MetaFix® Reagent Slurry Preparation and Application Guidelines

INTRODUCTION

MetaFix® Reagents are proprietary formulations of reducing agents, reactive minerals, mineral activators, catalysts, and pH modifiers to cost effectively address heavy metals at even the most challenging sites. MetaFix® is capable of treating comingled plumes of multiple heavy metals and chlorinated solvents. Following placement of MetaFix® into the saturated zone, a number of physical and chemical processes combine to create geochemical conditions under which common heavy metals are subjected to reduction, adsorption, precipitation, and conversion to stable mineral forms, including metal sulfides and mixed Fe-Cr oxyhydroxides similar to that of goethite (α-FeOOH). This provides far superior stabilization to conventional Cr(VI) stabilization techniques which are principally based on pH and/or redox manipulations. A wide range of chlorinated volatile organic compounds (CVOCs) are also degraded in reactive zones created with MetaFix® allowing for treatment of mixed plume impacts

SLURRY PREPARATION

MetaFix® is delivered as a dry powder in 50 lb. bags or in one ton bulk bags, and can be used in unsaturated soil mixing applications to stabilize soluble metals; or emplaced into the saturated zone via direct push injections, hydraulic and pneumatic fracturing, or direct soil mixing.

MetaFix® is mixed with water on site into a slurry. The amount of water needed to prepare the slurry will vary depending on the specific MetaFix® formulation used, as well as, on the desired injection volume and the slurry properties. When applied via direct injection, a concentration between 40 and 70 percent by weight (wt%) solids is normally targeted (i.e. mass of dry MetaFix® divided by total mass of slurry including MetaFix® and water).

Dilute slurries may promote permeation (as opposed to fracturing) in more granular formations if the flow rate and pressure is kept low. In general, more viscous slurries have been found to limit problems with daylighting; particularly for shallow applications in low-permeability formations.

The table below shows potential ranges of water needed per 50 lb bag of MetaFix® reagent. Please contact Evonik to obtain the information needed to determine the final slurry volume and specific gravity for your specific MetaFix® formulation.

TABLE 1 | METAFIX® SLURRY MAKE-UP FORMULATIONS

TARGET CONCENTRATION (WT% SOLIDS)	40%	50%	60%	70%
Volume Water per Bag (USG)	9	6	4	2.6
Volume Water per Bag (L)	34.1	22.7	15.1	9.7
Calculated Slurry Volume	Evonik can provide this information for your specific MetaFix® formulation			
Slurry Specific Gravity				

Potential ignition sources need to be avoided during mixing operations and open containers or tanks should be used to allow any gasses or dusts to readily dissipate/dilute into the atmosphere. Keep potential sources of ignition away 15 feet or more from mixing vessels during operations and do not let batches of slurry stand overnight to minimize potential gas accumulation above the mixing vessels. Employ smaller batch sizes to minimize the amount of gas produced. Employ health and safety meter(s) equipped with LEL, H_2, H_2S and CO sensors to monitor for potentially flammable levels of gasses.

Evonik recommends a pneumatically or hydraulically actuated mechanical mixing system, such as provided on ChemGrout® environmental series mixers (e.g., CG-400, CG-500, and CG-550). In general, continuous mixing in smaller batches (<100 USG / 400 L) is recommended to avoid settling of solids at the bottom. ChemGrout's high pressure mixing and injection units are ideal for continuous preparation and injection of MetaFix® reagents. The slurry is prepared in open-topped hoppers with paddle mixers and transferred to a feed tank with a high-pressure piston injection pump (**Figure 1**); that way the slurry can be prepared continuously while the injections are performed. The slurry mixes quickly in these types of systems and the injections can proceed without interruption.

Figure 1 | ChemGrout's CG-500 mixing unit with high pressure piston pump

PUMP REQUIREMENTS

An injection pump that is capable of generating at least 500 psi of pressure at a flow rate of 5 gpm is recommended. The pump needs to be able to handle solids. For example, piston pumps, grout pumps, and progressive cavity pumps have worked well in the past, with a preference towards the piston and grout pumps. MetaFix® slurries are typically injected at pressures of 100 to 200 psi, however, higher pressures may be required to initiate the injection. Deeper installations may require higher injection pressures. Flow rates are expected to range between 3 and 6 gpm.

Figure 2 | Low pressure water test of pressure activated tip with 4 horizontal openings

INJECTION APPROACH

For each injection point, the rods are initially advanced to the top (or bottom) of the targeted depth interval and a specified volume of slurry is injected before proceeding to the next depth. The injections are to be evenly distributed over the targeted depth interval using a vertical injection spacing of approximately 1-3 ft. The preferred approach for the injections is often in the top-down direction using an injection tip that directs the slurry horizontally; for example pressure activated injection tips have been successfully utilized.

Top-down injections would be recommended to ensure proper vertical distribution in particular for soils that could be expected to stay open as the rods are pulled up and if a larger vertical depth interval is targeted (particularly in heterogeneous lithologies). However, in some formations, issues with daylighting and clogging has prevented the use of top-down injections and it is therefore recommended to stay flexible in the field and make adjustments if needed; note that bottom-up injections can be equally effective depending on the lithology and thickness of the targeted zone.

INJECTION SPACING

The recommended spacing between injection points is based on two factors: distribution (ROI) and soil acceptance. Both of these factors may vary greatly depending on injection technique and lithology. We recommend staying as flexible as possible during a field installation and/or to evaluate these parameters during a pilot-scale test injection. However, based on experience from a range of sites, we normally estimate a ROI of at least 3 - 5 ft with direct injection and from this we normally recommend an injection spacing of 5 to 15 ft (staggered rows). Soil acceptance may also vary greatly depending on the lithology and injection depth. As a general guideline, we recommend no more than 100 lbs MetaFix® per vertical foot for more permeable formations. For clayey formations, soil acceptance has in some instances been limited to 20 lbs per vertical foot. Therefore, a closer spacing may have to be applied in a scenario with a higher dosing requirement combined with a low permeability formation to limit the injection volume per point.

Note: Significantly greater ROIs has been observed with fracturing techniques. Please contact Evonik for further information regarding ROI monitoring and site observations.

Having sufficient rod length and injection tips on site is recommended to allow 3 to 5 injection points to be capped overnight to prevent backflow, if need be (more for shallow depths and less for deep installations).

HEALTH AND SAFETY

While handling MetaFix® and preparing injection slurries, basic precautions regarding potential combustible dusts and gas generation should be followed. When working with MetaFix, minimize dust generation and accumulation; and keep away from ignition sources. Use the appropriate personal protective equipment including: safety glasses, suitable protective clothing, boots (steel toed), gloves, hard hat, and hearing protection (when direct push equipment is used). For dust, splash, or mist exposures wear a filtering mask and chemical protective goggles. A face shield can also be used in addition to goggles.

Please consult the MetaFix® reagent Safety Data Sheet (SDS) for guidelines regarding proper handling procedures. The SDS is posted on our web site at: http://www.evonik.com/remediation. Additional safety equipment may be required for mechanical and site operations.

Please contact Evonik for additional guidance.

Evonik Corporation
Active Oxygens Business Line
Soil & Groundwater Remediation

remediation@evonik.com
evonik.com/remediation