United States
Environmental Protection
Agency

EPA/540/MR-94/528
November 1994

SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION

Demonstration Bulletin

Radio Frequency Heating

KAI Technologies, Inc.

Technology Description: Radio frequency heating (RFH) is a process that uses electromagnetic energy in the radio frequency (RF) band to heat soil in situ, thereby potentially enhancing the performance of standard soil vapor extraction (SVE) technologies. An RFH system developed by KAI Technologies, Inc. was evaluated under the Superfund Innovative Technology Evaluation (SITE) Program at Kelly Air Force Base (AFB) in San Antonio, TX. This demonstration was performed in conjunction with a technology evaluation being performed by the U.S. Air Force (USAF).

Figure 1 is a schematic diagram of KAI's RFH system. A 25-kW, 27.12-MHz RF generator serves as the energy source for the system. Coaxial transmission lines supply energy to two antennae installed near the center of the treatment zone, progressively heating the soil in a radial direction from each antenna. Water and contaminants volatilize as the soil is heated.

Prior to the demonstration, six extraction wells were installed on the edges of the treatment zone, and two extraction wells were installed near the center of the treatment zone. A vacuum was applied to one or more extraction wells. The vacuum level and the extraction wells to which the vacuum was applied were varied periodically throughout the demonstration. The vacuum system pulled water and contaminant vapors into the extraction wells, through a vapor collection system, and into a vapor treatment system. The vacuum was applied throughout the heating portion of the demonstration, for 11 days before heating was initiated, and for 14 days during cooldown.

The treatment zone was covered by a vapor barrier, which was designed to eliminate direct contact between the surface of the treatment zone and the ambient air. The vapor barrier had three functions: to help maintain a vacuum for vapor collection, to prevent fugitive emissions from the heated surface, and to control infiltration of air into the treatment zone and thus into the vapor treatment system.

The vapor treatment system consisted of condensate collection and incineration. Vapors that condensed in the vapor collection and treatment systems were collected, and were then transferred to a Kelly AFB wastewater treatment facility. Uncondensed vapors were burned in a natural gas flare. This vapor treatment system was site- and contaminant-specific and was not evaluated as part of the RFH system.

Waste Applicability: RFH is a potential enhancement for in situ SVE systems. RFH is designed to speed the removal of volatile organics and to make it possible to remove semivolatile organics that would not normally be removed by standard SVE

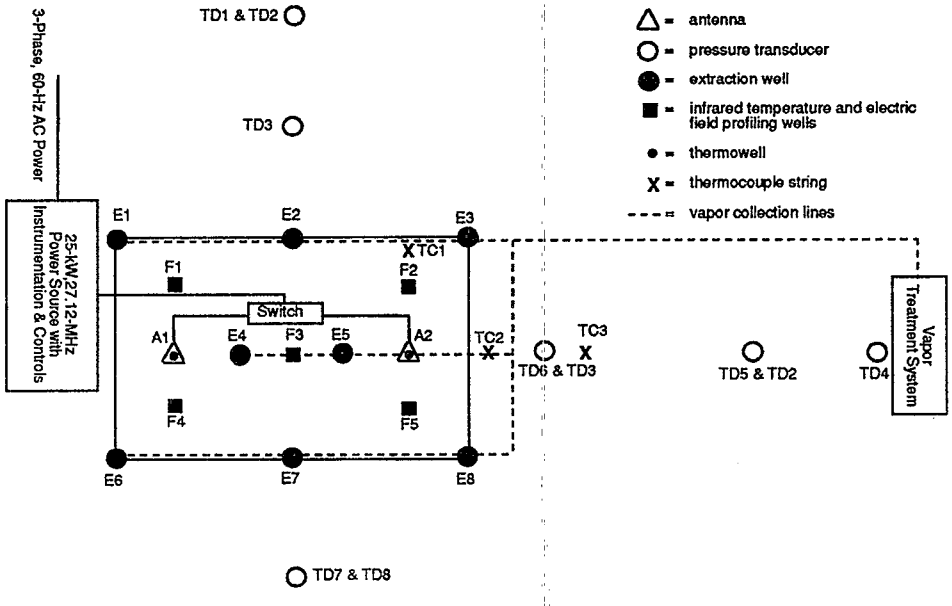

Figure 1. Schematic diagram of KAI RFH system.

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technologies. Inorganics, metals, and other nonvolatile contaminants will not normally be treated by SVE or RFH technologies.

Demonstration Results: The original treatment zone, which was within an area historically used for intermediate storage of wastes, was 10ft wide, 15ft long, and 20ft deep. RF heat was only applied to the upper half of the treatment zone, however. As a result, the upper half of the treatment zone is being designated the "heated zone." Samples were collected inside the original treatment zone, which includes the heated zone; below the original treatment zone to a depth of 30ft; and on two sides of the original treatment zone.

During the demonstration, RF energy was initally applied to antenna A2 for 25.6 days, was then applied to antenna A1 for 9.8 days, and back to antenna A2 for 11.1 days. Temperatures within and outside the treatment zone were monitored at various depths throughout treatment. KAI's target temperature range for the heated portion of the treatment zone was 100 to 130°C. The maximum temperature on the perimeter of the treatment zone was approximately 60°C. The maximum temperature recorded near the center of the treatment zone was 234°C, but this peak was not representative of the majority of the temperature measurements at this location. During most of the heating period, temperatures between 100 and 150°C were measured near the antenna to which energy was being applied. Although not observed during the demonstration, the developer claims that temperatures will become more uniform after all moisture is removed from around the antennae.

Changes in soil contaminant concentrations were evaluated as matched pairs; each post-treatment sample was compared to its corresponding pre-treatment sample. The primary objective of the demonstration was to evaluate the removal of total recoverable petroleum hydrocarbon (TRPH) concentrations (as measued by EPA Method 418.1, following extraction with freon). The TRPH concentration inside the original treatment zone exhibited a 29% decrease between pre- and post-treatment sampling. Inside the heated zone, the TRPH concentration exhibited a 42% decrease between pre- and post-treatment sampling.

Changes in pre- and post-treatment concentrations of volatile and semivolatile organic compounds (as measured by SW-846, Method 8240 and 8270, respectively) were also evaluated. Because pretreatment concentrations of these compounds were expected to be low, these analyses were considered non-critical and were performed for only half of the matched sample pairs. Preliminary data indicate that pre- and post-treatment concentrations of many volatile and semivolatile organic compounds were near or below practical quantitation limits, but final data may indicate removal of some of these compounds.

A Technology Evaluation Report and an Innovative Technology Evaluation Report describing the complete demonstration will be available by summer 1995.

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