

## **Next Generation Injection Manifold for Controlled Delivery of Liquid Amendments for Enhanced Distribution and Contact**

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### **Background/Objectives.**

Contact of in situ chemicals with contaminant mass is one of the biggest challenges in achieving effective remediation. However, there have been few developments with injection technology since its inception in early 2000. To enhance delivery of liquid reagents, a new injection manifold was designed to enhance controlling injection flows and associated pressures to design specifications (typically maximum flow rates below fracture pressures and groundwater mounding) while eliminating operator error associated with manual control of ball valves either at a single injection location or multiple manifolded injection locations (e.g. 10). Based on experience at hundreds of injection projects, it is not uncommon for chemistries to not meet remediation expectations because injection flows and pressures were not managed to design specifications developed to achieve contact.

Considering the tens of millions of dollars invested in in situ remediation each year, it makes a lot of sense that a more robust injection manifold be developed to ensure they are injected properly. It is expected that overall remediation performance of our industry will improve with this more focused attention to controlled and digitally documented injection.

### **Approach/Activities.**

In order to achieve better injection, control a manifold system was developed using more robust flow monitoring with digital magnetic flow meters over traditional digital turbine flow meters that tend to plug frequently and can be difficult to calibrate. Additionally, electronic ball valves tied into digital pressure sensors ensure flow rates are not exceeded that could result in pressure exceedences that result in fracturing of the target interval and uncontrolled distribution of reagents. Since all pressure and flow data is digitally recorded, documentation of injection performance is readily available to confirm design specifications were achieved. Just relying on periodic documentation by injection operators reading pressure and flows from gauges or flow meters does not provide the resolution needed to determine if injection was performed pursuant to design specs.

### **Results/Lessons Learned.**

Cascade will present results of pilot tests performed with chemical oxidant and carbon substrates with this next generation injection manifold where distribution was verified using various techniques including soil cores, electrical conductivity logging and tracer studies. Distribution was evaluated based on a comparison of distribution using various injection tool screens, flow rates and pressures optimized for distribution based on the heterogeneity of the transmissive zones targeted.