EnviroSnap Resin Series Best Practices Guide

PMW Technologies has developed a new and revolutionary styrene and monomer-free resin family to address the environmental and pungent odor issues associated with styrene and styrenated resins used in the Cured-In-Place Pipe (CIPP) industry. While much effort was put into making these resins as similar to their styrenated counterparts with regards to handling and use, there are some keys to success that need to be highlighted and addressed. This guide was created to assist the wet out and installation crews as they begin to incorporate these new resins into their routine usage.

This guide covers the portion of the CIPP process from resin storage through liner curing and post curing. Many guidelines and suggestions have been provided throughout this guide with the intent of aiding in the production of a properly wet out, installed and cured liner being the end result. With that in mind, please pay special attention to the following:

- Resin should be stored at temperatures between 60°F and 75°F and kept from heat ignition sources and sunlight.
- Styrene free resins tend to build viscosity faster as resin temperature is reduced compared to their styrenated counterparts.
- Resin temperature should be between 60°F and 75°F to allow for proper catalyst dispersion and liner wet out.
- PMW recommends use of Cumene Hydroperoxide (CHP) Only as a catalyst for ENVIROSNAP resins
- ENVIROSNAP resins cure in the absence of oxygen, under vacuum or pressure
- Wet out liners may be stored cold and on ice in accordance with CIPP industry best practices.
- Installation and cure/post cure should follow accepted CIPP industry best practices.

This manual is not intended to address all of the unique situations that can be encountered in underground rehabilitation projects or to be a substitute for operator experience.

This manual is not intended to replace engineering and design "best practices" or the accumulation of years of hands-on experience.

For assistance with information not contained in this manual, please contact PMW Technologies Technical Support or your resin sales professional for help with specific contact information.

ENVIROSNAP vinyl hybrid resins are formulated specifically for Cured-In-Place Pipe (CIPP) applications. They are styrene-free and monomer-free resins with a bisphenol-epoxy vinyl ester polymer backbone. ENVIROSNAP resins are thixotropic pre-promoted resins formulated for use with Cumene Hydroperoxide (CHP) instead of the traditional initiators used in CIPP. ENVIROSNAP resins combine outstanding corrosion resistance and high temperature performance with excellent tube wet out and low odor due to being monomer free.

FEATURES	BENEFITS
Styrene Free, Monomer Free	No styrene migration into the environment No HAPS or VOCs Reduced resident complaints due to styrene odor
Highly-rigid polymer backbone	Provides elevated temperature performance Excellent corrosion resistance to many chemical media
Thixotropic Resin	Resists sagging on vertical surfaces Resists draining around reinforcements
Tailored inhibitor system	Rapid curing at moderate temperatures Excellent catalyzed stability
SPC/SQC Controlled	Batch-to-batch consistency and uniformity

ENVIROSNAP Handling and Use Guidelines

Safety Precautions

READ AND UNDERSTAND THE MATERIAL SAFETY DATA SHEET BEFORE WORKING WITH THIS PRODUCT

Obtain a copy of the Material Safety Data Sheet on this product or contact PMW Technical Support prior to use. Material Safety Data Sheets are available from your PMW Technologies Sales Representative. Such information should be requested from suppliers of all products and understood prior to working with their materials.

DIRECTLY MIXING ANY ORGANIC PEROXIDE WITH A METAL SOAP, AMINE, OR OTHER POLYMERIZATION ACCELERATOR OR PROMOTER WILL RESULT IN VIOLENT DECOMPOSTION. WHEN ADDING ORGANIC PEROXIDES TO A RESIN SOLUTION, PROMPTLY AND THOROUGHLY MIX THE RESULTING PRODUCT. NEVER ADD ORGANIC PEROXIDES TO A HOT DILUENT OR PROCESS. PREVENT CONTAMINATION WITH FOREIGN MATERIALS, INCLUDING WITHOUT LIMITATION, ACCELERATORS (SUCH AS DIMETHYANILINE, OTHER AMINES OR COBALT COMPOUNDS), HEAVY-METAL OXIDES OR SALTS (PARTICULARLY THOSE OF COBALT, IRON AND COPPER), STRONG ACIDS AND SANDING DUSTS. USE CLEAN CONTAINERS MADE OF GLASS, POLYPROPYLENE, TEFLON, POLYETHYLENE, OR CERAMIC TO PREVENT CONTAMINATION OF ORGANIC PEROXIDES DURING ITS HANDLING.

Dispensing Resin into Smaller Containers

When dispensing bulk resin into smaller containers, such as from 55 gallon drums to 5 gallon or smaller pails, ensure that the resin is properly agitated for a minimum of ten (10) minutes before transfer. This will ensure that the resin in the pails is of the same consistency as the original mixed and certified batch and that the resin will perform as expected.

Failure to follow these guidelines can result in improperly catalyzed resin and lead to uncured or partially cured liners.

Be sure to follow all applicable safety procedures when transferring resin to avoid personal injury or damage to property.

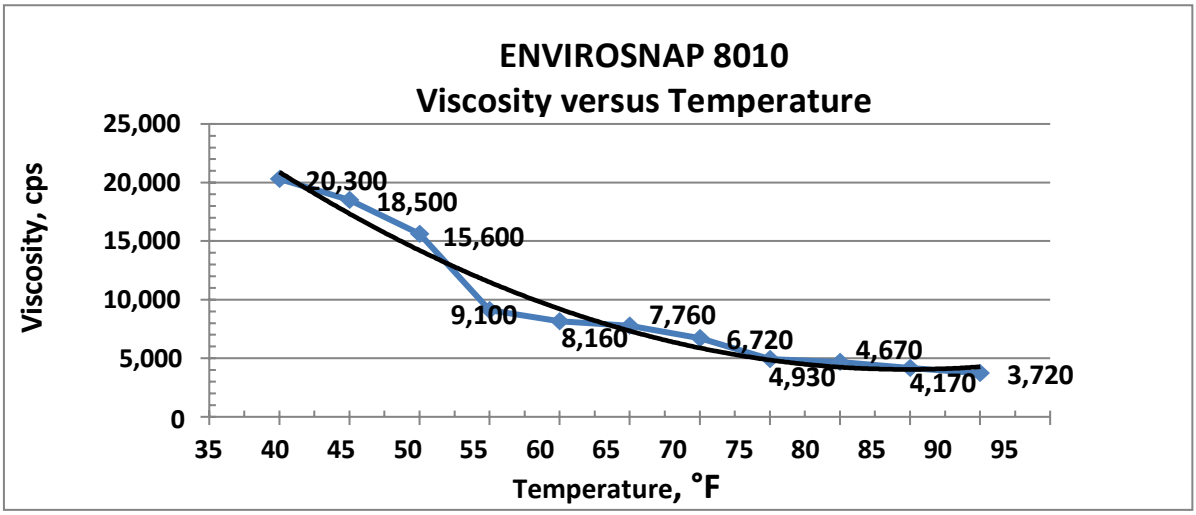
Storage Guidelines

To ensure maximum stability and maintain optimum resin properties, ENVIROSNAP resins should be stored in the original closed container, if non-bulk load, at temperatures between 16°C/60°F and 24°C/75°F away from heat ignition sources and sunlight. Resin should be allowed to warm to at least 16°C/60°F prior to liner wet out in order to assure proper curing and handling. Mild agitation of both neat and filled versions of ENVIROSNAP is recommended after prolonged storage. Avoid contamination of product with water and do not store outdoors. Keep containers sealed to prevent moisture pick-up and potential for contamination. All storage areas and containers should conform to local fire and building codes. Copper or copper-containing alloys should be avoided as containers. Store separate from oxidizing materials, peroxides and metal salts. Keep containers closed when not in use.
Inventory levels should be kept to a reasonable minimum with first-in, first-out stock rotation.

Guidelines for Wet Out

Due to the fact that the ENVIROSNAP series of resins do not contain styrene or a similar monomer like the vast majority of resins currently used in CIPP, they do not react in a similar fashion when subjected to swings in temperature or viscosity. The conventional styrenated resins widely used in CIPP exhibit a smooth and gradual build in viscosity as resin temperature falls. It is likely that, because it is a solvent, styrene maintains its ability to reduce resin viscosity at temperatures lower than 16°C/60°F.

In contrast, ENVIROSNAP resins exhibit a different behavior as temperature falls. As shown by the following graph, ENVIROSNAP 8010 initially has a similar temperature-viscosity profile as the resin temperature is reduced from 90°F to 55°F. It is not quite as shallow a profile as the styrenated resins but is still similar. A transition takes place between 55° F and 50°F as the viscosity increases by 6,000 cps and from 55°F to 40°F the slope of the curve is steeper than prior to the transition. This behavior is demonstrated in the following graph.



The implications of this behavior are applicable to wet out and should be considered by the wet out team. Some increases in viscosity with temperature reduction can be reasonably accommodated however, there is a level at which this build-up in viscosity can prevent the wet out team from producing a quality liner for installation. This is particularly evident with regards to proper catalyst mixing and dispersion into the resin. As the resin viscosity increases, additional mixing time is necessary to ensure proper and complete catalyst dispersion. In some instances, a different mixing setup or system may be necessary.

Catalyst and Mixing

If you are mixing the resin and catalyst in a drum or mix tank, be certain to mix the catalyst into the resin for a minimum of ten (10) minutes. **Proper catalyst mixing is essential to obtain optimum physical properties in the cured liner.**

PMW ENVIROSNAP Resins are designed to use commonly available CHP as the catalyst. Use of conventional polyester and vinyl ester initiators is not recommended.

ENVIROSNAP Resin	% Catalyst by Weight	Typical 77°F Stability
ES-8010	1% CHP	>24 hrs
ES-8010	1% CHP + 0.5% TBPB*	6-8 hrs

*TBPB assists in completing the cure, which is a consideration when time is a factor. The compromise is shorter catalyzed stability time.

While on the subject of resin catalyzation and mixing, it should be noted that ENVIROSNAP resins have a specially tailored inhibitor system. This system allows the resin to gel and cure in a fashion similar to the conventional styrenated resins (that wet out and installation crews are accustomed to working with) while having the added benefit of excellent catalyzed stability. Stability of these resins when catalyzed with 1.0% CHP is in generally in excess of 8 hours at 77°F. This means that premature gelation of a liner during the wet out process should not be of major concern to the wet out team provided they follow these guidelines and accepted industry best practices.

Based on this behavior and the stability of the catalyzed resin, the recommended temperature range for wet out of ENVIROSNAP resins is between 60°F and 75°F. This follows the CIPP industry's accepted best practices and will help to ensure proper catalyst distribution. **Failure to follow these guidelines can result in improperly catalyzed resin and lead to uncured or partially cured liners.**

Guidelines for Wet Out Liner Storage and Transport

Once the liner has been properly wet out with ENVIROSNAP resin, it is now ready to be placed into storage and/or shipped to the jobsite. As with wet out, PMW advocates following accepted industry best practices for the handling and storage of the wet out liner. This part of the process does not require any special considerations due to the resin being styrene/monomer free. At this stage of the process, the liner may be treated the same as if it were a conventional, styrenated resin.

It is recommended that the wet out liner be placed into a refrigerated space for storage and transport. It should be kept from contact with the floor as well as direct contact with other layers of wet out liner. It is recommended that ice and refrigerated air be used to maintain the temperature of the liner below 50°F. A periodic monitoring program should be in place to ensure that the liner remains at the proper/desired temperature for the duration of its time in storage/transport. Contingencies should be in place for loss of refrigeration due to power outage or a refrigerated truck running out of fuel.

Finally, it is recommended that the time the wet out liner is in storage/transport be kept to a minimum. Catalyzed resin has a finite shelf life which changes with the conditions of storage. Excessive time in storage and transport, even when kept at the proper temperatures, increases the risk of losing a liner to premature gelation and curing.

Guidelines for Installation and Curing

There are really no special guidelines for handling ENVIROSNAP resins during the installation and curing process. Liners wet out with these resins should be installed and cured using the same procedures and industry best practices as is currently being used with their conventional, styrenated counterparts.

1) Water Cure

Depending on the liner diameter, in some instances you will ramp straight to top temperature (usually 180°F) and in others you will perform a step cure to better control the gel/cure process. You want to see a minimum interface temperature of 160°F during the exotherm. You should also ensure that the interface temperatures stabilize. The following table will provide you with cure schedules for various liner thicknesses. Included are recommendations on whether to ramp or step cure the liner and the temperatures and hold time recommendations. Please note that these times are not meant to be the final authority for each particular job. Site conditions and experience will likely dictate that you deviate from these guidelines from time to time.

Water Cure Guidelines

Liner Thickness	*Cure Schedule Type*	*1st Step Temp/Hold Time[1,2]*	*2nd Step Temp/Hold Time[2]*
6 mm	Ramp[3]	160°F/0.5 hours	N/A
7.5 mm – 12 mm	Ramp[3]	160°F/1 hour	N/A
13.5 mm – 18mm	Step[4]	160°F/1 hour	180°F/2 hours
19.5 mm – 24mm	Step[4]	160°F/1.5 hours	180°F/2 hours
25.5 mm – 30mm[6]	Step[5]	160°F/2 hours	180°F/2 hours

[1]- For cure schedules that call to ramp directly to top temperature, there will be no values in the 2nd Step Temp/Hold Time column.
[2]- All hold temperatures and times are listed as minimums. Shorter cure times can be expected with higher temperatures.
[3]- Ramp time to top temperature should not be less than 1 hour.
[4]- Ramp time to 160°F should not be less than 1 hour. After 1st Step Hold, ramp to 180°F should not be less than 30 minutes.
[5]- Ramp time to 160°F should not be less than 1.5 hours. After 1st Step Hold, ramp to 180°F should not be less than 30 minutes.
[6]- For liners over 30mm thickness, please call PMW's technical representative for recommended cure times.

NOTE: If maximum interface temperature does not reach 160°F, additional hold times should be used to ensure that the liner is properly cured. An addition of 1 hour for every 10°F below 160°F is recommended.

Monitoring of the interface is essential. Thermocouple readings of the coolest interface temperatures are the decisive factor. The stability of the readings (+/- boiler differential, 10º F) at the coolest monitoring point is generally held for a minimum of 2 – 3 hours.

The cure schedule we recommend is based on achieving a certain temperature at the liner/host pipe interface and maintaining that temperature for a specified amount of time. Adjustments to these recommendations will have to be made for instances where the proper interface temperature cannot be maintained.

2) Steam Cure

NOTE: The steam cure schedule described below is based on inflating and curing an 8" liner that was pulled in place.
After the liner has been pulled into place and properly positioned, inflate the liner in the host pipe using 5 - 10 psi pressure and using air only - no steam. Once the liner is inflated, increase the air pressure to 12 - 14 psi and hold for at least 5 minutes. This is to allow the liner to dimple into the service laterals and to fully expand. Go to steam/air mix. Watch the interface temperature. When the interface temperature has increased by 5°F or after 20 minutes, go to full steam. Use 180° - 190° F steam at 12 - 14 psi pressure. This is the start of your cure cycle. Cure time should be one hour minimum. Monitor interface temperatures. You should be able to determine when the resin kicks and exotherms. Monitor the exotherm. When the exotherm reaches its maximum temperature and begins to decrease, increase the steam temperature to 215° - 240° F and the pressure to 10 - 13 psi. You want to achieve a minimum of 160° F at the interface for at least 30 minutes. Slowly remove steam and go to air. Cool to 100° F, then cool for an additional 20 minutes before removing pressure from line.

CAUTION: Do not allow anyone to enter the manhole once pressure has been placed on the liner. Also, be very careful to not get close enough to the liner while steam is flowing that a sudden tear would spray someone with live steam.

To reiterate, when using steam to cure CIPP, you must closely monitor the interface temperature. You should be able to determine when the resin kicks and begins to exotherm by a spike in the temperature readouts at the interface(s). When the exotherm reaches its maximum temperature and begins to decrease, the gel/cure process is over, and you can start your post cure if one is to be performed. You want to achieve a minimum 160°F temperature at the interface for a set minimum time, based on liner thickness. The following table lists cure schedules for various liner thickness ranges. As before, note that these recommendations are that only, recommendations, and are not intended to overrule necessary changes due to jobsite considerations.

Steam Cure Guidelines

Liner Thickness	*Cure Time[1,2]*	*Post Cure Time[1,2]*
6 mm	0.5 Hour	N/A
7.5 mm – 12 mm	1.0 Hours	N/A
13.5 mm – 18 mm	1.5 Hours	1 Hour
19.5 mm – 24 mm	2.0 Hours	1 Hour
25.5 mm – 30 mm[3]	2.5 Hours	1.5 Hours

[1]- All hold times are listed as minimums. Shorter cure times can be expected with higher temperatures.
[2]- Cure time is defined as hold time after the exotherm begins while post cure time is defined as the hold time after exotherm begins to decline that interface temperature stabilizes at 160°F or greater.
[3]- For liners over 30mm thickness, please call PMW's technical representative for recommended cure times.

NOTE: If maximum interface temperature does not reach 160°F extend the cure time until you have 160°F stabilized for 30 minutes of cure.

Disclaimer

The guidelines and/or recommendations made herein are based on our research and experience and that of others and are believed to be accurate. No guarantee is made to the accuracy or the results to be obtained from using any of the guidelines and/or recommendations. Each manufacturer should make their own determination on the suitability of any guideline and/or recommendation for their own particular application and system. Nothing herein shall constitute or be construed as an express or implied warranty of any guideline and/or recommendation and the manufacturer assumes all risk associated with using any of the guidelines and/or recommendations.

For additional information or questions, please contact PMW Technical Support:

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