxide Enhanced Germicidal Irradiation (pegi)

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Peroxide Enhanced Germicidal Irradiation (PEGI) is a novel technology that combines low concentration hydrogen peroxide (H₂O₂) vapor with UV irradiation to provide a 10-100X more rapid inactivation of airborne and surface bio-contaminants than individual constituents alone. PEGI technology can be adapted for deployment via autonomous systems with low resource needs, low powered battery powered nebulization of low concentration hydrogen peroxide and UV leds are the main requirement, making it a solution to reduce human risk in rapid asset decontamination.

Increased attention has been paid to disinfection of bioaerosols and surfaces leveraging advanced oxidative processes (AOPs). AOPs are widely used in water treatment applications and rely on highly reactive intermediary species to induce oxidative damage of biological materials. These intermediary species (most often hydroxyl radicals) are typically produced by the combination of one or more primary oxidants such as hydrogen peroxide alongside an energy source such as ultraviolet light. Hydroxyl radicals (OH•) are highly reactive due to their unstable nature and seek chemical stabilization, thus reacting rapidly with a high degree of non-specificity with biological and chemical species. In the case of H₂O₂, which in and of itself is a potent disinfectant, interaction with UV-C wavelengths between 210 nm and 350 nm photolyzes H₂O₂ molecules to generate hydroxyl radicals.

PEGI work to date has focused on the decontamination of airborne and surface biological pathogens within large spaces for the purposes of whole room or large asset decontamination with a number of variables studied including humidity, UV wavelength and volume. Effectiveness of this new combined approach has been shown against a variety of pathogens for example against airborne MS2 Virus, tested in a 10 m³ chamber at high humidity (60%) with a low-dose 254 nm UV source with just 1ppm of airborne H₂O₂ a log 6 reduction or inactivation of the virus was achieved in 45 minutes contact time. In addition to airborne decontamination PEGI has shown rapid (10 seconds) surface inactivation of Bacillus subtilis spores on a variety of surfaces for example polystyrene and vinyl fabric substrates, using 3% H₂O₂ misted onto tested surfaces. PEGI work to date has focused on optimization of this technology with the lowest possible inputs of UV and H₂O₂ and

Whilst the effectiveness of PEGI as a means for biological decontamination has been shown future interest areas include using PEGI as an AOP in the decontamination of chemical substances of interest for example fentanyl as other studies and the EPA do recommend hydrogen peroxide an effective species for decontamination. The benefits of PEGI for biological decontamination are also expected for oxidation and degradation of chemical contaminants.