

# RegenOx™

## Advanced Chemical Oxidation

### Carbonate Scavenging

#### What is “Carbonate Scavenging?”

In environmental applications of free-radical mediated oxidation chemistry, much ado has been made about the potential for “carbonate scavenging.” This term is meant to describe the process by which the carbonate ion loses an electron to become the carbonate radical ( $\text{CO}_3^{\cdot-}$ ).

#### *Carbonate Radical Adds to Longevity*

The carbonate radical is a secondary radical that usually results from the reaction of hydroxyl radical with carbonate/bicarbonate in chemical oxidation processes.<sup>1</sup> As such, carbonate is known as a hydroxyl radical “scavenger” in the advanced oxidation process literature. It should be noted that the resulting carbonate radical is not an end product, but rather a reactive intermediate. Compared to a hydroxyl radical, it reacts with target groundwater contaminants more slowly which, in fact, may be advantageous. In the treatment of groundwater *in-situ*, extremely fast oxidant decomposition is a disadvantage. Time is needed for the chemical oxidant to come in contact with the contaminant because of incomplete mixing and other distribution issues in the subsurface. Therefore, an oxidant with some longevity offers a better chance of being distributed and therefore can be more effective in groundwater remediation.<sup>1,2</sup>

#### What is the Role of Carbonate in RegenOx?

#### “One man’s scavenging is another man’s stabilization”

The percarbonate-based RegenOx treatment system offers reasonably fast contaminant reduction rates and sufficient longevity to offer cost-effective distribution. RegenOx is a catalyzed form of the powerful chemical oxidant percarbonate. Percarbonate is often referred to as solid hydrogen peroxide as it is a stabilized form of hydrogen peroxide whereby three molecules of hydrogen peroxide are bound to two carbonate molecules ( $(\text{Na}_2\text{CO}_3)_2(\text{H}_2\text{O}_2)_3$ ). When placed into a contaminated aquifer, the percarbonate is slower to react than hydrogen peroxide alone, but still offers rapid contaminant degradation in the presence of the catalyst system. The presence of carbonate slows the destruction of peroxide, but does not lower the overall capacity of the oxidant. The formation of the carbonate radical (“scavenging”) adds to the stability of the peroxide in the percarbonate. In controlled laboratory experiments, researchers found that the net amount of contaminant destruction per hydrogen peroxide consumed did not significantly change in the presence of carbonate. Carbonate only reduced the rate of hydrogen peroxide decomposition.<sup>3</sup>

## Summary

Under the conditions of RegenOx oxidation it is likely that some carbonate radical is formed. However, it is not a terminal end product, but rather an oxidant itself. It is important to note that carbonate radical is a reactive species that can contribute to the overall oxidation of contaminants. It is not a terminal pathway or a “scavenger” as many have described it. Carbonate radical is not the major active species in RegenOx as applied; however, the small quantities that are generated do contribute to the oxidation of contaminants and intermediates.

## Works Cited

1. Huang, Jipin and Mabury S., Steady-State Concentrations of Carbonate Radicals in Field Waters. *Environmental Toxicology and Chemistry*. August 2000, 2181-2188.
2. Canonica S., Kohn T., Mac M., Real F.J., Wirz J., and von Gunten U., Photosensitizer Method to Determine Rate Constants for the Reaction of Carbonate Radical with Organic Compounds. *Environmental Science & Technology* 2005. Vol. 39, num. 23, p. 9182-9188.
3. Valentine R. and Wang A., Iron Oxide Surface Catalyzed Oxidation of Quinoline by Hydrogen Peroxide. *Journal of Environmental Engineering*. January 1998.