BENEFITS OF DEEP WELL INJECTION FOR WASTE DISPOSAL AND CLIMATE CHANGE

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The Underground Injection Control (UIC) program was established under the Safe Drinking Water Act (SDWA) to ensure that fluids injected into geologic media do not pose a threat to Underground Sources of Drinking Water (USDWs). The UIC program sets standards and requirements for injection wells and provides permitting and compliance mechanisms to enforce those standards.

Underground injection is a safe and proven way to manage, sequester, and isolate unwanted fluid wastes. The focus of this article is on underground injection in the context of the benefits provided to manufacturing and facility operations. In this context, the two most beneficial underground injection operations are Class I and Class VI UIC Wells.

Class I UIC wells are used to dispose of wastewaters into deep, confined rock formations. Class I wells have been utilized historically and are utilized currently in Illinois. Class I wells can be considered beneficial when the discharge of wastewaters into the environment is prohibited or the treatment of those wastewaters prior to discharge is expensive.

Class VI UIC wells are used to inject carbon dioxide (CO2) into deep rock formations. This permanent underground storage is called geologic sequestration (GS). Illinois is the location of the first operational Class VI UIC well. Class VI wells can be considered beneficial for manufacturing facilities that produce carbon dioxide-rich off-gas streams, such as ethanol plants, cement kilns, and chemical production facilities.

A successful Class I or Class VI UIC well requires suitable geologic conditions, including pore space, that provides sufficient capacity for injected fluids and rock units that prevent upward migration into protected drinking water aquifers (caprock). The Illinois Basin covers parts of Illinois, Indiana, Kentucky, and Tennessee. It contains suitable geologic conditions, has been reasonably well characterized, and is in proximity to a number of facilities that generate injectates that would benefit from Class I and Class VI disposal.

Why Consider a Class I UIC Well for Wastewater Disposal?

Regulations are continuously evolving, and discharge requirements to surface waters become more stringent over time through the National Pollution Discharge Elimination System (NPDES). In addition, regulation of per- and polyfluoroalkyl substances (PFAS) is advancing both in Illinois and nationally. The increasingly stringent requirements lead to increasing disposal costs and the risk of being cut off from the receiving facility. The economics of a UIC well are often advantageous to a wastewater discharge that is collected and hauled to a treatment facility.

Regardless of the TMDLs or NPDES discharge requirements, the pre-treatment requirements for a Class I UIC serve to protect the UIC well and the geologic unit, versus reduction of contaminant loading. A Class I UIC well can offer a consistent mechanism for cost-effective wastewater disposal that mitigates the impact of evolving regulations.

When to Consider a Class VI UIC Well for CO2 Sequestration

Climate change has become a focal point of Environment and Social Governance (ESG) goals and pending mandates to reduce carbon footprints. The United States Department of Energy (USDOE) is leading the CarbonSAFE program across the U.S. to conduct research for the development of technologies for mitigating greenhouse gas emissions to the atmosphere. The state of Illinois hosts a portion of the program called CarbonSAFE – Illinois.

Carbon Capture and Sequestration (CCS) applies to facilities that are point-source

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emitters of CO2, including ethanol plants, cement kilns, and chemical production facilities. Geologic Sequestration of CO2 (GS) requires a Class VI UIC permit. Under the U.S. Environmental Protection Agency's (USEPA) UIC program, a Class VI injection well injects supercritical CO2 (i.e., highly compressible fluid without distinct solid and gas phases) into deep geologic unit(s). The size and location of a Class VI facility relative to the disposal location is an important part of project scoping.

Suitability of Geologic Sequestration in the Illinois Basin

The Illinois Basin is generally considered feasible for Class I and VI UIC from a geologic standpoint; however, not all locations within the basin will be suitable. Feasibility depends on several geologic conditions. Investigation of the appropriate subsurface geology serves to minimize project risk and comply with SDWA requirements. A suitable UIC location requires several components:

- Geology for Injection: A geologic unit exists with sufficient thickness, extent, porosity, and permeability, and a lack of extensive faulting.
- Confining Geology: The geologic unit for injection is overlain by a unit that is of sufficient thickness and extent and has low porosity and permeability. The confining unit should lack faulting that would compromise the unit as a confining interval.
- Area of Review: Penetrations into confining/injection units are sufficiently cased or plugged.

If an injection location is found to contain all of these components during the fatal flaw analysis portion of project scoping, on-site UIC is likely to be feasible and the facility should proceed with a detailed feasibility study. If uncertainties or challenges are identified at a selected injection location, the facility should proceed by conducting additional assessment along with a detailed feasibility study. The challenges and uncertainties must be defined, accompanied by an assessment of cost-effective methods to overcome them. If the required components are clearly determined to be not present during the fatal flaw analysis portion of project scoping, on-site UIC is likely not feasible. However, alternatives to on-site UIC can be explored, including the possibility of transportation for off-site UIC in a location that is feasible.

Financial Advantages

The economic factors for Class I UIC vary based on the geographic location of the well, geology, and construction material prices, and should be considered on a project-specific basis. There is heavy cost associated with early portions of the process (i.e., feasibility study, permitting, and construction). However, it is typical for facilities to see an 18 to 36-month return on investment (ROI) after Class I UIC operation commencement. If the Class I well is permitted as a commercial well to accept third-party waste streams, it will provide additional revenue and will help financially support long-term Class I operations. Additionally, pre-treatment costs associated with Class I UIC are likely to be considerably lower than hauling costs for zero-discharge facilities. These pre-treatment costs are also likely to be lower than the cost of treatment of wastes prior to discharge into the environment.

For Class VI wells, the economics are currently driven by financial incentives related to national goals to lower greenhouse gas content in the atmosphere. Through the Inflation Reduction Act (IRA) of 2022, facilities that capture and sequester CO2 can qualify for federal tax incentives (45Q). These facilities can reduce net carbon emissions by employing CCS, which prevents CO2 emissions from entering the atmosphere, promotes them as environmental stewards, and helps foster economic growth.◆