Quenching $\text{H}_2\text{O}_2$ Residuals After UV/ $\text{H}_2\text{O}_2$ Drinking Water Treatment Using Granular Activated Carbon

Jinghong (Elena) Li $^{1,3}$, Arash Zamyadi $^1$, Ron Hofmann $^1$, Jane Bonsteel $^2$

$^1$ Department of Civil Engineering, University of Toronto
35 St. George St., Toronto, Ontario M5S 1A4

$^2$Region of Peel

$^3$Author to whom correspondence should be addressed

EXTENDED ABSTRACT

The use of ultraviolet light coupled with hydrogen peroxide (UV/$\text{H}_2\text{O}_2$) as an advanced oxidation treatment for taste and odor control during drinking water treatment is an emerging technology, with a new installation at the Lorne Park Water Treatment Facility in the Region of Peel (Ontario, Canada). A challenge with UV/$\text{H}_2\text{O}_2$ is that the majority of the applied $\text{H}_2\text{O}_2$ remains in the water following UV/$\text{H}_2\text{O}_2$ treatment, and must be removed prior to secondary disinfection since it exerts a strong chlorine demand (Dotson et al., 2010). The Lorne Park plant is using a granular activated carbon (GAC) contactor to quench the residual $\text{H}_2\text{O}_2$.

The fundamental process by which GAC decomposes $\text{H}_2\text{O}_2$ has not been well-studied, so there is some question as to which type of GAC works best for this application, how long the GAC may last, and which factors may help or hinder the process.

A pilot-scale test was undertaken at the Lorne Park Water Treatment Facility, coupled with laboratory tests, to examine $\text{H}_2\text{O}_2$ quenching as a function of six different types of GAC, monitoring the performance over time. The impact of continuous versus periodic exposure to $\text{H}_2\text{O}_2$ was also examined, since facilities experiencing only periodic taste and odour events will operate $\text{H}_2\text{O}_2$ in an on/off mode. The deterioration of the GAC over time and exposure to $\text{H}_2\text{O}_2$ was tracked through surface analysis of the GAC using SEM imagery and XPS analysis, and through $\text{H}_2\text{O}_2$ reaction kinetics tests.

Pilot-scale results showed that the $\text{H}_2\text{O}_2$ quenching performance for all GACs tested deteriorated quite quickly during the early stages of application (e.g. the first 25,000 bed volumes of water treated), but thereafter the performance stabilized and quenching capacity remained relatively stable for beyond 100,000 bed volumes treated (the maximum length of the experiment to date). The presence of $\text{H}_2\text{O}_2$ in the water flowing through the GAC contactor had a measurable but relatively small effect on causing additional reduction in GAC-$\text{H}_2\text{O}_2$ reactivity, but most of the deterioration in performance is thought to be unrelated to the presence/absence of $\text{H}_2\text{O}_2$. This suggests that the majority of the GAC-$\text{H}_2\text{O}_2$ reaction may be catalytic.
This work will be of interest to professionals who are considering alternate methods to quench residual H$_2$O$_2$ following UV-AOP treatment, by removing some of the uncertainty surrounding design criteria and GAC selection.

Figure 1: Pilot-scale Installation at the Lorne Park Water Treatment Facility

(A: Full pilot-scale set-up, with 22 columns; B: sampling ports, four ports on each column)
REFERENCES

Dotson, A., Corwin, C., Rowley, C., Downs, M., Linden, K., 2010. Dynamic bench-scale quenching of \( \text{H}_2\text{O}_2 \) by GAC. Savannah, Georgia, USA: AWWA WQTC.