CASE STUDY

EUROFINS EAG LABORATORIES: QUANTITATION OF STYRENE VIA HHS-GC/MS

Three water samples were tested using utilizing Heated Headspace Gas Chromatography with Mass Spectrometry (HHS-GC/MS) to quantify styrene content. The analyte was not detected in S1 at or above the client-specified detection limit of 1 part per million.

THE CHALLENGE

United Felts wanted to ensure that CIPP installation using EnviroCure®-Felt reduces styrene emissions, and their associated smells, from trenchless rehabilitation jobsites while also falling well-below the EPA standards. The objective of this study was to perform a quantitative GC/MS analysis on installation and cure water samples taken from a 36" x 15 mm EnviroCure-Felt liner to identify and determine styrene content.

For CIPP, a tube saturated with a styrene-based polyester resin is installed through the deteriorated host pipe. Once the old pipe has been lined with this material the polymerization step begins with a curing procedure. Curing involves heating the resin to harden it, which strengthens the host pipe. Upon completion, the old sewer pipe has a new tight-fitting structural lining extending its useful life.

When rehabilitating pipes using a styrene-based polyester resin system, during the installation and curing process, small concentrations of residual styrene monomer can be emitting and detected at the jobsite. These emissions can sometimes be detected within connections to the host pipe. After the tube is cured, the styrene eventually dissipates to a non-detectable concentration, so styrene exposure is short-term. Breathing elevated concentrations of styrene can create respiratory issues, and irritation of the eyes, nose, and lungs, but the main complaint during trenchless rehabilitation is an unusual, plastic odor.

Because of the potential health hazards due to working with styrene, United Felts decided to perform an independent study with Eurofins EAG Materials Science, LLC Laboratories to prove that EnviroCure-Felt liners provide styrene mitigation and encapsulation that prevents a dangerous level of styrene from emitting into the environment.

EnviroCure-Felt, manufactured by United Felts, is a styrene impermeable polymer coating applied to traditional CIPP liners that eliminates styrene emissions and odor. The proprietary all-felt or hybrid felt/glass liners coated with a styrene barrier vastly reduces, if not eliminates, styrene odors and emissions on the jobsite before, during, and after installation — removing the significant cost and unpredictability of styrene-free resin systems.

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PROJECT SNAPSHOT

PROJECT
Quantitation of Styrene

OBJECTIVE
To perform a quantitative GC/MS analysis on water samples taken from a 36" x 15 mm EnviroCure®-Felt liner to identify and determine styrene content.

TESTING GROUP
Eurofins EAG Materials Science, LLC.

SAMPLE ANALYSIS PERFORMANCE DATE(S):
09/28/2023 – 10/05/2023

UNITED FELTS PRODUCTS USED

EnviroCure®-Felt

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CASE STUDY

THE STUDY

To assist EAG Laboratories with the assessment of any styrene risks of EnviroCure®-Felt, the team at United Felts submitted three water samples:

1. Install 09/19/23
2. Exotherm 091/19/23
3. Cool Down 09/19/23

The testing utilized Heated Headspace Gas Chromatography with Mass Spectrometry (HHS-GC/MS) to quantify styrene (CAS No.: 100-42-5) content. Please see the table below for a summary of the styrene quantitation.

Results Summary for Styrene in Water Samples

SAMPLE	AVERAGE STYRENE CONCENTRATION[1] (µg/g[2])	RPD[3]
"Install 09/19/23"	< LOD[4] (1.00)	N/A
"Exotherm 09/19/23"	15.13	1.2%
"Cool Down 09/19/23"	4.17	6.2%

[1] Average of duplicate preperations | [2] µg/g = parts per million
[3] RPD = Relative Percent Difference | [4] LOD = Limit of Detection

The water samples were prepared for analysis using the following approach:

- Aliquoted and hermetically sealed in 20-mL headspace vials, as-received.

THE RESULTS

Table 1 summarizes the results of the quantitation of styrene (CAS No.: 100-42-5) in S1-S3. The quantitation was carried out using Heated Headspace Gas Chromatography with Mass Spectrometry (HHS-GC/MS). The analyte was not detected in S1 at or above the client-specified detection limit of 1 part per million (µg/g); however, the data suggests S2 and S3 contain trace levels of styrene. Therefore, S2 and S3 were fortified with a known amount of styrene to assess accuracy and the spike recoveries were observed to be 40% and 32%, respectively. For quantitation, a five-point calibration curve was generated and observed to have an R2 of 0.98.

IMPACT

1. Three water samples were tested using utilizing Heated Headspace Gas Chromatography with Mass Spectrometry (HHS-GC/MS) to quantify styrene content.

2. The analyte was not detected in S1 at or above the client-specified detection limit of 1 part per million.

3. EnviroCure®-Felt liners provide styrene mitigation and encapsulation that prevents a dangerous level of styrene from emitting into the environment.

ANATOMY OF ENVIROCURE-FELT LINER

1. **Inner Felt Layer - With Styrene Barrier Coating**
2. **Felt Liner Layers - Resin Saturated**
3. **Pre-Liner - Optional**

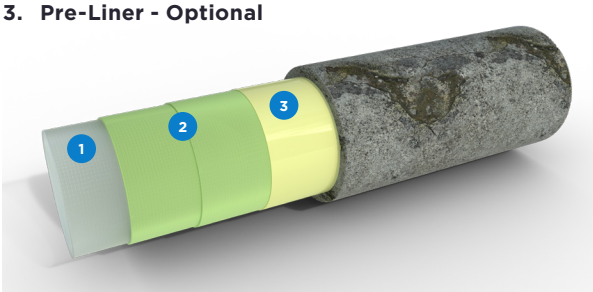

Table 1 | Quantitation Summary of Styrene in S1-S3

SAMPLE DESCRIPTION	PREPERATION NO.	STYRENE CONCENTRATION (µg/g)[1]	AVG. STYRENE CONCENTRATION (µg/g)[1]	RPD[2]
S1	1	< LOD[3] (1.00)	< LOD[3] (1.00)	N/A
	2	< LOD[3] (1.00)		
S2	1	15.23	15.13	1.2%
	2	15.04		
S3	1	4.30	4.17	6.2%
	2	4.04		

[1] µg/g = parts per million | [2] RPD = Relative Percent Difference | [3] LOD = Limit of Detection

To note, low spike recoveries of S2 and S3 were likely obtained due to the instability of styrene in water, specifically at low concentrations. The data suggests the concentration of styrene in S2 and S3 decreased rapidly over time. If similar testing is conducted in the future, the following precautions are advised to preserve the integrity of the sample matrices:

1) send multiple bottles or jars of each sample
2) leave little to no headspace in the vessel of choice, and
3) send the samples over ice to reduce loss of volatile content.

The results of the installation and cure water analysis illustrate the ability of the EnviroCure®-Felt coating to reduce styrene concentrations below current regulatory levels of acceptance.

Water sample S1 taken after the liner was inverted using hydrostatic head demonstrates that the EnviroCure-Felt coating prevents styrene diffusion into the waterfilled CIPP tube; the styrene Limit of Detection was not reached.

Sample S2 was taken as the water was heated to initiate the curing reaction of the resin. At this point styrene concentrations of 15ppm were detected, however the source of the styrene is unknown. This trace concentration may have resulted from residual styrene present in the boiler/heating equipment used to circulate water during the curing process, especially if this equipment has been used previously for traditional CIPP liners. Sample S3, collected after the curing water was cooled prior to release contained styrene levels of 4ppm. The decrease in styrene concentration between S2 and S3 is indicative of the rapid biodegradation of styrene. Even with the presence of rogue styrene, the EnviroCure-Felt lining system reduced styrene concentration below regulatory limits.