Application Note

CONTAMINATED SOIL: ONLINE MEASUREMENT OF CHLORINATED COMPOUNDS IN SOIL-GAS

Fig.1 The soil gas probe with the sampling tube connected

The Opportunity

Monitoring the amount of pollutant removed from the soil helps to evaluate the efficiency of the remedial system.

Contaminated soil is a serious and widespread problem that normally needs resolution to avoid pollution of the ground water reservoir. Many remedial technologies are available for solving the problem – and depends on the pollution level, chemical substances in the pollution, and the geological structure of the ground. Chlorinated solvents in the sub-surface are very common pollutants, especially PCE (Tetrachloroethylene) and TCE (Trichloroethylene). A source of these pollutants is, for example, dry cleaners.

At an actual site, a very cost-effective method for in situ treatment of contaminated soil was tested. The operating agent for the project was NIRAS Consulting Engineers and Planners. It was sponsored by three Danish counties and the Danish EPA under the Technology Demonstration and Evaluation Program.

The Tested Technique

Passive soil vapor extraction relies on the naturally occurring variations in barometric pressure. In Denmark, this oscillation primary results from the passage of weather fronts and can be as high as 25 mBar over a 24 hour period. As the barometric pressure rises, air is driven into the soil. When the pressure drops, soil-gas will ascend into the atmosphere. When low permeable layers are present above the polluted volume, one can create a one directional flow from the perimeter of the polluted soil volume towards its center by use of a number of bore holes and a one-way valve. This principle is shown in Fig. 2.

The Monitoring Need

To be able to evaluate the efficiency of the remedial system, monitoring the amount of pollutant removed from the soil is necessary. This is completed by measuring the flow and gas concentration of the soil-gas leaving the one-way valve.

As different compounds might be cleaned up at different speeds, it was decided to monitor four gases, simultaneously, during the test period. The four gases were:

- Tetrachloroethylene (PCE)
- Trichloroethylene (TCE)
- 1,1,1-Trichloroethane (TCA)
- Chloroform (TCM)

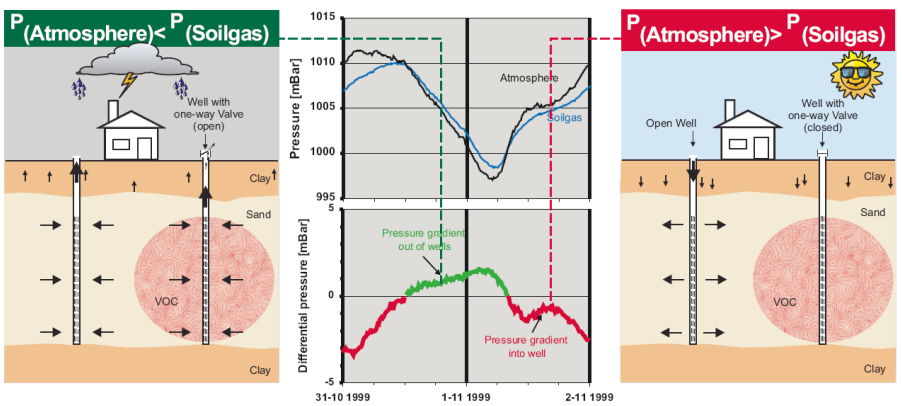


Fig. 2 The working principle of passive soil vapor extraction. (where P = pressure) Drawing courtesy of NIRAS

Figure 3: INNOVA 1512 Photoacoustic Gas Monitor.

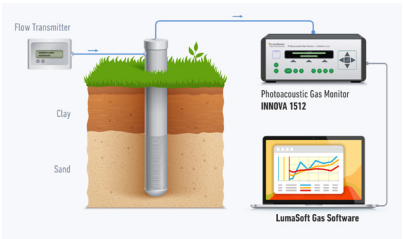


Figure 4: The measurement setup

Our Solution

The Photoacoustic Gas Monitor INNOVA 1512 was chosen for this application because of its following features:

- Long term stability
- Possibility to measure all four gases simultaneously
- Ability to compensate the measured values for any interference generated by water vapor or other gases
- Low detection limit

The low detection limit and the long time stability of the instrument are characteristics of the photoacoustic measurement principle employed. Low drift (as low as one detection limit per three months) is common for this measurement principle. The interference compensation feature is a mathematical matrix equation, which allows signals from an interfering gas to be cancelled when both, the gas in question and the interfering gas, are measured. The high quality of the interfering compensation is mainly due to the construction of the three element optical filters used to define the infrared measurement range for each gas. If needed, the 1512 can be configured to measure up to five gases and water vapor. Among 1512 features useful in soil monitoring is the build-in data-logger facility, and the 12 channel multiplexer option.

Measurement Result

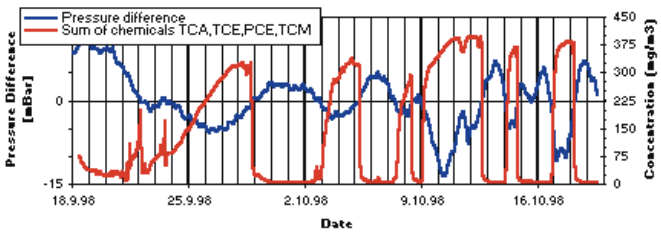
The monitoring period lasted 34 days where the soil-gas was measured for chlorinated compounds every 15 minute. The following maximum concentrations were observed:

- PCE: 15 mg/m^3
- TCE: 350 mg/m^3
- TCA: 61 mg/m^3
- TCM: 5 mg/m^3

The measurement showed that the dominating substances in the soil-gas were TCE and TCA. By multiplying the flow rate in the soil-gas stream by the gas concentrations, the mass removal rate of the four substances was calculated. The mass removal rate of the TCE/TCA was 45g/24hrs, or 180-200g TCE/TCA for the total measuring period.

At this site, the removal rate of volatile compound (primarily PCE and TCE) is expected to be 5 kg per year. A quarterly monitoring of the gas concentrations and ground water concentrations is scheduled to indicate the long term effect of the remedial

Boring B5: Variation in pressure difference between the saturated zone and the atmosphere and the resulting concentration of the pore-air vented from the bore hole



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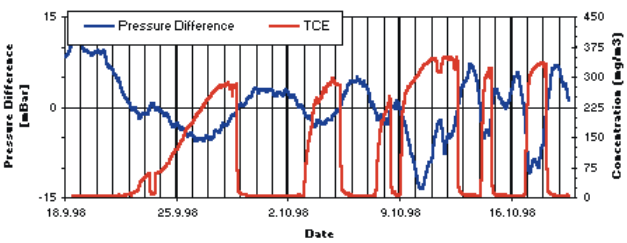

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