Dynamic Underground Stripping

Hydrous Pyrolysis/Oxidation

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

Problem:

The issue of spills and plumes of conventional materials such as solvents, fuels, and mixtures or organic materials is significant. Estimates have shown that DOE has a $10-billion legacy of such plumes to clean up. Plumes of contaminants in groundwater pose several problems: hazards to public safety and health when the water is used, cleanup cost burdens to property owners, and, because of the associated liabilities, transfer of property ownership. While transferring property is not a burden to most DOE sites (which are likely to remain in government possession indefinitely), it is an obstacle to DoD site closure and reuse of valuable lands. That method works well for near-term regulatory compliance (the site owner is doing something in good faith) to control the spread of plumes, but it rarely removes all the contaminants. Toxic compounds in spills have had decades to sink and bind to fine silts and clays. They are unlikely to be removed by simply slowly flushing water through them.

Solution:

Lawrence Livermore National Laboratory developed Dynamic Underground Stripping which uses steam applied to the subsurface environment to mobilize difficult materials such as heavy oils, which can be extracted at greatly accelerated rates. This method for treating underground contaminants with heat is much faster and more effective than traditional treatment methods. Livermore scientists also developed Hydrous Pyrolysis/Oxidation, a process that converts contaminants in the ground to such benign products as carbon dioxide, chloride ions, and water. By introducing both heat and oxygen, this process has effectively destroyed all petroleum and solvent contaminants that have been subjected to laboratory tests.

Southern California Edison beginning test steam injections.

Application:

During the summer of 1997, both processes were used for cleanup of a four-acre site in Visalia, California, owned by Southern California Edison. The utility company had used the site for 80 years to treat utility poles by dipping them into creosote, a pentachlorophenol compound, or both. By the 1970s, these highly toxic substances had seeped into the subsurface to depths of approximately 100 feet. During the first six weeks of operation, between June and August 1997, the team removed or destroyed in place approximately 300,000 pounds (135 metric tons) of contaminants, a rate of about 46,000 pounds (22 metric tons) per week. Previously, Southern California Edison had been removing contaminants from the subsurface using pump-and-treat most recently at a rate of just 10 pounds (0.03 metric tons) per week. In contrast, the amount of hydrocarbons removed or destroyed in place in those six weeks was equivalent to 600 years of pump-and-treat, about 5,000 times the previous removal rate.

Plans exist to apply Dynamic Underground Stripping and Hydrous Pyrolysis/Oxidation at eight other EPA Superfund sites, and three Department of Energy sites including: Portsmouth (already begun), Savannah River Site, and Los Alamos National Laboratory.

Benefits:

- Significantly increases reaction rates; decreases remediation time
- Provides an economical alternative to pump-and-treat or pump-and-treat with vacuum extraction
- Encourages bioremediation — an important final step in soil and groundwater cleanups
- Eliminates need for further treatment, handling, and disposal requirements (Hydrous Pyrolysis/Oxidation)

An employee clears condensed water from the steam line prior to start of injection at the test site. Condensate is removed to avoid water hammer in the steam lines.

"...the technology saves money. Before using [Dynamic Underground Stripping], the utility estimated it would have to pay $1 million annually for decades to clean the site. And at that, plenty of pollutants would have remained stuck in the soil and rock, up to 115 feet below the surface of the pole yard. With the new process, [Southern California Edison] will pay just $20 million to restore the site." (Thomas York, *Investor's Business Daily*)[1]

"In its first nine months of use at the Visalia site, dynamic underground stripping removed or destroyed contaminants that would have required more than 1,000 years with traditional methods" (*Business Journal - Fresno,* December 7, 1998, "Difficult job of cleaning wood preservatives at industrial site underway" by Michele D'Ambrosio)[2]

Mechanical technician measuring the injection well to be used for the Hydrous Pyrolysis/Oxidation experiments at Visalia. Tracer gases and air will be added at the location of the small, red valve in the lower left; it is attached to a 1" stainless steel injection tube open in the steam zone. (Purpose of experiment was to verify mixing of steam, oxygen, and contaminants using tracer gases to measure amount of mixing.)

"Edison's success at extracting a 'nasty' brew of chemicals from beneath a utility pole yard in Visalia catches the attention of state and federal officials.....In 16 months, engineers have removed 902,000 pounds of contaminants at the Visalia site. It would have taken more than 1,000 years to achieve the same results using conventional pump-and-treat methods." (Sarah Yang, *Los Angeles Times*)[3]

"Steam injection, electricity may be used to clean Wyckoff site....It's working....This is the only site we know of where steam has been used to remove creosote contamination." (Laura T. Coffey, *Daily Journal of Commerce*)[4]

"Pump-and-treat remediation had been used at the Visalia site for 20 years, which on average removed only 10 pounds of the contaminant per week in the past few years.....Under the new [Dynamic Underground Stripping/Hydrous Pyrolysis Oxidation] method, it was possible to remove 300,000 pounds of the contaminant in six weeks." (Jennifer Silverman, *Daily Environment Report—Bureau of National Affairs*)[5]

"[Southern California Edison's] projected cost savings of $25 million in cleanup costs result from the vastly accelerated time frame of remediation than would have been possible using pump-and-treat and treat alone or enhanced in situ bioremediation alone."[6]

"Techniques being tested at Southern California Edison Visalia Pole Yard Superfund Site show impressive results.....This steam injection system [Dynamic Underground Stripping] has increased the rate of contaminant recovery more than 1,000-fold over a conventional "pump and treat" system." (Environmental Protection Agency)[7]

Chemist checks the flow of xenon tracer gas being injected along with cold water, prior to the first steam injection.

Sunset steam at Visalia.

Wide view of the Visalia site showing the two blue tanks that are now full of creosote-free product (40,000 gallons). Two more tanks were brought on the site as recovery continues at a high rate.

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[1] Thomas York, "'Targeting America's Dirtiest': New Super Technology Attacks Superfund Sites," *Investor's Business Daily* 20 December 1998.

[2] Michele D'Ambrosio, "Difficult job of cleaning wood preservatives at industrial site underway" *Business Journal - Fresno* 7 December 1998: 1.

[3] Sarah Yang, "Cleaning Soil With Steam: a Hot New Method," *Los Angeles Times* 26 November 1998: A11.

[4] Laura T. Coffey, "Deep heat considered for old creosote plant," *Daily Journal of Commerce* 28 April 1998.

[5] Jennifer Silverman, *Daily Environment Report— Bureau of National Affairs* 67 (8 April 1998): A8-9.

[6] Mark A. Cummings, Department of Energy, Los Alamos National Laboratory "Visalia Steam Remediation Project Case Study of an Integrated Approach to DNAPL Remediation," LA-UR-97-4000 (February 1998):1.

[7] The United States Environmental Protection Agency, Superfund in California "New Technology to Speed Clean Up and Reduce Costs" March 1998

For more information:

Jim Wright, DOE-Savannah River Site
(803) 725-5608
jamesb.wright@srs.gov

Kim Abbott, DOE-Oakland
(510) 637-1501
kim.abbott@oak.doe.gov

Dr. Roger Aines, Lawrence Livermore National Laboratory
Principal Investigator
(510) 423-7184
aines1@llnl.gov

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