INFORMATION

With the successful implementation of in situ chemical oxidation (ISCO) and in situ bioremediation (ISB) programs to remediate contaminated soil and groundwater aquifers worldwide, these approaches have become established as traditional remediation techniques. Based upon historical successes, remediation is now being completed routinely in increasingly difficult geologic environments, including formerly problematic locations such as those containing non-aqueous phase liquid (NAPL), fractured bedrock, low-conductivity media, and highly layered and/or heterogeneous aquifers. Effective delivery of amendment, however, remains the single most important aspect of successful remediation, particularly given the range of potentially applicable delivery methods and site complexities. Constant head injection employs a continuous low-pressure application method to deliver amendments over a long period of time. This synergistic method complements the existing site conditions and heterogeneity, working with the natural conditions, rather than destroying the site geology using highly aggressive delivery techniques. Constant head injection therefore provides highly controllable treatment in low permeability materials, remote areas and complex geologies where simply increased pressures do not provide effective distribution.

CONSTANT HEAD INJECTION

Constant head injection increases the liquid level in an injection location above static conditions. This increase imparts a small head at the point of injection. The excess head is slowly dissipated as the excess liquid recharges into the formation. If the liquid level is raised again, the injected fluid is again dissipated (ideally by radial flow); this process of maintaining elevated liquid level above static is termed “constant head.” Admittedly the head is not “constant,” but the amount of fluctuation exceeds the natural conditions so that the formation “feels” a slight increase in pressure continuously, which is dissipated as the liquids flow into the formation. Over time, this combination of small injection volumes, coupled with infiltration, can result in the development of a significant radius of influence, an increase in injection volumes, and prolonged imparted geochemical changes. The constant head method has multiple benefits:

• Automation – the constant head approach is amenable to automation
• Scalability – multiple programmable logic controller (PLC) controlled applications can operate concurrently and independently
• Remote control – remote user viewing and/or control can be provided
• Cost effectiveness – this approach can reduce the overall scale of the system, minimize duplication, facilitate security, and enhance chemical control, while providing redundancy and secondary containment for hazardous materials
• Decreased labor and infrastructure costs – systems have been deployed at numerous sites for concurrent injection in as many as 12 locations (though the maximum number of concurrent locations is essentially unlimited) injecting RemOx® L ISCO reagent and/or sodium lactate solutions for ISCO and ISB, respectively
• Improved safe performance by preventing breakout or short-circuiting – constant head approach closely controls fluid level to maintain a separation between shallow unintended recharge conduits, eliminating concerns with short circuiting, excess line pressures and leaks, while improving the overall health and safety and sustainability of the injection program
• Portability – can be accommodated in a small lockable utility trailer providing rapid portability, multiple use, easy setup, and breakdown and over-the-road transportation by non-commercial vehicles
• Sustainability – constant head systems are amenable to low-power equipment and electricity supplied via renewable sources such as system-mounted solar panels or wind turbines

SUSTAINABLE EQUIPMENT OPERATIONS

ERM and National Environmental Systems (NES) have constructed an automated, remote controlled constant head injection system (patent pending). This system was installed in a trailer-mounted secondarily contained system originally to apply dilute 40 percent liquid sodium permanganate at a user controlled concentration (0 to 10 percent) into a minimum of 10 injection wells using only one power cord (120 V) and municipal water supplied via garden hose.

The information contained herein is accurate to the best of our knowledge. However, data, safety standards and government regulations are subject to change; and the conditions of handling, use or misuse of the product are beyond our control. Carus Corporation makes no warranty, either expressed or implied, including any warranties of merchantability and fitness for a particular purpose. Carus also disclaims all liability for reliance on the completeness or confirming accuracy of any information included herein. Users should satisfy themselves that they are aware of all current data relevant to their particular use(s).
In-well sensors maintain the liquid level at present elevations and continuously applied solution using demand-based constant head injection, irrespective of well capacity. High level liquid sensors were provided to de-energize injection should excessive liquid accumulate in any well (due to sensor failure, rainfall events or surface infiltration).

The trailer was provided with internet-based telemetry, allowing remote viewing and control, thereby eliminating unnecessary field visits, decreasing corresponding labor expenses, and promoting a sustainable method to site remediation. Pumping was efficient, using only the municipal water pressure and a mechanical differential dosing pump – eliminating the need for transfer pumps and electric motors, all remotely viewable by several cameras mounted in the trailer and site to provide additional security and control.

Through the use of automation, the constant head approach can be completed in remote areas using sustainable power sources (wind and solar) while still providing real-time remote control and monitoring that:

- Maximizes the use and radius of influence of existing wells, minimizing the need for additional capital improvements
- Minimizes the carbon footprint through automation, resulting in reduced site visits and decreased labor costs
- Minimizes the overall scale of the treatment system by implementing a demand-based multiple use system, eliminating the need for mix tanks, circulation pumps, and additional storage
- Facilitates on-line monitoring, surveillance, and redundancy using PLC control and camera system, providing capabilities for remote alarm reporting, acknowledgement, and reset
CONCLUSION
The constant head method provides a capable, flexible and robust alternative for the application of amendments at low permeability sites. Using the capabilities of technology and working with the natural site conditions, modern system infrastructure can provide capable, cost-effective applications, even in low flow sites that were previously considered difficult, if not impossible, to treat.

AUTHORS
Mr. Tim Pac, Technical Director
ERM

Mr. Ethan Gyles, Senior Project Manager
ERM

REFERENCES


