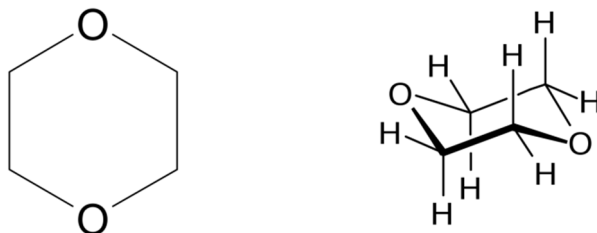




1,4-Dioxane Bench-scale Treatability Studies

One of the most difficult and recalcitrant compounds to remediate is 1,4-Dioxane. This compound is used primarily as a stabilizer in chlorinated solvents such as 1,1,1-Trichloroethane (TCA) as well as in Trichloroethene (TCE). Stabilizers are used to prevent solvent break down and to inhibit any reactions that may degrade the properties of the solvents.



Two different views of the structure of 1,4-Dioxane

1,4-Dioxane Properties

As an ether, 1,4-Dioxane has many properties that make it difficult to remediate. Some of these properties are:

Property	Value
CAS Number	123-91-1
Formula	C ₄ H ₈ O ₂
Molecular weight	88.1
Melting Point (at 760 mm Hg)	11.8 °C
Boiling Point (at 760 mm Hg)	101.1 °C
Flash Point (at 760 mm Hg)	12 °C
Density (at 20 °C)	1.0329 g/ml
Water Solubility (at 20 °C)	Miscible
Vapor Density (Air =1)	3.03
Octanol-Water Partition Coefficient (K _{ow})	0.27
Vapor Pressure (at 20 °C)	30 mm Hg
Henry's Law Constant	4.88 x 10 ⁻⁶ atm m ³ /mole

1,4-Dioxane Synonyms

1,4-Diethylene dioxide	1,4-Diethylene oxide	p-dioxane	Diethylene oxide
Diox	Dioxyethylene ether	DX	tetrahydro-1,4-dioxan



1,4-Dioxane Bench-scale Treatability Studies

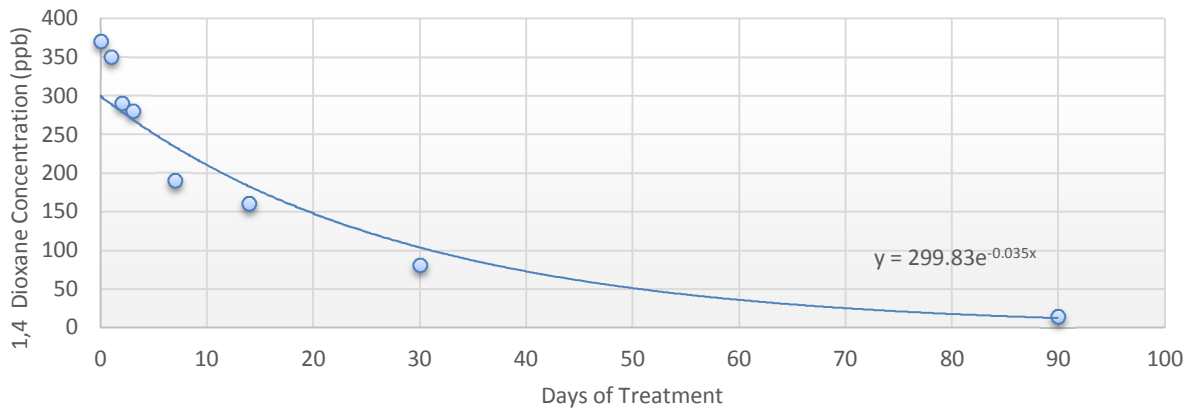
EN Rx Groundwater Bench-scale Treatability Study

This study was set up to test the ability of EN Rx’s reagents for use on a site in North Florida. A third party obtained a sample from the site and set up varying combinations of EN Rx’s reagents. Below is a summary of the study, showing the successful oxidation of the constituents.

Reaction Time	1,2-Dichloroethane		1,1-Dichloroethene		1,4-Dioxane	
	Results	% Reduction	Results	% Reduction	Results	% Reduction
Initial	5.7	-	150	-	370	-
14 Days	2.0	65	0.99	99	160	57
30 Days	NA	NA	NA	NA	81	78
90 Days	NA	NA	NA	NA	14	96
Regulatory Limit	3.0		7.0		3.2	

All results in ug/L; NA = Not analyzed

Based on the data, EN Rx has proven the ability of its reagents to oxidize 1,4-Dioxane and its comingled contaminants in groundwater in a controlled reaction (96% in 90 days).



EN Rx Soil Bench-scale Treatability Study

This second study was set up to test the ability of EN Rx’s reagents for use for soil treatment on a site in North Carolina. A third party obtained a sample from the site. To the right is a summary of the bench study, showing the successful oxidation of the constituents.

1,4-Dioxane		
Reaction Time	Results	% Reduction
Initial	49.8	-
20 Days	<3.8	>92
Regulatory Limit	3	
All results in ug/Kg; NA = Not analyzed		

Based on the data, EN Rx has proven the ability of its reagents to oxidize 1,4-Dioxane in soil in a controlled reaction (92% in 20 days) to the very low standards for soil.



1,4-Dioxane Bench-scale Treatability Studies

Current Treatment Options

Standard pump and treat technology using air stripping and carbon adsorption tend to be ineffective. The current treatment for 1,4-Dioxane in ground water tends to be expensive and energy intensive. These treatments such as Advanced Oxidation tend to be performed *ex situ* and involve the pumping, treating and discharging of very large volumes of water.

With the successful bench scale studies, there are now several options for the application of EN Rx's reagents for the treatment of 1,4-Dioxane and its associated contaminants. Some of these options are:

- A single safe reagent to treat 1,4-Dioxane, chlorinated alkanes and alkenes as well as aromatic contaminants.
- The slow reaction of EN Rx's allows for the use of a system based application that can provide large amounts of oxidizer into various lithologies.
- A system based application is conducive to renewable energy. EN Rx's systems are able to be run using wind and solar energy. This is opposite to the current energy intensive technologies.
- The *In situ* treatment lowers or eliminates the amount of water that must be discharged from the site during remediation.
- An *ex situ* treatment can also be complete utilizing EN Rx products minimizing the number of vendors involved, maximizing cost effectiveness.
- The safety of EN Rx's reagents allows EN Rx to blend its reagents into contaminated soil safely. EN Rx's reagents do not produce the high heat and pressure that other reagents do. Blending into contaminated soil lowers the concentration and can save on disposal costs.

About EN Rx, Inc.

EN Rx is a service disabled veteran owned business (SDVOB). EN Rx manufactures reagents for the oxidation of contaminants in the environment. EN Rx has successfully treated ground water and soil for chlorinated pesticides, chlorinated solvents, and petroleum related contaminants.

EN Rx leases solar powered injection systems that reduce site labor and allow for the proper quantities of oxidants to be injected into the subsurface in a controlled and cost effective manner.

EN Rx also sells products to reduce perchlorate and bind metals.

For additional information, please feel free to contact EN Rx, or obtain information from our website (www.enrxinc.com).