Lessons Learned from Injecting More Than One Hundred Tons of Potassium Persulfate

Drew Baird (dbaird@frx-inc.com) (FRx, Inc., Charlotte, NC, USA)
Doug Knight and Jesse Lowe (FRx, Inc., Travelers Rest, SC, USA)

Background/Objectives. Persulfate has long been known to present very strong oxidation potential and thereby degrade some of the most recalcitrant contaminants. As a liquid reagent it has been applied routinely through direct push drilling equipment and screened wells. Within the last five years it has become commercially available in solid form as potassium persulfate (KP). Solid granules can be placed in the subsurface to act as a long-term, passive source of oxidant that distributes in situ by both diffusive and advective processes.

Hydraulic fracturing provides a robust method to install massive amounts of granular solids at precise locations in the subsurface. Hydraulic fracturing with potassium permanganate ($KMnO_4$), another granular oxidizer, has been conducted since the late 1990's, and safety paradigms and protocols for it have been established. This presentation summarizes relevant experience with KP accumulated since 2017.

Approach/Activities: In aggregate, more than 130 metric tons of KP were injected into contaminated formations at five sites in diverse geologic settings. At four sites, KP was received in supersacks and staged in secure facilities prior to use; smaller packaging was utilized at one site based on project-specific needs. Supersacks were moved by all-terrain, variable reach forklift that permits adroit positioning of each bag above injection equipment. The equipment metered the granular solids into a continuous mixer along with water viscosified in a fashion similar to making slurries with $KMnO_4$. The resultant slurry was distributed by hose to injection points comprising direct push rods. Injection pressure was observed by strategically positioned gauges and logged electronically at 0.5 Hz.

Results/Lessons Learned. In many ways, handling granular KP presents the same challenges as handling granular $KMnO_4$. KP packaging, handling, mixing, and injection practices follow from 20 years of experience injecting more than 670 tons of $KMnO_4$. Risks related to dust generation, personnel exposure, and spill prevention and mitigation are carefully considered and incorporated into prudent practice. From the perspective of personnel exposure, light contact with KP slurry does not result in skin discoloration or brown staining that occurs with $KMnO_4$ even though heavy contact can still cause irritation and needs to be avoided.

Unlike $KMnO_4$, KP is typically activated with various compounds that affect slurry chemistry and characteristics, and safe handling and material compatibility must be thoroughly evaluated for different KP activation methods. Alkaline activation of KP with hydrated lime reduces corrosion effects on carbon steel and other equipment components. Additional engineering controls incorporate stainless steel and other chemically resistant materials that have proven to be an effective means of minimizing potential equipment compatibility issues.