

# RegenOx™

## Advanced Chemical Oxidation

### Groundwater Temperature and Pressure after Application

RegenOx™ uses a solid alkaline oxidant with sodium percarbonate as the main active ingredient. The product is delivered as two parts that are combined and injected into the subsurface using common drilling or direct-push equipment. Once in the subsurface, the combined product produces an effective oxidation reaction comparable to that of Fenton's reagent, yet without a violent exothermic hazard. As a result of this reaction RegenOx safely, effectively and rapidly destroys a wide range of contaminants in both soil and groundwater.

Considering a Fenton's-type treatment, all the hydrogen peroxide is immediately available for reaction. In its infancy, Fenton's-type oxidations were applied using hydrogen peroxide concentrations as high as 30%. More recently, concentrations are typically lower at or near 16% hydrogen peroxide. Regardless of the percentage, the hydrogen peroxide is immediately available to react causing extreme temperature and pressure increases. Because of the Arrhenius response to temperature, the reaction rates increase and as a result, large temperature and pressure increases can often be measured (Figure 1). One liter of a 16% hydrogen peroxide solution can produce 300 liters of vapor instantaneously under typical Fenton's-type reaction conditions.

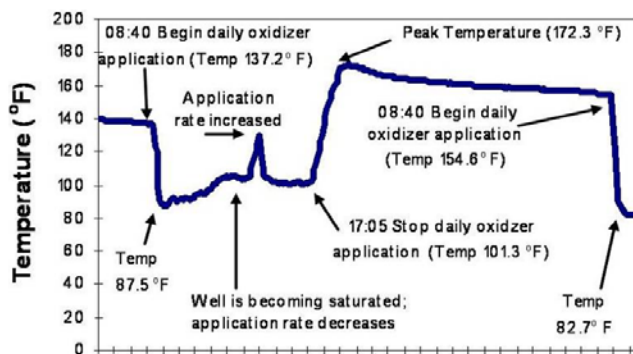


Figure 1. Fenton's Reagent Temperature Effects

In contrast, RegenOx is typically applied as an 8% solution which is approximately 3% bounded-hydrogen peroxide. Under RegenOx reaction conditions, the hydrogen peroxide becomes available for reaction as it is slowly released in a controlled manner from the carbonate ion. In field application, RegenOx produces a mild exothermic reaction that may result in a gradual temperature increase over 5-10 days. Groundwater temperatures typically return to ambient levels after 10-20 days (Figures 2 and 3). Both temperature profiles were at sites in which approximately 1000 pounds of oxidant was delivered as a 12% solution over a 2 day injection period. The overall temperature increase has not been observed to exceed approximately 5 degrees Celsius (8 degrees Fahrenheit). Increased pressures have only been observed during the injection event as a function of physical injection pressure and

localized groundwater mounding and/or short-circuiting. Some oxygen gas may be produced during RegenOx injections, however the amount is much less than a comparable Fenton's application.

Thus, observation of RegenOx application in the field demonstrates that it does not produce violent exothermic reactions that are commonly associated with other Fenton-type chemical oxidation applications and therefore is considered a safer subsurface contaminant oxidant.

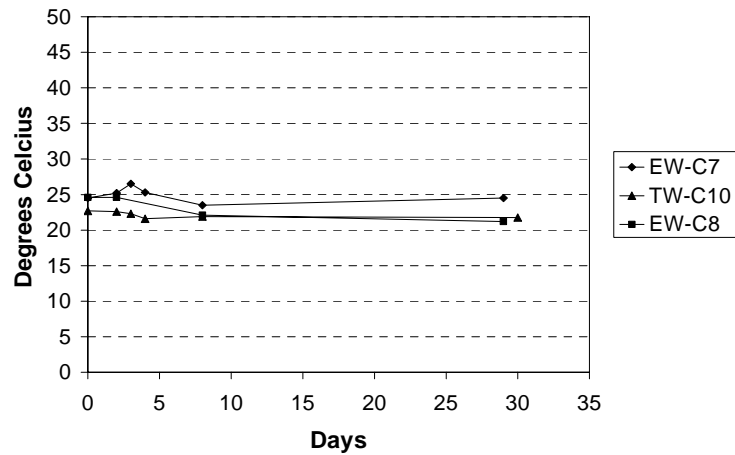


Figure 2. Temperature at Georgia Beta Test Site

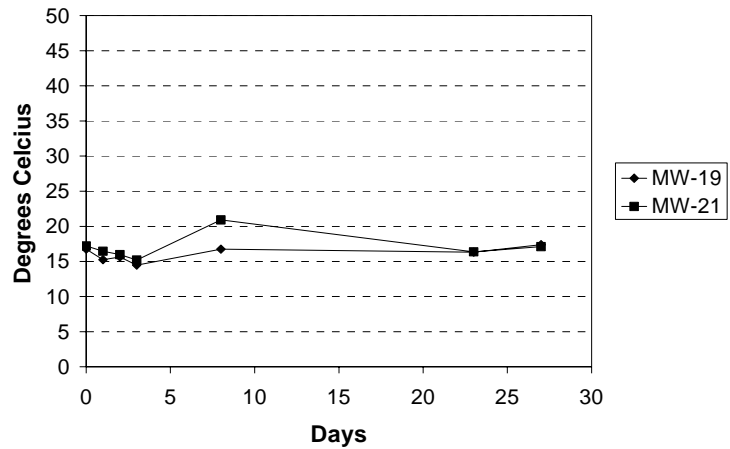


Figure 3. Temperature at Vermont Beta Test Site