Novel, Internet-of-Things-based, Solid-State pH Sensors for Soil and Groundwater

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Abstract. The Center for Contaminant Hydrology seeks to develop technology that can help to better understand the chemical environment in the subsurface associated with hazardous chemical releases. Some of the developments include a suite of low-cost, Internet of Things (IoT) based sensors that can be deployed continuously through time in the soil and water at contaminated sites to monitor the in-situ chemistry. These sensors offer the benefits of continuous monitoring in real-time from the office, home, or field, no matter how remote the site. Because of their low relative cost, they can be deployed in greater numbers that can provide large datasets to monitor sites in higher resolution than typical networks of monitoring wells or associated analytical equipment. Previous successful designs include sensors for temperature, pressure, and oxidation-reduction-potential (ORP). The goal of this work is to study and develop sensors for monitoring pH.

Many sites have regulatory requirements for monitoring and operation of remedial actions but are very costly to monitor using existing methods. Often, sites are not well understood for lack of data to characterize and monitor the site effectively. Better understanding of the subsurface chemistry at a site can lead to better decisions for site managers to remediate the site and protect the public and environment. Existing pH sensing systems do not fulfill these goals because of their fragility, need for frequent maintenance and calibration, and inability to measure and report data over long periods of time.

To solve this problem, we have developed a novel pH sensor and measuring system that can be placed deep in the subsurface in the vadose zone or below the groundwater table for extended periods of time (months to years) that can report data via cellular or internet connectivity at intervals as short as a few seconds with accuracy of at least one-half pH unit. Applications for this technology extend to sites with legacy contamination, active industrial sites, agricultural operations, and more.