

# S-Micro **ZVI**<sup>®</sup>

Sulfidated Zero-Valent Iron

## Application Instructions



## S-MicroZVI Quick Reference Table

The following table is a quick reference guidance providing only the most relevant information. Please review the entire document carefully, plus the product Safety Data Sheet prior to any application. Please contact REGENESIS Technical Support if you need any further assistance.

<b>Viable application methods</b>	Direct push In wells
<b>Typical dilution factor</b>	10% (exact dilution to be discussed with REGENESIS) 1 kg of S-MicroZVI concentrate in 10 litres of water
<b>Mixing activities</b>	Homogenize concentrated product before transferring Transfer concentrated product to tank already filled with water. <a href="#">More info on mixing instructions</a>
<b>Mixing activities – co-application with 3-D Microemulsion (3DME)</b>	Use dilution factor required for 3DME First mix and homogenize 3DME with water Add S-MicroZVI to the prepared 3DME solution
<b>Recommended injection pump</b>	Diaphragm pump
<b>Recommended injection pressure</b>	Low pressure injection. Typically 1-4 bar <b>DO NOT</b> over-pressure the target matrix and <b>DO NOT</b> fracture Adjust pressure using pressure regulator Take note of pressure and flow rate for each step
<b>Direct push injection</b>	Use a retractable screen tip; avoid pressure activated tip Typical injection steps every 30-60 cm <a href="#">More info on direct push applications</a>
<b>In well application</b>	Low pressure injection; <b>DO NOT</b> gravity feed Use single or double packer Flush well with clean water after application <a href="#">More info on well applications</a>
<b>Other recommendations</b>	Always wash and flush equipment with clean water Seal injection direct push points after injection Do not operate P&T or other activities likely to disturb groundwater in surrounding area during and after injection
<b>Recommended monitoring</b>	Typically, monthly to quarterly monitoring. Monitoring period typically 9 months to 2 years Parameters: contaminants of concern. Supporting evidence: O <sub>2</sub> , redox, pH, electrical conductivity, Fe, Mn, nitrates, sulphates, eventual daughter products (Fe & Mn need to be filtered and acidified in the field)

## S-Micro Zero Valent Iron<sup>®</sup>

S-Micro Zero Valent Iron<sup>®</sup> (S-MicroZVI), is an advanced zero-valent iron (ZVI) product proven to accomplish In Situ Chemical Reduction (ISCR) of contaminants within the subsurface environment. S-MicroZVI is delivered as a colloidal suspension **40% ZVI** by weight in glycerol with a particle size of less than 5 microns. S-MicroZVI is manufactured using a state-of-the-art sulfidation process resulting in a particle coating which increases activation toward specific contaminants and extends performance longevity.

S-MicroZVI Safety Data Sheets will be supplied with all delivered products. These should be read carefully prior to S-MicroZVI handling. It is assumed that the user is appropriately trained and competent and will have completed a comprehensive site-specific health, safety & environmental risk assessment for the works they intend to carry out.

## Pre-Application Guidance

S-MicroZVI is typically supplied in **227kg drums**, which are shipped 4 drums to a pallet on a heavy goods vehicle. Please discuss any site access restrictions with REGENESIS, so an appropriately sized delivery vehicle is used. Prior to S-MicroZVI application, REGENESIS recommends completing a pre-application test injection using clean water. This procedure is useful to determine the quantity of liquid the target zone will accept and will provide valuable flow rate and pressure information to inform the subsequent S-MicroZVI injection. REGENESIS recommends the injection test volume of water is in the range of **15-20%** greater than the single-point design volume e.g. if the design specifies a S-MicroZVI volume of 1,000L per point then the water test injection should aim for 1,150L – 1,200L.

## Mixing Instructions

The delivered S-MicroZVI concentrate should be thoroughly mixed within the delivered container prior to dilution. If supplied in drums, we would recommend using a hand-held paddle mixer to mix the product. Ensure the mixer makes contact with the bottom of the container to adequately disturb any settled product, particularly in cold conditions.

S-MicroZVI should only be applied after dilution with water. In this form it offers optimal distribution of the S-MicroZVI material throughout the target aquifer from the injection point. This in turn will result in

minimal number of injection points required overall for the project, reducing time and cost.

The S-MicroZVI should be mixed in an appropriately sized tank, preferably conical or flat bottomed to aid mixing. Mixing can be achieved using a high flow pump via recirculation or mechanically using a paddle mixer.

REGENESIS recommends that mixing proceeds in the following order:

1. The required volume of water should be added to the mixing tank.
2. Engage the mixing mechanism prior to adding the S-MicroZVI concentrate.
3. S-MicroZVI concentrate is a relatively thick substance, particularly in low temperatures, and a drum pump or similar should therefore be used. We would not recommend adding water to the S-MicroZVI concentrate as this results in an instable mixture which is more difficult to pump.
4. As the concentrate is added to the water ensure that they are mixed together vigorously to begin with. Please note that continuous gentle mixing is required throughout injection to prevent the build up of product at the bottom of the mixing receptacle.

Depending on the level of the mixing tank, mixed S-MicroZVI in the mixing tank may siphon back into the containers of S-MicroZVI concentrate. This can be avoided by installing lever valves on the supply hose or removing the supply hose from the mixing tank after adding S-MicroZVI.

## Direct Push Application

A typical S-MicroZVI project will only require a single application. As multiple applications are not necessary, and where geological conditions are suitable, direct-push application is the preferred application method (lower costs as compared to injection well installation).

The injection rods should be advanced to the target depth and the S-MicroZVI injection-ready dilution applied, while note is taken of the flow rate and pressure. Once the requisite volume has been applied evenly over the target horizon, clean water should be used to flush through the pump, hoses and injection tip to ensure all S-MicroZVI has been displaced into the formation.

Once the point has been completed the injection hole should be sealed with bentonite or cement. The purpose of this effort is to seal off any potential pathways to the surface and in doing so reduce the risk of S-MicroZVI flowing upwards ('daylighting'). If the S-MicroZVI application is based on a grid design,

the application should ideally be performed by systematically working from the outside to the centre of the injection array to minimise local mounding of groundwater. Where possible, a suitable distance should be maintained between consecutive injection locations to avoid localised overloading of the formation with injected product (e.g. inject at every 3<sup>rd</sup> point in a barrier).

## Well Applications

S-MicroZVI can be injected via fixed injection wells where direct push is not considered practical. REGENESIS recommends that injection wells should generally be constructed using **≥50mm diameter** HDPE. Where possible, the well seal above the slotted section should consist of a maximum of **300mm** of bentonite pellets, above which a sand & cement mix should be applied to seal to the surface. Prior to injection of any remedial reagent, REGENESIS recommends that the injection wells be purged of fine-grained particles present in the well bore to the extent practicable. When wells are used for S-MicroZVI injection, the injection wells and nearby groundwater monitoring wells should be either tightly capped or alternatively equipped with a pressure gauge and relief valve. This will reduce potential for daylighting.

Once the requisite volume has been applied evenly over the target horizon, clean water should be used to flush through the pump, hoses and well to ensure all S-MicroZVI has been displaced into the target formation. REGENESIS would advise that all equipment is flushed through with clean water at the end of each working day and on completion of the injection works.

## Co-Application with 3-D Microemulsion (3DME)

S-MicroZVI maybe mixed and applied with 3DME, REGENESIS recommends that 3DME is diluted according to the 3DME application instructions before S-MicroZVI. Once the 3DME is well combined with the water to form a diluted microemulsion the S-MicroZVI may be added resulting in a light grey mixture (exact shade depends on the quantities of both products). As with a S-MicroZVI only dilution, mixing should be maintained throughout the injection process and REGENESIS recommends that a dose of clean water is used to clean the system and wells after each injection point or at the end of the day.

In some instances, a small layer of foam may form on the top of the diluted combined product. Continual mixing will reduce the volume of foam and care should be taken to avoid injecting any of this as it will introduce air to the pump with the potential to cause mechanical damage.