A Comparison of In-Situ Chemical Delivery Methods

A series of three chemical oxidant injection events, utilizing different techniques, was conducted at a petroleum impacted site. Subsurface soils are unconsolidated, poorly sorted, fine to coarse grain size sands, with some fine gravel. The depth to groundwater ranges between 8½ and 12½ feet below grade surface; this is the water table of an unconfined aquifer having a thickness of approximately 100 feet, and bound at depth by a semi-confining clay unit.

During each application event, the oxidant was mixed onsite following the manufacturer's specifications. Injection was conducted through temporary boreholes, installed using direct-push/percussion-hammer equipment. The injection target depth was between 10 feet and 18 feet below grade surface.

Summary of Injection Methods & Performance Evaluation

	Method I Diaphragm Pump	Method II Diaphragm Pump, coupled with supplemental injection tool	Method III Kinetically Adjustable Pore Space Dilation Injection Delivery System
Vertical Treatment Zone	12-18 feet below grade	12-18 feet below grade	10-19 feet below grade
Number of Injection Depths per borehole	3	3	3
Vertical Influence per Injection Depth	1 - 2 feet	1 - 2 feet	4 - 5 feet
Number of Injection Points Completed	1	1	12
Volume of Mixture Applied	137 gallons (~69% of total anticipated volume)	175 gallons (~88% of the total anticipated volume)	1,500 gallons/injection point (18,500 gallons total)
Mass of Oxidant Applied	110 lbs per boring	140 lbs per boring	750 lbs per boring (9,050 lbs total)
Application Event Duration	1 day	1 day	7 days (2,600 gallons/day average)
Daylighting (surfacing)	from the injection rod annulus limiting the injected volume	from the injection rod annulus limiting the injected volume	at a distance from the borehole, minimal volume from the injection rod annulus that did not limit the volume injected
Observed Influence in Monitoring Wells	none observed, <5 feet	>5 feet (30 ppm of H_2O_2) <10 feet from the injection point observed the day following injection activities	At least 14 feet (60 ppm H_2O_2) from the injection point observed during injection activities

The above assessment between the three methods define the higher performance achieved utilizing Kinetically Adjustable Pore Space Dilation Injection Delivery System (KAPSDIDS). By comparison, oxidant solution was delivered at least 3 times further from the injection point at higher solution strength using KAPSDIDS. With an average injection rate of 28 gallons per minute, 500 gallons of

treatment chemical was distributed to the target depth in less than 20 minutes. Significantly higher flow rates and chemical distribution reduce the number of injection locations and time on-site.

The core achievement of this technology is the distribution and physical contact between treatment solution and impacted media, resulting in increased remedial effectiveness. Differences of chemical distribution are evident in analysis of the field-screened peroxide concentrations.

Designed by Badger Injection Solutions, LLC, KAPSDIDS enables target emplacement of a broad range of in-situ remediation products faster and farther from the point of injection than any other available method. For additional details about the Badger KAPSDIDS, please visit our website (enviro-asmnt.com & badgerinjectionsolutions.com) or contact Environmental Assessment & Remediations, your Badger Regional Service Provider - Jaime Brown 631.447.6400 ext 153 or JBrown@Enviro-Asmnt.com.