NJECTIS

SPIN®

INJECTION TECHNOLOGY

TECHNOLOGY PATENTED TECHNOLOGY

THE INNOVATIVE AND HIGH-QUALITY INJECTION TECHNOLOGY

DEVELOPMENT

THE SPIN® INJECTION TECHNOLOGY HAS BEEN DEVELOPED TO OVERCOME THE LIMITATIONS ENCOUNTERED WITH THE TRADITIONAL TECHNOLOGIES FOR DIRECT INJECTION OF REAGENTS INTO THE SUBSURFACE FOR SOIL AND GROUNDWATER REMEDIATION PURPOSES.

With the traditional direct injection technologies, an injection rod is being pushed or hammered into the soil. Reagents are being injected – mostly at discrete depths - while going down (top-down) or retraction of the injection rods (bottom-up). By pushing injection rods with a conical point into the subsurface, the soil material is being pushed aside and soil compaction and soil smearing occur at the point of injection. As a consequence, the soil porosity and hence the hydraulic conductivity reduces dramatically and increased injection pressures are needed to inject reagents into the surrounding soil. Often, the critical injection pressure is being exceeded, causing unwanted fracturing and short-circuiting of the injection product. The injection product can even appear at the surface (daylighting or blowout along the injection rods). In aquifers characterized by a lower hydraulic conductivity, the injection pressure withdraws only slowly which causes the reagents to remain under pressure in the soil fractures for a longer period. This can result in the injection product to come back to the surface after retraction of the injection rods (reflux). These phenomena (fracturing, daylighting, reflux, blowout) cause injection products not to be distributed at the right location and lead to a decreased efficiency of the entire soil remediation process.

An additional limitation of the traditional direct injection technologies, is that a huge force is needed to push the rods into the soil. On the one hand, this power is provided by the mass of the injection rig itself and, as a consequence, these machines need to be heavy and voluminous, restricting their use inside buildings. On the other hand, in case the mass of the injection rig is not sufficient to generate the necessary downward pushing force, injection rods are being hammered or vibrated into the soil. This process causes lateral vibrations of the rods creating a preferential flow path for the injection product next to the injection rods what can trigger blowout to the surface.

Beginning of 2015, a first Spin® prototype was developed with the goal to eliminate the above described drawbacks. As the first series of tests had astonishing results, the technology has been further developed and refined by Injectis during the years 2016 and 2017. Based on the practical experiences gathered during the multiple field applications, the final design of the Spin® injection technology was established beginning 2018.

> PATENT HAS BEEN GRANTED FOR THIS TECHNOLOGY.

TECHNOLOGY

> THE SPIN® INJECTION TECHNOLOGY HAS BEEN DESIGNED TO AVOID SOIL COMPACTION AND SOIL SMEARING AT THE POINT OF INJECTION.

As a consequence, lower injection pressures can be applied and large injection flow rates can be achieved without unwanted fracturing to occur. Moreover, hammering is not being used to bring the injection head to depth so that preferential flow paths next to the injection rods are not being formed. As a result, there is a high degree of certainty that the product is being injected in the targeted soil layer.

The design of the Spin® injection technology allows for continuous top-down injection over the entire depth interval. During the injection process, injection volume, pressure and flow rate are being measured every centimeter with the Spin® measure and logging system. Additionally, a relative value for the hydraulic conductivity ($K_{s,rel}$) of the different soil layers is being determined, what gives a clear image on the texture and stratification of the subsurface. The data generated from each injection point are being presented in the so-called "Spin® injection logs" in which total volume, flow rate, pressure and relative hydraulic conductivity are plotted against the depth below ground level.

ADVANTAGES

IN MOST CASES, THE SPIN® INJECTION TECHNOLOGY OFFERS A SOLUTION FOR THE LIMITATIONS ENCOUNTERED WITH THE TRADITIONAL INJECTION TECHNOLOGIES. THE MAJOR ADVANTAGES ARE LISTED BELOW.

Lower injection pressures

Since the soil structure at the point of injection is minimally disturbed, lower injection pressures can be used and hence the risk for blowout, unwanted fracturing, daylighting and reflux is decimated.

Higher injection volumes

Due to the lower injection pressures, large injection volumes can be injected what results in a larger radius of influence of the injection. Volumes of more than 1.500 L per meter were already successfully injected.

Exact whereabouts

As the injection rods of the Spin® technology are not bended during injection, the location of injection can be more exactly defined. Moreover, the exact depth of injection is continuously measured and registered with the Spin® measure and logging system.

Homogeneous distribution

With the Spin® measure and logging system, the desired volume per meter of injection can be set in advance allowing the homogeneous distribution of the desired volume of product over the entire depth interval to be treated. As a consequence, the product is being applied to every single soil layer of the aquifer with a high degree of heterogeneity. During injection the injected volume is being registered every centimeter. In this way it is possible to evaluate how the injection was executed compared to the initial plan.

Soils with limited permeability

Aquifers or soil layers with limited or low permeability are characterized by a high degree of silt and clay particles. Hence, these soil types are sensitive to compaction and smearing; fracturing, daylighting, blowout and reflux are likely to occur with traditional direct injections technologies. Because soil compaction and soil smearing do not occur with the Spin® technology, injection in silty and clayey soils is possible. Experience has learned that even an extended radius of influence can be achieved in these soil types.

Hydraulic conductivity profiles

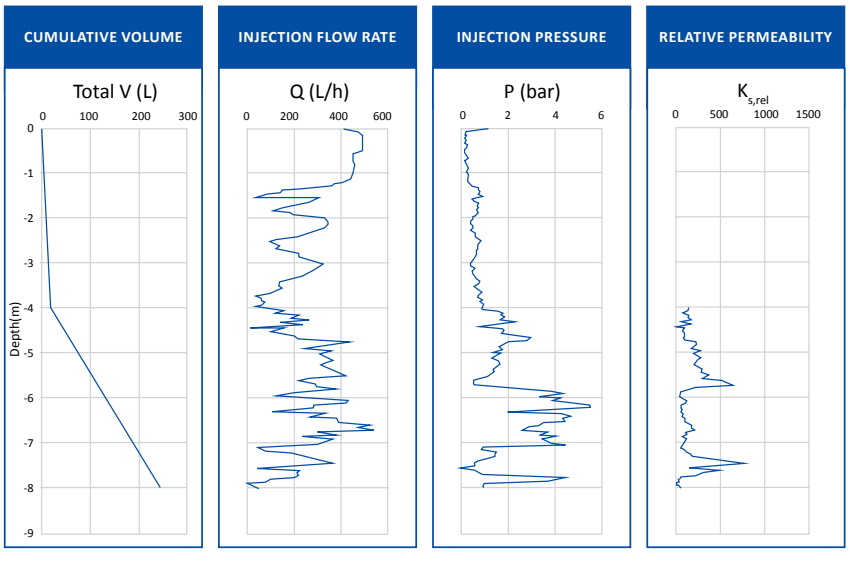
A relative value for the hydraulic conductivity across the injected depth interval is determined from the data measured during the injection process. In this way, additional information on the presence of more and less permeable layers in the subsurface is being gathered. This information can give more insight into the migration patterns of contamination and injection products in the soil. Because injection points are mostly executed in a more dense grid compared to investigation points (like monitoring wells or MIPs), the Spin® injection technology gives additional high-resolution 2D or 3D information on the heterogeneity and permeability of the subsurface.

Focused injection

The Spin® measure and logging system in combination with the stepless regulation of flow rate and injection pressure allows for continuous adjustments during the execution of every injection at every depth. For example, specifically identified soil layers can be targeted for injection or injection can be stopped when reaching sealing clay layers.

Transparency towards clients and consultants

Injection depth, injected volume, pressure, flow rate and the hydraulic conductivity are being registered continuously every centimeter. As a result, the so-called Spin® injection logs can be generated which give a visual representation of the distribution of product over the depth interval, the applied pressures, flow rate and the heterogeneity in hydraulic conductivity of the subsurface. These injection logs are made available for all involved parties to guarantee that the injection works proceed with 100% transparency. Depending on the observations in these logs, the injection strategy can be adapted during the project.



Efficient use of injection products

In case daylighting, blowout or reflux occurs, injected reagents come back to the surface and are hence of no use at all. Unwanted fracturing leads to the formation of preferential flow paths and short-circuiting, by which the injected products do not end up in the targeted location in the soil. By the design of the Spin® injection technology, these unwanted phenomena are less likely to occur and the injected products are being applied efficiently.

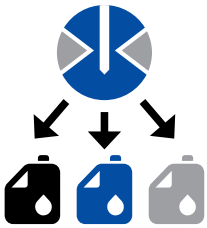
Automatic injection hole sealing

Thanks to the design of the Spin® injection head, the injection hole is being sealed automatically and recompacted with the original soil material during retraction of the injection rods. As a result, preferential pathways for reagents injected in nearby injection points is being avoided and hence injection points can be implanted closer to each other if necessary. Additionally, by sealing the injection holes, the formation of vertical preferential pathways for DNAPL migration is avoided.

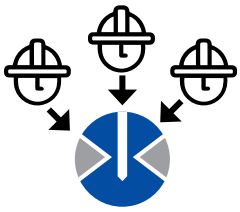
Access to small spaces

With the Spin® injection technology, heavy nor voluminous injection rigs are needed to reach significant injection depths. The *micro*-Spin® injection rig has especially been developed for small spaces with limited access dimensions.
A standard door opening (B: 78 cm; H: 200 cm) is sufficient to enter the area of injection and only a working height of approximately 200 cm is necessary.

Injectis searches
for the most appropriate
and most efficient injection plan
together with the client



Injectis can deliver
the reagents
if desired



Injectis works
for certified soil remediation
companies and consultants

INJECTIS

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