CATALYZED PERSULFATE OXIDATION TREATABILITY STUDY

LACQUER MANUFACTURING PLANT
NORTHERN INDIANA

Clients: **Confidential**

Contaminants: **MIBK, Toluene, Xylenes (17 Total VOC's)**

Impacted Matrix: **Saturated Soils and Perched Ground Water**

Augmentations: **Catalyzed Persulfate (Klozur™) and Proprietary Catalyst**

PROJECT OVERVIEW:

Specialty Earth Sciences, LLC was contracted to provide reduction of VOC mass present within saturated soils and ground water located beneath and adjacent to a lacquer manufacturing facility. Shallow ground water, tight soils, location of heavily impacted area, and numerous co-mingled contaminants provided for a very challenging remedial application.

In-situ persulfate oxidation was selected as the remedial method of choice based upon the chemical properties of the contaminants, local geology, impacted area logistics, and favorable bench scale testing results.

PERSULFATE OXIDATION TECHNOLOGY OVERVIEW:

Persulfates are the most powerful oxidants of the peroxygen family. They exist as salts and are available in a sodium, potassium, or ammonium form. Persulfates are commonly used for many industrial purposes including cosmetics and pharmaceuticals (such as the preparation of antibiotics). The use of persulfates in ground water treatment applications is a relatively new technology, developed for use with contaminants that are typically not amenable to oxidation using other, more traditional oxidants such as ozone or permanganate.

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Modified advanced oxidation technology (mAOT-*persulfate*) relies on the enhanced delivery of a catalyzed persulfate compound within the subsurface providing recalcitrant contaminant remediation; with final benign reaction products of carbon dioxide, water, inorganic salts, and chloride ions via free radical and anion radical processes.

Sodium persulfate is very stable and can persist in an optimum ground water environment for substantial lengths of time. The long lasting effects of the oxidant compound coupled with its high level of solubility can typically provide greater in-situ influence than more traditional oxidant compounds.

INJECTION AREA WITHIN CHEMICAL TRANSFER ROOM OF FACILITY

PERSULFATE OXIDATION INJECTION EVENT:

Chemical injections were implemented over 1.5 weeks utilizing a combination of Klozur™ persulfate oxidant, hydrogen peroxide, and proprietary catalyst solution; in conjunction with Subterranean Hydrocarbon Oxidation Circulation (SHOC) in-situ delivery techniques. Inoculate mixtures and concentrations were derived from in-house bench scale testing, site geology, stoichiometry, FMC (Klozur™ persulfate manufacturer) correspondence, and experience at similar sites within the region.

FIELD TESTING OF OXIDANT DISPERSION WITHIN THE FORMATION.

A total of 3,750 lbs. of sodium persulfate, 575 lbs.-*approx.* of hydrogen peroxide, and 780 lbs.-*approx.* of hydrated proprietary catalyst compounds were injected into the subsurface formation (very shallow 2′ – 8′ vertical interval) during the course of an 8 day period.

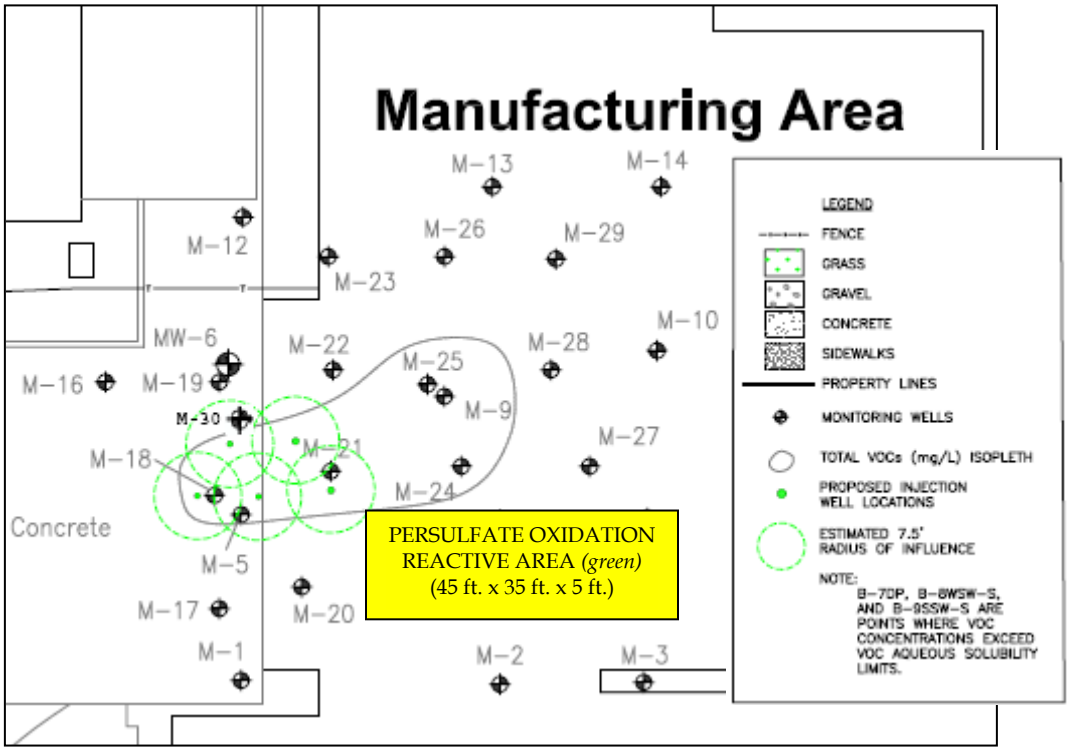
The subsurface formation consisted of plastic sandy clays (approx. 0-8′) underlain by very stiff clays; with a perched water zone located 1′ to 8′ below grade.

PERSULFATE OXIDATION INJECTION EFFECTIVENESS:

Post analytical results (Post 7-Day, Post 45-Day, Post 100-Day) demonstrated an overall total VOC reduction of the following,

Primary Observation Wells: 242,000 µg/L within M-21,
187,324 µg/L within M-30,
7,565 µg/L within M-18.

Secondary Observation Wells: 14,262 µg/L within M-22,
8,535 µg/L within M-17.



SITE LAYOUT WITH PERSULFATE INJECTION SCENERIO

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PRIMARY PERFORMANCE OBSERVATION WELLS: M-21, M-30, M-18

SECONDARY PERFORMANCE OBSERVATION WELLS: M-22, M-17

***Results reported in µg/L.**

	Sample Date	MIBK	Toluene	Ethylbenzene	Xylenes	Total VOC's
M-21	3/5/2007	46,000	35,900	6,640	25,700	116,640
	1/11/2007	63,000	91,100	11,500	49,900	220,321
	11/27/2006	80,800	100,000	12,640	54,280	249,648
	Persulfate Oxidation Event (11-14-06)					
	11/13/06	**226,000**	**80,400**	**9,900**	**42,400**	**358,700**

	Sample Date	MIBK	Toluene	Ethylbenzene	Xylenes	Total VOC's
M-30	3/5/2007	72,300	3,970	726	3,520	88,086
	1/11/2007	122,000	5,270	< 5	5,260	141,222
	11/27/2006	188,000	3,160	702	3,230	202,832
	Persulfate Oxidation Event (11-14-06)					
	11/13/06	**242,000**	**21,300**	**1,910**	**10,200**	**275,410**

	Sample Date	MIBK	Toluene	Ethylbenzene	Xylenes	Total VOC's
M-18	3/5/2007	131,000	5,120	<1,000	<2,000	146,690
	1/11/2007	147,000	11,200	1,300	6,180	175,117
	11/27/2006	109,000	6,540	1,000	2,813	125,478
	Persulfate Oxidation Event (11-14-06)					
	11/13/06	**151,000**	**6,730**	**343**	**1,640**	**164,255**

	Sample Date	MIBK	Toluene	Ethylbenzene	Xylenes	Total VOC's
M-22	3/5/2007	6,250	< 50	< 50	2,150	10,448
	1/11/2007	3,280	4,070	1,030	5,390	18,251
	11/27/2006	11,140	5,100	93	527	17,262
	Persulfate Oxidation Event (11-14-06)					
	11/13/06	**10,700**	**7,120**	**1,000**	**5,890**	**24,710**

	Sample Date	MIBK	Toluene	Ethylbenzene	Xylenes	Total VOC's
M-17	3/5/2007	3,790	< 50	< 50	169	6,383
	1/11/2007	10,800	175	83	947	19,455
	11/27/2006	13,090	199	75	628	20,753
	Persulfate Oxidation Event (11-14-06)					
	11/13/06	**14,100**	**73**	**23**	**226**	**14,918**

COSTS SAVINGS:

Projected Cost Savings: **$550,000**

(Based on the following: partial facility demolition, soils excavation, de-watering activities, transport, disposal, partial facility new construction, temporary operations shut-down).

CURRENT SITE STATUS:

Client is currently seeking post closure monitoring status based on the persulfate oxidation results, modeled plume stability, and Voluntary Remediation Program (VRP) criteria.