United States
Environmental Protection
Agency

EPA/540/MR-93/524
September 1993

SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION

Demonstration Bulletin

IN-SITU Thermal Oxidative Process

HRUBETZ Environmental Service

Technology Description: The HRUBOUT® system is an in situ thermal oxidative process that removes hydrocarbons from contaminated soil. In the HRUBOUT® process, heated, compressed air is injected into the soil below the zone of contamination. As the heated air rises, it transfers heat to the soil and evaporates soil moisture. Most of the volatile organic compounds are removed with the water vapor by steam distillation effect. The vapor is collected as it rises to the surface and is directed to a thermal oxidizer unit that operates at temperatures of up to 1,500°F.

The HRUBOUT® system is designed to treat soil contaminated with nonhalogenated organic compounds in any concentration range and can be designed to treat an area of up to 3,600 square feet at a time. The system consists of two air blowers, a burner, and a thermal oxidizer. Injection wells of 6 to 8in. in diameter with perforated casing at the base are drilled to a depth below the contamination. The number of injection wells depends on the soil permeability and the area of contamination.

Heated, compressed air is delivered by an air blower at a rate of 8,500 pounds per hour (lb/hr) at pressures of up to 12 pounds per sqare inch-gauge (psig), or 5,000 lb/hr at pressures of up to 24 psig. The air is heated up to 1,200°F using a 2.9 million British thermal units per hour (Btu/hr) adiabatic burner, fueled by either natural gas or propane. The heated air is distributed to the individually flow-controlled injection wells through a stainless steel manifold. The objective of the system is to maintain a horizontally uniform rising flow of air across the treatment area. Well spacing is generally the same as the well depths. Initially, low-temperature air is pumped into the soil until a steady state flow rate is achieved, and then the temperature of the injected air is gradually increased. As the heated air progresses upward throughout the soil, the moisture is evaporated, removing the volatile contaminants. The temperature of the soil is recorded using 8-point thermocouple probes placed in several wells. The thermocouple probes provide a secondary check on the uniformity of gas flow within the soil.

As the soil temperature gradually increases, the semivolatile and nonvolatile constituents are volatilized or thermally oxidized. Diesel fuel will oxidize or vaporize and will be removed from the soil at approximately 500°F. Heavier hydrocarbons, such as crude petroleum, heavy heating oil, and lubricating oil, will be removed

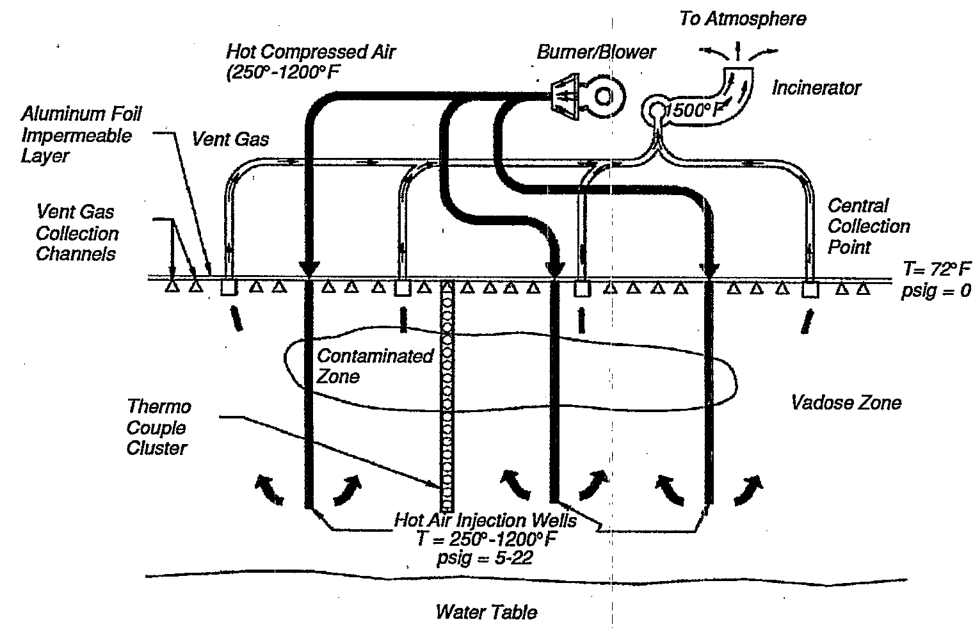

Figure 1. HRUBOUT® Process Simplified Diagram

from the soil at approximately 800°F when treated for a sufficiently long period of time.

The soil vapor is collected at the surface and fed to the thermal oxidizer. The thermal oxidizer has a rating of 3.1 million Btu/hr and operates at 1,500°F, with a 0.6-second retention time. According to the developer, the unit will destroy at least 99.5 percent of the hydrocarbon contaminants, and is fueled by either natural gas or propane.

A large capacity vacuum blower dilutes the collected soil gas with ambient air before incineration if they approach the lower explosive level of concentration. Automatic system safety shutdown features are included for flame failure, high temperature, high and low gas pressure, and low air flow. A local flame arrestor is also incorporated into the system.

The blower, thermal oxidizer, and the control systems are mounted on a trailer for easy transport of the system. The system operates from a central control panel. The unit operates 24 hours a day while on site, and can operate largely unmanned.

Low permeability and high soil moisture significantly reduce the effectiveness of more traditional soil vapor extraction systems. According to the developer, HRUBOUT® technology's use of heated air instead of unheated air or even steam enables the system to effectively treat low permeability, high moisture soils by (1) removing the moisture from the soil mass and increasing air flow and (2) by creating micro and macro fissures in low permeability soils such as clays through shrinkage of soils after moisture loss.

FIELD DEMONSTRATION: The HRUBOUT® technology was demonstrated in January and February of 1993 at Kelly Air Force Base in San Antonio, Texas. On June 14, 1988, approximately 80,000 gals of jet fuel (JP-4) spilled from a ruptured high-pressure fuel pipeline in the 1100 Area of the base. The fuel was spilled into the shallow alluvial sediments at the site, and a portion of this fuel flowed onto the surface, where evaporation, runoff, and infiltration occurred.

The surficial geologic deposits at the site consist of unconsolidated fluviatile alluvium and terrace deposits, consisting of clay and silt, and to a lesser degree, sand and gravel. Groundwater is found at a depth of approximately 20-25 feet below ground surface in the 1100 Area.

Characterization of the JP-4 contamination at the 1100 Area following the spill indicated that benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations in soil were generally less than 130 parts per million (ppm). Likewise, total recoverable petroleum hydrocarbon (TRPH) concentrations in soil were generally less than 1,000 ppm. Pretreatment samples collected as part of the SITE demonstration revealed average soil TRPH concentrations of approximately 2,700 ppm in the 20-foot-deep treatment area. Within the treatment area, the highest concentrations were observed in the top 10 feet of the soil mass.

Six hot air injection wells were installed in a rectangular 10-by 20-foot grid spaced 10 feet apart from each other. The system was operated 24 hours a day for approximately 3 weeks.

Computer data acquisition systems were used throughout the demonstration to continuously monitor various system parameters. These parameters included the temperature and pressure of injected air; incinerator inlet temperature, pressure, and flow rate; and incinerator outlet temperature. In addition, the pressure, flow rate, and moisture content of the incinerator outlet stream, the moisture content of the incinerator inlet stream, and vertical soil temperature profiles were measured and recorded periodically throughout the demonstration. Analysis of the extensive soil sampling performed before and after the treatment process will be used to analyze the effectiveness of the HRUBOUT® system. The soil samples were analyzed for TRPH, total organic content (TOC), permeability, and moisture content.

Description of all field activities, as well as, a thorough analysis and interpretation of the results will be presented in the Technology Evaluation Report. The Technology Evaluation Report will be available in the Winter of 1993.

FOR FURTHER INFORMATION:

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*U.S. Government Printing Office: 1993 — 750-071/80099

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Environmental Protection Agency
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EPA/540/MR-93/524