



SITE

SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION



Demonstration Bulletin

Pneumatic Fracturing Extraction (™) and Hot Gas Injection, Phase I

Accutech Remedial Systems, Inc.

Technology Description: The Pneumatic Fracturing Extraction (™) (PFE) (™) process developed by Accutech Remedial Systems, Inc. makes it possible to use vapor extraction to remove volatile organics at increased rates from a broader range of vadose zones. The low permeability of silts, clays, shales, etc. would otherwise make such formations unsuitable for cost-effective vapor extraction and require more costly approaches. Pneumatic fracturing provides an innovative means of increasing the permeability of a formation and thus extending the radius of influence so that contaminants can be effectively extracted.

In the PFE process, fracture wells are drilled in the contaminated vadose zone and left open bore (uncased) for most of their depth. A packer system is used to isolate small (2 ft) intervals so that short bursts (~20 sec) of compressed air (less than 500 psig) can be injected into the interval to fracture the formation. The process is repeated for each interval. The fracturing extends and enlarges existing fissures and/or introduces new fractures, primarily in the horizontal direction. When fracturing has been completed, the formation is then subjected to vapor extraction, either by applying a vacuum to all wells or by extracting from selected

wells while others are capped or used for passive air inlet or forced air injection.

The developer also has proposed that catalytic oxidation can be cost-effectively used for aboveground treatment of the extracted VOCs, particularly when contaminant concentrations are above ~50 to 100 ppmv. Catalysts suitable for oxidation of chlorocarbons such as trichloroethene now are commercially available. In addition, Accutech has suggested injecting the waste heat from catalytic oxidation either directly or indirectly (using a heat exchanger) into the formation to further enhance volatilization and removal of VOCs.

Figure 1 presents a schematic of a total system as it might be used for remediation. The segments investigated in this SITE demonstration are shown with solid lines; the catalytic oxidation system is shown with dashed lines.

Waste Applicability: The Pneumatic Fracturing Extraction process should be particularly beneficial for the *in situ* removal of VOCs from formations with low permeability such as shales and

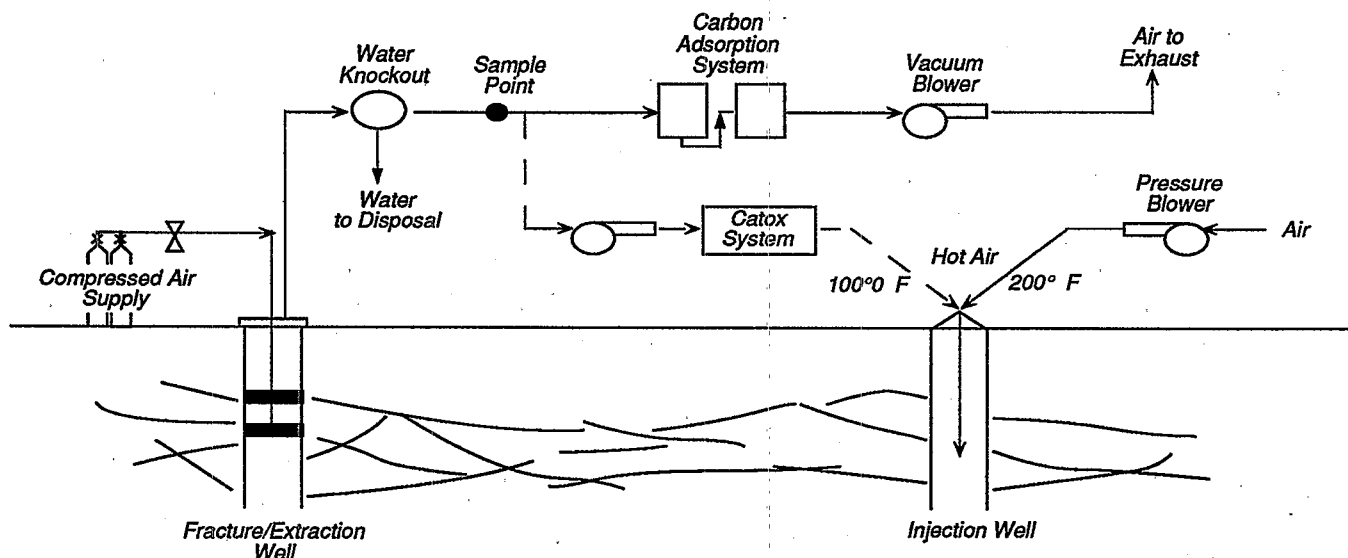


Figure 1. PFE system and operating modes.



other rock formations. According to the developer, the process also improves the vapor extraction rate for clays and even for sands, albeit to a lesser degree. The PFE process also may provide increased access to pockets of VOCs that otherwise might not be reached by conventional vapor extraction.

Site characteristics can be important in determining whether a site is suitable for PFE. Natural anomalies and man-made structures in the formation, such as faults, pipelines, existing wells, foundations, etc. all may influence the pattern achieved by fracturing, even to the extent of causing unexpected eruption to the surface. Free water in the vadose zone, such as perched water, may interfere with fracturing and with subsequent vapor extraction, or, at least, may change the nature of the fracturing that does occur.

The process has been demonstrated for the removal of chlorinated VOCs, specifically trichloroethene, but should be equally suitable for other volatile hydrocarbons such as benzene, toluene, ethyl benzene and xylenes.

Demonstration Results: The Accutech Pneumatic Fracturing Extraction process was demonstrated over a four-week period in August/September 1992 at an industrial site in north central New Jersey. A plan was devised to evaluate PFE in terms of air flow rate, TCE mass removal rate, and radius of influence for extraction. Site characteristics and the extent of contamination limited the demonstration to the comparison of results from *short term* (1 to 4 hr) vacuum extraction experiments before and after fracturing of the formation. To evaluate hot gas injection, hot air (~200°F) generated by compression heating was injected into one well in the formation while extracting from one or more other wells. Catalytic oxidation was not investigated in this Phase I demonstration.

Based on the results from the SITE demonstration, the following conclusions were reached concerning the technology's effectiveness and cost.

- The Accutech Pneumatic Fracturing Extraction process increased the extracted air flow rate by >600% relative to that achievable in this formation prior to fracturing.

- While TCE concentration in the extracted air remained approximately constant (~50 ppmv), the increased air flow rate resulted in TCE mass removal rates after fracturing that were an average of at least 675% higher over the 4-hr tests.
- Significantly increased extracted air flow rates (700% to 1,400%) were observed in wells 10 ft from the fracturing well. Even in wells 20 ft away, increases in air flow rates of 200% to 1,100% were observed. Coupled with well pressure data and tiltmeter data for surface heave, these results suggest an effective extraction radius of at least 20 ft.
- Based on capital and operating cost data provided by the developer and several very optimistic assumptions, a cost of \$140/lb of TCE removed was estimated for a remediation of the demonstration site or a comparable site.
- Even higher increases in air flow rates and TCE mass removal rates were observed when one or more of the monitoring wells were opened to allow passive air inlet. Under these conditions, air flow rates increased an average of 19,000% and TCE mass removal rates increased 2,300%.
- The results of the hot gas injection experiments were inconclusive. While some increase in the soil gas temperature in the formation was observed, it is unclear whether this was accompanied by improvements in TCE mass removal.

A Technology Evaluation Report and an Applications Analysis Report describing the complete demonstration will be available in the Summer of 1993.

For Further Information:

EPA Project Manager
Uwe Frank
Releases Control Branch
U.S. Environmental Protection Agency
2890 Woodbridge Avenue
Edison, NJ 08837-3679
(908) 321-6626

*U.S. Government Printing Office: 1993 — 750-071/80009

United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

Official Business
Penalty for Private Use
\$300

EPA/540/MR-93/509

BULK RATE
POSTAGE & FEES PAID
EPA
PERMIT No. G-35