

Abstracts

Thursday, May 1

Session K3: Continuous Monitoring: Sensor Developments in Energy Production/Hydrofracking

10:00 – 11:30 am | Room 261

Application of an Aqueous Methane Sensor to Evaluate Spatial and Temporal Changes in Dissolved Methane Concentrations in a Groundwater Monitoring Well

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Abstract

Conventional dissolved methane groundwater monitoring methods are expensive, labor and resource intensive, as well as time consuming. In addition, these methods can often be inaccurate due to inconsistencies associated with sampling methods, handling, transport, and laboratory analytical analysis. Recent advances in sensor technology have reduced the need for conventional groundwater sampling, and can provide continuous, accurate chemical concentration values in near real-time. This paper describes the development of a low cost real-time aqueous sensor for detecting dissolved methane concentrations in groundwater in response to projected increased monitoring requirements associated with conventional and unconventional oil and gas exploration and development. The dissolved methane sensor is 1.75-in in diameter and 8-in in length and can be deployed in conventional 2-inch groundwater monitoring wells. The sensor also has the capability to monitor dissolved ethane and propane. The dissolved methane sensor has many applications, including monitoring of temporal and spatial variation in background dissolved methane concentrations, providing continuous monitoring of groundwater associated with oil and gas development or other activities, minimizing groundwater monitoring costs, and reducing the environmental footprint of dissolved methane monitoring activities. Extensive laboratory testing has been performed to validate dissolved methane sensor operation under expected field conditions. The methane sensor was deployed in a groundwater monitoring well in northeast Pennsylvania where background dissolved methane concentrations above 10 ppm have been shown to exist. The methane sensor was used to prepare a vertical profile of dissolved methane concentrations within the >100-ft thick water column within the well. The sensor was subsequently deployed at a depth where elevated dissolved methane concentrations were observed to collect dissolved methane readings at 15 minute increments for several days to evaluate the daily fluctuation in dissolved methane concentrations at the desired depth. Methane sensor readings were compared to conventional methane sample concentrations collected immediately after sensor deployment. Results of the field test will be used to understand the spatial and temporal variation of dissolved methane in a groundwater monitoring well and subsequently optimize the baseline dissolved methane monitoring program.

Continuous Monitoring of Methanol Concentration in Water Treatment Processes Associated with Hydrofracturing

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Abstract

Methanol is widely used in hydrofracturing fluids as a corrosion inhibitor and winterizing agent. It is present in the flowback water, which is sometimes mixed with produced water for treatment. Currently, plants designed to treat these waters are not able to monitor methanol or other contaminant concentrations continuously, quantitatively, and specifically; instead, they rely on infrequent samples sent to off-site analytical laboratories. The lack of continuous measurements means that treatment systems operate inefficiently and risk under-treating water.

We have developed a sensor system for the continuous, direct, quantitative measurement of methanol in aqueous streams. The sensor system has three parts: a replaceable sensor tip, an opto-electronic hardware unit, and an optical fiber with a length appropriate for the application. The sensor tip includes a two-layer detection element – one layer containing a detection enzyme affixed to another fluorophore-containing layer. The change in fluorescence characteristics depends on the methanol concentration, and these sensors can be designed to provide quantitative output over different ranges of methanol concentration. Performance metrics including the limit of detection, impact of environmental factors such as pH and temperature, and lifetime have been determined.

Testing of these methanol sensors in commercial produced/flowback water treatment systems is underway. The sensors could also be deployed in monitoring wells to provide an alert in the event that methanol-contaminated water was migrating off-site.

Preliminary Findings from Continuous Water Chemistry Monitoring in Watersheds Impacted by Shale Gas Drilling in the Susquehanna River Basin

Dawn Hintz

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Abstract

The Susquehanna River Basin Commission (SRBC) continuously monitors water chemistry in select watersheds in the Susquehanna River Basin undergoing shale gas drilling activity. Initiated in 2010, 58 monitoring stations are included in the Remote Water Quality Monitoring Network (RWQMN). Specific conductance, pH, turbidity, dissolved oxygen, and temperature are continuously monitored and additional water chemistry parameters (metals, nutrients, radionuclides, etc.) are collected at least four times a year. These data provide a baseline dataset for smaller streams in the basin, which previously had little or no data.

The two parameters most commonly used as indicators of shale gas drilling activities are specific conductance and turbidity. Any spills or leaks of flowback water from the drilling process can impact the specific conductance of a stream, while the infrastructure (roads and pipelines) needed to make drilling possible in remote watersheds may adversely impact stream sediment loads. The monitoring stations were grouped by Level III ecoregion with specific conductance and turbidity analyzed using box plots. Based on available data, land use, permitted dischargers, and geology appear to play the greatest role with influencing turbidity and specific conductance.

In order to determine if shale gas drilling and the associated development activities are impacting monitored streams, SRBC completed trend analyses on three stations with three years of continuous monitoring data. The analyses showed mixed results, with specific conductance and turbidity showing a decreasing trend at Choconut Creek, and pH and temperature showing an increasing trend at Hammond Creek. Dissolved oxygen did not show a trend at any of the stations and Meshoppen Creek did not show a trend with any parameters. The natural gas well density varies within the watersheds; Choconut Creek has no drilling activity, the Hammond Creek Watershed has less than one well per square mile, and the well density in the Meshoppen Creek Watershed is almost three times that of Hammond Creek. Although the analyses were only performed on three stations, the results show the importance of collecting enough data to properly characterize conditions in these previously un-monitored watersheds, recognizing the range of factors that can influence water quality conditions.

Natural Variation of Specific Conductivity and Major Ions in Wadeable Streams of the Conterminous United States

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Abstract

To assess the effects of changes in ionic strength and salinity on streams, we need to understand natural variation in the levels of specific conductivity and major ions. I compiled data for randomly selected sites from stream

surveys conducted from 1985 to 2009 by the U.S. Environmental Protection Agency (EPA). I followed EPA methods to estimate current reference values, for specific conductivity (60 ecoregions) and individual major ions (34 ecoregions) as the 25th percentile of values in wadeable streams in Level III ecoregions with data from ≥ 25 sites. These reference values estimate current ambient concentrations for these ions in the absence of newer anthropogenic sources of salts to these waters. The 25th percentiles of specific conductivity were less than 200 $\mu\text{S}/\text{cm}$ for most eastern and western montane ecoregions. Arid western ecoregions had higher specific conductivities (*e.g.*, 557-693 $\mu\text{S}/\text{cm}$). Ca^{2+} was generally the most abundant cation followed by Mg^{2+} , Na^{+} and K^{+} . HCO_3^{-} was generally the most abundant anion followed by SO_4^{2-} and Cl^{-} . Ecoregions where SO_4^{2-} or Cl^{-} concentrations were greater than the HCO_3^{-} concentration have been affected by acidic precipitation or are influenced by marine air masses, respectively, and have very low specific conductivities. Patterns of variation appear to be associated with the 3 processes controlling major ions in freshwaters: underlying geology, concentration and crystallization associated with water evaporation, and precipitation ion content.