Indirect Detection of Intentional Chemical Contamination in the Distribution System Using Low Cost Turbidity Sensors

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Abstract. Rapid detection of chemical contamination in the distribution system is essential in protecting public health, and using water quality surrogates to signal a contamination event offers the advantage of detecting a large number of chemicals. The concern over using surrogate parameters is whether they offer the ability to detect contaminants at concentrations low enough to prevent serious illness. The best candidates for water quality surrogates are generally thought to be chlorine residual and TOC, with conductivity, pH and turbidity being less sensitive to many chemical contaminants. All of these surrogate measurements have been in direct response to the chemical contaminant itself. This paper describes research on how the indigenous biofilm in the presence of toxic chemicals may provide an effective, indirect surrogate response with either turbidity or UV254. Rotating annular bioreactors and pipe loops were used to quantify the effect that the biofilm has on the turbidity and UV254 measurements. The hypothesis is that, if toxic chemicals are added to the distribution system, the biofilm would die and slough off to an extent that would change the UV254 absorbance and light scattering of the water so that relatively inexpensive monitors could detect the event. In previously documented work, three reactors with 20 PVC coupons in each were used to acclimate the biofilm for at least six weeks. The number of biofilm cells on each coupon was enumerated using automated fluorescence microscopy. The coupons were submersed into beakers with four potential chemical contaminants; aldicarb, cyanide, arsenate and fluoroacetate. The concentration of the contaminants was less than 1 mg/L, a concentration that was shown to be feasible to achieve in a distribution system in previous research. The turbidity was measured after 1, 8 and 48 minutes to determine the response time of the biofilm to the chemicals. In all cases, the turbidity significantly increased after one minute and in most cases continued to increase at the longer times. The batch data indicate that turbidity may be a useful surrogate monitor for chemical contamination due to die-off of the indigenous biofilms Biofilm slough-off and increased turbidity response occurred in the present study in which a commonly used turbidity monitor and a simple, inexpensive turbidity sensor monitored a simulated distribution system inoculated with five common industrial chemical contaminants. We will detail the results of the pipe loop study at the conference and describe the inexpensive turbidity monitor that has been developed.