

# Catalytic Destruction of Perchloroethylene (PCE) and Trichloroethene (TCE) from Soil Vapor Extracted Gases

## Park-Euclid State Superfund Site

### Description

This remediation technology involves the destruction of vapor phase chlorinated compounds (e.g. TCE, PCE) in recovered gas streams from Soil Vapor Extracted (SVE) gases, thus eliminating or minimizing the need for activated carbon beds. Destruction is based on metal-catalyzed reactions under redox conditions. The catalysts used are similar to the “off the shelf” catalytic converters that improve the quality of automobile exhaust streams. The resultant gas stream is essentially contaminant free, with solvents converted to either ethane/methane, carbon dioxide or hydrochloric acid (HCl).

The most important innovation of this study is the use of redox conditions: the gas stream to be treated is contacted with a mixture of oxygen (from atmospheric air) and a reductant (hydrogen (H<sub>2</sub>) or a low molecular weight hydrocarbon). This allows the reactor to achieve complete reduction of chlorinated compounds at relatively low temperatures (<450°C), while at the same time maintaining an oxidizing environment that prevents carbon residue (coke) formation and catalyst poisoning.

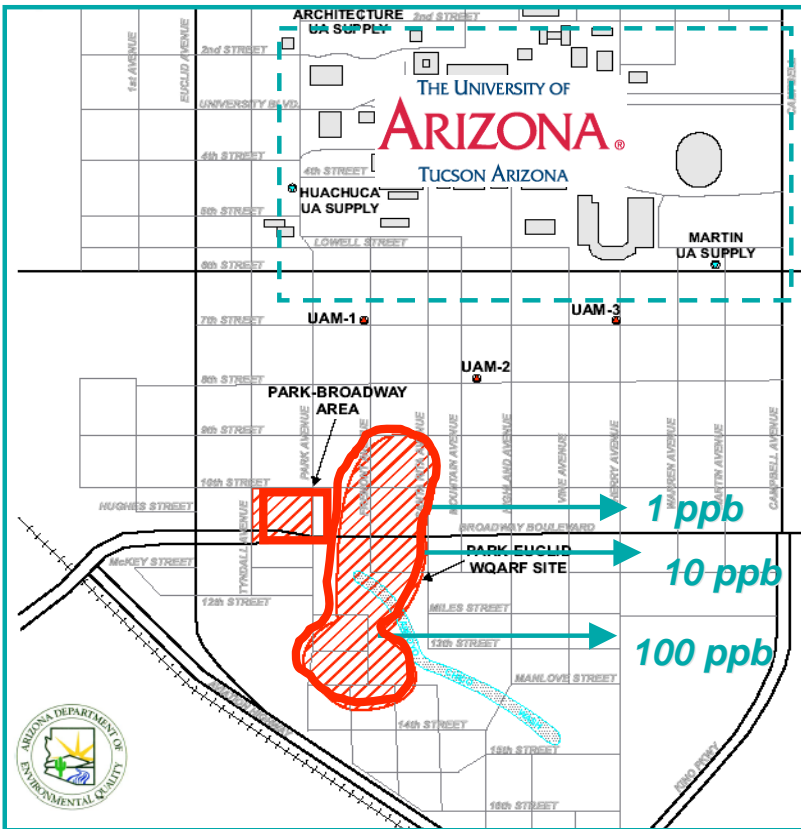


Image 1. Site Vicinity Map of Park-Euclid WQARF site, Tucson, AZ.

### Field Trial Conditions

- 2 Alumina supported Pt/Rh catalysts
  - 2" long x 4.7" major axis; 3.15" minor axis
- 450 – 650°C Temperature Range
- 25 – 200 ppmv PCE, 10 – 50 ppmv TCE
- 100 Lpm total flow rate, 0.2 sec Residence Time
- 1.0 – 2.0% Propane by volume

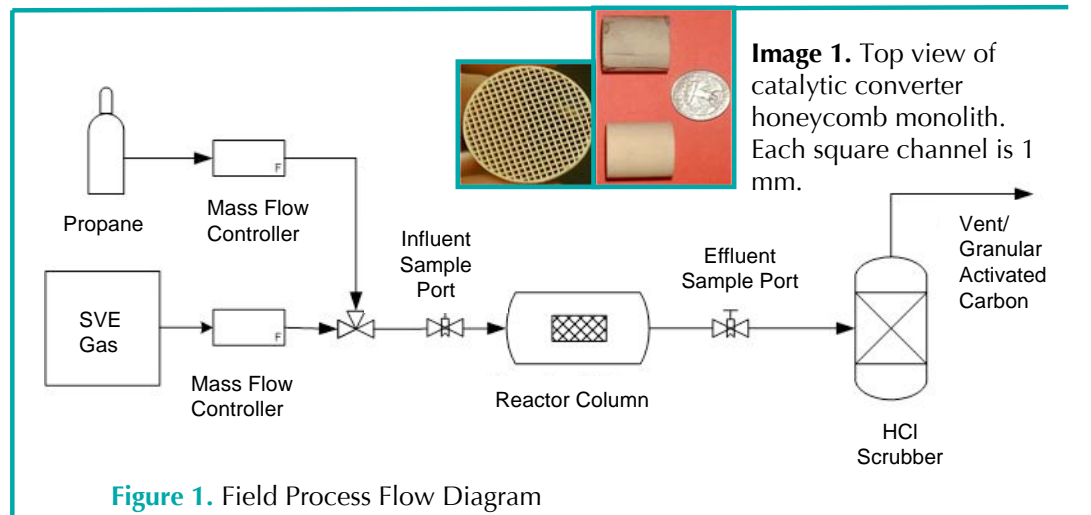
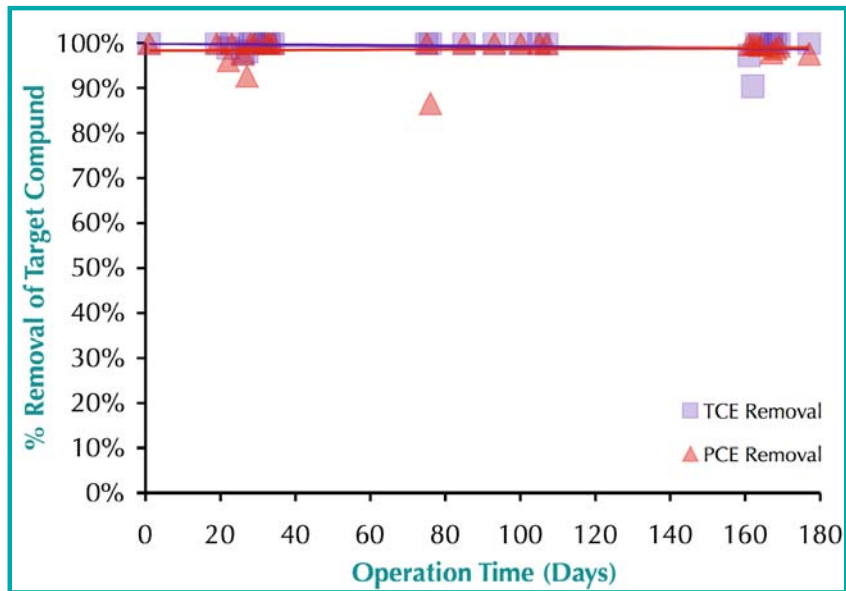


Figure 1. Field Process Flow Diagram



**Graph 1.** The Catalytic Destruction technology has removed 90-100% PCE and TCE from SVE gases over the 180 days of operation.

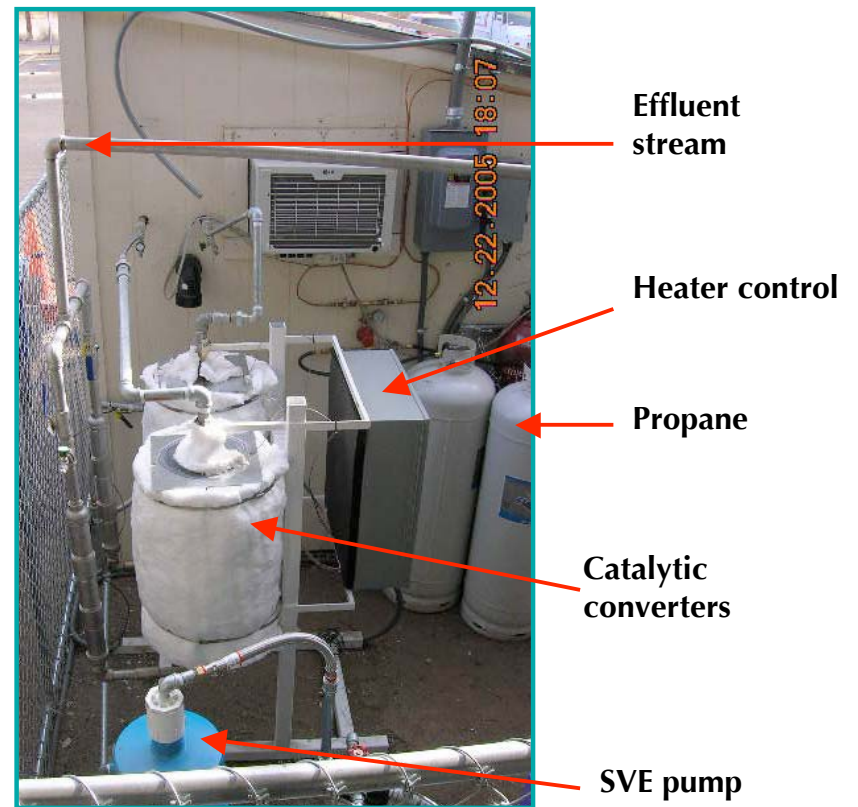
### Sustainability

A toxic organic pollutant (PCE) is totally mineralized into inorganic carbon dioxide and hydrochloric acid (which is easily neutralized and turned into sodium chloride).

PCE is destroyed on site, not captured on activated carbon (i.e., merely transferred from one medium to another). Since PCE is destroyed there is no need to transport it off site (as hazardous waste) and dispose of it or incinerate it.

### Results

Pilot-scale reactors have been built to treat 100 L/min of SVE gases containing TCE and PCE that contaminate the vadose zone over the underground aquifer. These SVE gases contain evaporated diesel fumes that do not interfere with conversion. Results show near complete destruction of TCE and PCE has been achieved, without signs of catalyst deactivation over 180 days of almost continuous operation (Graph 1). This efficiency remained even when contaminant inlet concentrations were increased.



**Image 2.** Actual layout of the catalytic redox converter system at the Park-Euclid State Superfund site.

## Cost comparison done at “top of well” (SVE pumping costs are not included)

### Catalytic Converter

Major cost is the propane, which is added to maintain stoichiometric combustion conditions with available oxygen (i.e., propane is independent of PCE concentration within limits)

- **Conditions**
  - $\approx$  200 ppmv PCE
  - $10^6$  L soil vapor treated
- **Cost**
  - 2% v/v propane @ \$1.70/gal (DOE, 2005)



Propane-only treatment costs  $\leq$  \$10/lb PCE destroyed  
(PCE-dependent)

**Bottom Line: The higher the PCE Concentration  
the cheaper the catalytic converter technology**

### Granular Activated Carbon (GAC)

Treatment costs increase with PCE concentration since the GAC will become saturated with PCE sooner, and therefore have to be switched out more frequently

- **Conditions**
  - 200 ppmv PCE, 50 cfm, 85 °F
- **GAC-only treatment costs**
  - \$7.00/lb PCE absorbed (Siemens Water Technologies, Sept. 2006)



### Conclusions

- Destruction of chlorinated contaminants by using an automobile catalyst is efficient under unique redox conditions.
- Catalyst poisoning is minimal; the end products are environmentally benign like ethane, CO<sub>2</sub>, and HCl which is removed. No toxic byproducts such as dioxins or furans are produced (as they sometimes are in high temperature incineration).
- Propane is a promising alternative to H<sub>2</sub> as the reductant; a cost-effective, long-term operation is feasible in the field.

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