

Detection of dissolved hydrocarbons within the subsurface in real-time using near infrared spectroscopy

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ABSTRACT

We have been developing a chemical sensor that could be used *in-situ* to detect both organic and inorganic contamination in groundwater and report results in real-time. To date we have been successful at detecting pure hydrocarbons and distinguishing them from water (Ghandehari et al., 2008), which by itself has many applications in the oil, gas, and mining industry. For example, based on the previous results, we could use the sensor to detect leaking hydrocarbons beneath liquid storage tanks, or in the subsurface surrounding chemical processing plants. We point out that our previous work has also shown that the sensor is capable of real-time analysis of pH levels, oxygen, moisture, and other relevant species so the realm of possible monitoring applications is quite large (Ghandehari and Vimer, 2004). A sensor capable of *in-situ*, real-time analysis of aqueous solutions both organics and inorganics within porous media has numerous applications in the mining, gas, and oil industry. This sensor could be installed around former acid-mining sites to provide an early warning of contaminant migration by providing either pH measurement or detection of dissolved inorganics. This paper presents our recent work at using near infrared (IR) optical fiber analysis for measuring liquid hydrocarbons dissolved in water, which can consequently be applied at detecting the same contaminants within the subsurface.

Keywords: NAPLs, groundwater contamination, soil pollution, fiber optics, near infrared spectroscopy, *in-situ* monitoring, chemical sensor.

INTRODUCTION

Tools for on-site evaluation of contamination in air, water and soil may be grouped in two broad categories (EPA-542-B-05-001): 1. sampling for laboratory evaluation 2. probes for real-time analysis. The first category has the benefit of determining precise chemical specie and concentration. However, drawbacks include high cost of laboratory instruments and long turnaround/analysis time. Furthermore, handling of the samples could result in possible changes to the collected items by the time they are tested. These evaluation tools do not offer *in-situ* analyses, thus site conditions may vary after samples are gathered. Mitigating these drawbacks, portable field analytical instruments have been developed for more frequent and efficient information gathering but the cost of such instruments are still rather high, typically ranging from \$25,000 to \$35,000, and more importantly require operation by on-site personnel. The second category of evaluation tools includes probes for real-time analysis. Such probes are commonly attached to cone penetrometers and inserted into the subsurface. Some examples include Geo Probe,

SimulProbe, and GoreSorber. While these probes can detect organic contaminants below the subsurface, they typically require personnel to operate. Since the option for *in-situ*, real-time analysis is not available, the feedback from these devices represents site conditions that are momentary.

BACKGROUND AND THE STATE OF THE ART

Considerable effort has been made toward development of tools for *in-situ* monitoring of aqueous and organic species within the subsurface. Excellent reviews of monitoring techniques, described above, can be found by Looney (2000) and Ho (2001). These techniques may be classified into four broad categories, including: 1) chromatography, 2) electrochemical, 3) mass measurement, 4) optical. Each category offers competing qualities such as selectivity, detection limit, robustness, low cost and ease of installation. The work presented in this paper was conducted for the development of an optical probe with a number of qualities in mind; these include a) distributed detection, b) low cost, c) species discrimination, and d) long-term durability.