Wireless real-time soil data used in contaminated soil cleanup operation

By Keith Bellingham

Using a data acquisition network by Stevens Water Monitoring Systems, Environ International Corporation (ENVIRON) is developing new methods to bioremediate contaminated soils.

All organisms need food, which provides energy and nutrients. Food first needs to be metabolized so that it can be converted to energy and materials for cell growth. When an organism digests food, it chemically takes the food apart one molecule at a time by breaking and making chemical bonds.

When a chemical bond is broken, the organism needs to get rid of extra electrons. Organisms get rid of the extra electrons using electron acceptors. Chemical removal of these extra electrons is done during respiration, or breathing. There are two types of respiration: aerobic and anaerobic. Aerobic biochemical reactions use oxygen as an electron acceptor, and anaerobic organisms use other compounds such as sulfates and phosphates.

Animals, some bacteria and fungi are aerobic, while other kinds of bacteria are anaerobic. Generally, aerobic microorganisms can decompose petroleum hydrocarbons, glycols, and explosives. Anaerobic microorganisms can decompose chemicals that contain halogens such as pesticides, dry cleaning and chlorinated solvents.

ENVIRON is treating chlorinated pesticides both anaerobically and aerobically, using an innovative new approach. Dichlorodiphenyltrichloroethane (DDT) and other chlorinated compounds are lethal to pests because they shut down an organism's nervous system.

Generally, aerobic bacteria will not decompose chlorinated compounds. One of the methods ENVIRON is using to decompose the DDT is called CVSR (Controlled Vadose-Zone Saturation Remediation). CVSR employs anaerobic microorganisms, which do not require oxygen and in fact thrive in an oxygen deficient environment.

In order to maintain anaerobic conditions in the CVSR areas, the soil is irrigated to, or near, saturation (40 to 50%).

Caption

The CVSR areas are also dosed with a lactate electron donor/energy source prior to irrigation to promote microorganism growth. While the upper contaminated soil needs to stay at or near saturation, it is important that soil moisture levels below the treatment areas stay below the field capacity (25 to 30%) to prevent toxins from leaching downward, contaminating the underlying aquifer.

Data from the Stevens Hydra Probe helps ensure that the soil moisture levels at the various depths stay at the optimal moisture level, allowing the anaerobic microorganism community to thrive, while preventing the downward leaching.

The second method ENVIRON is using to remediate the chlorinated pesticide contaminated soil is a new, innovative aerobic process utilizing fungi. Because white rot fungus (WRF) does not have a nervous system, chlorinated pesticides is not toxic to it.

ENVIRON's research involves using WRF to decompose pesticides under aerobic conditions in biopiles. Soil moisture in the biopiles is maintained at a constant 30%. In addition to maintaining the soil moisture at 30%, biopiles are also aerated with blowers.

ENVIRON is operating a total of nine stations, with two or three Hydra Probe sensors in each station. Five of the stations are aerobic biopiles containing the WRF, and four of the stations are anaerobic CVSR. Hydra Probes are configured to be digital RS485 half duplex. The first RS485 bus reaches four CVSR stations consisting of 14 Hydra Probes. The second RS485 Bus contains 10 Hydra Probes in the aerobic biopiles (two probes per pile) and is connected wirelessly to the first bus using 900 MHz Spread Spectrum Technology. The Master Radio, as well as the RS485 bus, are connected to a cell modem. A Python script running on a virtual server polls the data from the sensors and exports them to the Stevens-Connect website. Theis site includes an easy-to-use graphing feature that allows users to display historical data and compare it to real time data. This tool helps hydrologists and engineers to quickly evaluate large amounts of data , while having the power to select certain parameters. In addition to the advanced graphing feature, Stevens-Connect website can also store site data such as pictures and text.

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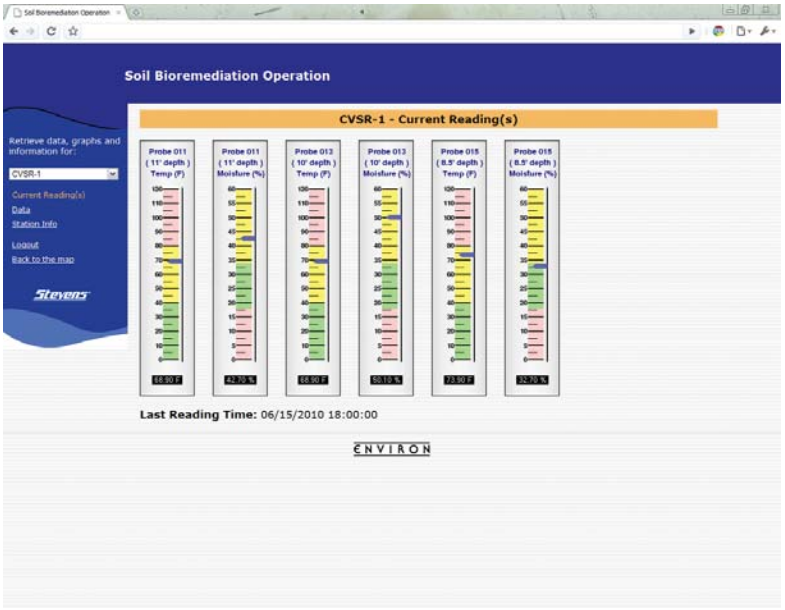

Caption

Figure 1: The Stevens Hydra Probe II, currently being used in soil remediation projects.

Figure 2: Soil remediation site, with contaminated soil contained under the black plastic cover. Shown is a radio node housed in a NEMA-4 box, with connected Hydra Probe soil sensors.

Figure 3:Controlled Vadose-Zone Saturation Remediation area with soil irrigation piping.

Figure 4: Installing the Hydra Probe into a soil remediation pile.

Figure 5: Real-time soil moisture data being reported to website.