

Trace Detection and Quantification of Hydrogen Peroxide Permeation through Polymeric Barriers

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Hydrogen peroxide (H_2O_2), can be used to make improvised explosives or incendiary weapons. Recent terrorist plots have involved hydrogen peroxide-based weapons in part because the ingredients are common and thus fairly easy to obtain and because the improvised device often resembles a bottled drink. In this talk we show an apparatus and method to detect and quantify the permeation of H_2O_2 through polymer barriers (i.e., plastic bottles). A two-chamber H_2O_2 permeation cell was developed that utilizes stirrers in both chambers and a septum crimp-cap in the top that allows for sampling of the liquid in the top chamber. Initially, the top chamber is pure deionized (DI) water and the bottom chamber is a solution of hydrogen peroxide. A sample is taken from the top chamber at different time points and analyzed for trace quantities of hydrogen peroxide. An analytical method developed by the Transportation Security Laboratory (DHS) that utilizes an HPLC-Fluorescence Detector was implemented in our laboratory. The HPLC method detects H_2O_2 in water via measuring the fluorescent dimer, 6,6'-dihydroxy-3,3'-biphenylacetic acid. The fluorescent dimer is generated when a H_2O_2 solution is mixed with a with 500 mM hydroxyphenylacetic acid reagent (0.1 M potassium hydroxide and 25 mM hematin solution). Measurements have been performed with 35 and 50 % hydrogen peroxide. The polymer barrier used was obtained from a blow-molded (polyethylene terephthalate) PET bottle that was 0.009 in thick. Sample aliquots were withdrawn from the top chamber at different time points and analyzed as discussed above. We discuss how the increase in hydrogen peroxide concentration in the upper (water) chamber can be used to track the permeation through the barrier.