Remediation of Volatile Organic Contamination from a Radioactive Environment Using Thermal and Catalytic Treatment Technologies.

Ryan D. McMurtrey[1], Michael D. Jorgensen[2], and Lisa A. Harvego[3]

Abstract: The Idaho National Engineering and Environmental Laboratory (INEEL) is currently involved in a remediation effort aimed at control and remediation of vadose zone organic contamination. The selected remedy consists of the extraction and destruction of organic contaminant vapors present in the vadose zone beneath and within the immediate vicinity of the Radioactive Waste Management Complex (RWMC) on the INEEL, and the monitoring of vadose zone vapors and the Snake River Plain Aquifer in the vicinity of the RWMC. To meet Record of Decision (ROD) objectives, vapor vacuum extraction units with recuperative flameless thermal oxidation (RFTO) and catalytic treatments were designed, built, and installed within the boundaries of the RWMC. Thermal oxidation units are single chambered vessels, equipped with a propane burner and a stack. Catalytic oxidation employs a catalyst bed; commonly platinum or palladium, to oxidize the contaminants at lower temperatures. This paper will focus on issues such as process performance including progress toward remediation goals, and effectiveness of the two types of processes. Historical vadose zone and groundwater monitoring data will be discussed as process performance indicators.

The Idaho National Engineering and Environmental Laboratory (INEEL) was established in 1949 as a center where nuclear power reactors and support facilities could be built, tested, and operated with maximum safety. The INEEL is a government-owned reservation managed by the DOE. The eastern boundary of the INEEL is located 52 km (32 mi.) west of Idaho Falls, Idaho. The INEEL site occupies approximately 2,305 km^2 (890 mi^2) of the northwestern portion of the Eastern Snake River Plain in southeast Idaho.

The Radioactive Waste Management Complex (RWMC) was established in the early 1950's as a disposal site for solid, low-level waste generated by INEEL operations. The RWMC is located in the southwestern portion of the INEEL. The RWMC encompasses 0.58 km^2 (0.23 mi^2) and consists of two main disposal and storage areas: (1) the Transuranic Storage Area (TSA) and (2) the Subsurface Disposal Area (SDA). The TSA is an interim storage area where TRU waste is stored in containers on asphalt pads. The SDA is a 35.6-ha (88-acre) area where radioactive waste materials have been buried in underground pits, trenches, soil vault rows, and one aboveground pad (Pad A).

[1]Senior Engineer, Chemistry and Environmental Restoration, Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, 83415-3920, USA, Ph 208.526.5156, Fx. 208-526-6852, mcmurd@inel.gov (corresponding author)

[2]Principle Technical Specialist, Environmental Restoration, Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, 83415-4206, USA

[3]Project Engineer, Environmental Restoration, Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, 83415-3920, USA

The majority of the contamination is within the subsurface underlying the RWMC and is primarily organic solvents. The highest contaminant concentrations are found immediately beneath the SDA, an area with several disposal pits and trenches previously used for the disposal of organic wastes.

The Organic Contamination in the Vadose Zone, OCVZ Operable Unit (OU) 7-08 is defined as that part of the unsaturated zone that is potentially contaminated by volatile organic compounds (VOCs) beneath the boundaries of the SDA. The vadose zone, which contains VOCs, begins at the ground surface and extends to the top of the saturated zone of the Snake River Plain Aquifer (SRPA), approximately 600 ft below land surface. The OCVZ OU 7-08 does not include the buried pits and trenches of the SDA.

The presence of organic contaminants in the vadose zone is a result of the burial and presumed breach at the SDA of containerized organic wastes. Some pits have been identified as receiving the organic wastes, which were mixed with calcium silicate to reduce free liquids and form a grease or paste like material prior to being placed in containers and sent to the INEEL for disposal in the pits. Also, the INEEL received an unknown quantity of organic waste before 1966, and the acid pit may have received organic wastes during past operations.

Samples are collected to provide operations and monitoring data. Operational sampling is conducted at the treatment units to determine the concentrations and quantities of organic contaminants that are being extracted from the vadose zone. To determine the effects that the treatment is having on the vadose zone, periodic monitoring samples are collected from numerous vapor ports located throughout the SDA at various depths. These data are used to calculate mass removal, optimize the operating systems, and establish spatial and temporal distribution of the volatile organic compounds (VOCs) in the vadose zone. Figure 1. Illustrates the total VOC mass removed since commencement of cleanup operations in January 1996.

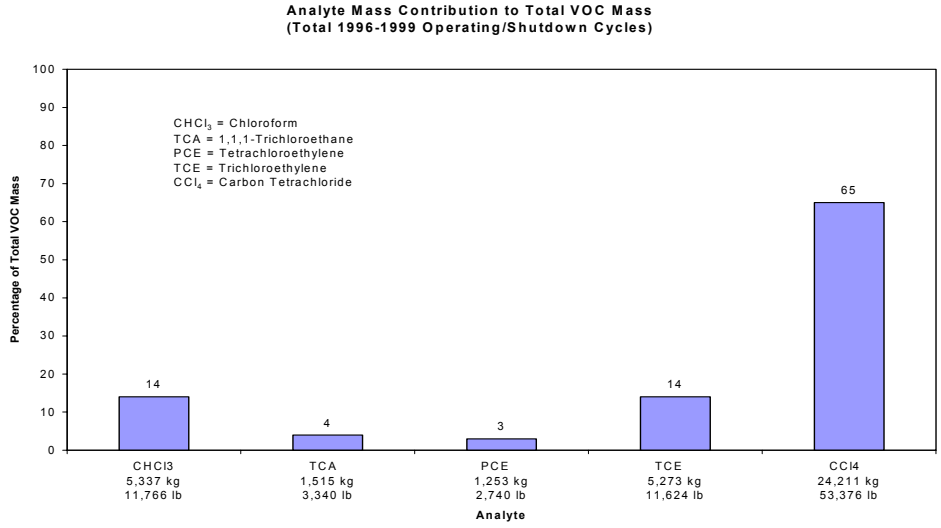

Figure 1. Total VOC Mass Removal

Two types of oxidation systems, thermal and catalytic, are currently employed for treatment of extracted vapors prior to discharge. Both system types enact the oxidation of halogenated organic compounds to form CO_2 and HCl as the primary products.

The thermal oxidizers, manufactured by Thermatrix, Inc. (Knoxville, TN), employ propane to heat a ceramic packing material to the system operating temperature. Once the bed is at temperature, the flow of VOCs is initiated. Propane is continuously fed to the oxidizer to provide supplemental heating and maintain the operating temperature of the system. A block diagram for the

The catalytic oxidizers, manufactured by King, Buck Technology (San Diego, CA) employ electrical resistance heaters to elevate the temperature of the catalyst bed to the system operating temperature. The proprietary catalyst is designed to efficiently oxidize halogenated organic compounds while resisting deactivation. Heat is continuously added to the feed gasses during operation to maintain the operating temperature.

Vapor samples are collected from the vadose zone within the boundaries of the RWMC. Concentrations are recorded for chloroform ($CHCl_3$), 1,1,1-trichloroethane (TCA), tetrachloroethene (PCE), trichloroethene (TCE), carbon tetrachloride (CCl_4), and total VOCs These samples are used to track progress toward remediation goals and to determine when the cleanup effort can be concluded. Samples are collected at various levels within the vadose zone. Since the start of extraction operations on January 11, 1996, CCl_4 concentrations in the vadose zone have been significantly reduced.

Significant progress has been made toward reduction and control of the spread of VOC contamination at the RWMC. The cleanup effort will continue until remediation goals have been achieved. Vadose zone vapor sampling will continue as a means of tracking progress toward remedial goals and will provide information required to determine when remedial goals have been met and cleanup activities can be concluded.