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THE ROLE OF RESINS IN THE CURED-IN-PLACE PIPE (CIPP) PROCESS

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For the past 40 plus years, the cured-in-place pipe (CIPP) process has been a significant tool to renovate the nation's deteriorating underground pipe infrastructure. The process saves time, energy and cost for a municipality or industry in need of a "fix". The significantly reduced social impact contributed by the process has made a difference to business owners, municipalities, drivers and others. An important material in the CIPP process is the resin component. The chemical structure of the polymers used contributes to the overall workability of the process. This article will describe the differences in resins used and reasons for the right resin choice.

Polyester, vinyl ester and epoxy resins make up the majority of thermoset resins used in the CIPP process. Polyester resins and vinyl ester resins are similar in chemistry. Epoxy resins use a different chemistry. All of the mentioned resins exhibit similar mechanical properties, corrosion resistance in the municipal market and anticipated service life when used properly.

Polyester resins are manufactured by a chemical method called "aldol condensation". The components of this reaction are acids and polyols reacted together by various catalyst systems. When a resin supplier talks about "isophthalic" or "terephthalic" resins, the supplier is telling us the acid component in the resin. In some cases, the supplier may call a resin an NPG/Iso or NPG/Ortho resin. In that case the supplier is telling us both the polyol and acid components of the polymer. This initial reaction is not the final step in creating the final product used in the CIPP process. This "adduct" is generally a crystalline solid which would be difficult for use in molding applications and is now ready to be blended with a reactive diluent. The diluent will make the resin into a liquid system at room temperature, will take part in the reaction, and crosslink providing improved mechanical properties. Styrene is the most commonly used reactive diluent in creating these polymers. It is the least expensive, the most reactive and safe when used properly. There are also non-styrene reactive diluents available, some are non-volatile organic compounds (non-VOCs). There are numerous combinations of these components available from resin suppliers.

The choice of which resin to select for the CIPP process boils down to the process requirements and the final properties desired.

For processing in the CIPP process, the resin used must be of the proper liquid consistency. It must wet the tube material properly, without air voids, quickly, and not drain from the tube when processed. The resin must also be stable enough to remain a liquid throughout the wet out, transport to the jobsite and installation process. The resin must also use an initiator system with little risk of problems. Historically solid initiators in heat cured CIPP processing have presented problems with poor mixing. Other heat cured initiators have proven unable to provide the proper pot life for the process. Newer initiator offerings in the heat cured resin sector are proving to minimize the risk of these problems. Ultraviolet (UV) cured resin/tube systems tend to be available directly from the tube manufacturer, eliminating the need for a contractor to be involved in that part of the process. These UV cured systems come with significantly longer pot lives when properly stored. Processing is slightly different and UV cured systems offer speedy cures for the applicable liner sizes. Limitations in liner diameter and thickness must be considered when considering this process.

The final properties of the cured liner are generally stipulated in the contract documents from the owner. These properties generally also include mechanical property requirements, corrosion resistant requirements and anticipated service life requirements. For almost all of the commercially available resins from manufacturers of CIPP resins, resin formulations are designed to meet these needs. Contractor installation requirements such as liner thickness, free of air voids, finning and blistering are generally not dependent on resin specific properties.

While the above describes polyester and vinyl ester resins, epoxy resins differ in chemistry. Epoxies are 100% solids, unlike most polyester and vinyl ester resins which contain a reactive diluent. Epoxies are two-part systems comprised of an epoxide and a hardener. Depending on the formulation, epoxy system ratios of epoxide and hardeners differ. Some formulas are 1:2, some 2:1, etc. Generally, epoxy systems and vinyl ester resin systems have similar mechanical, corrosion resistant and expected service life properties. Pot lives vary with epoxy systems but generally are shorter than polyester and vinyl ester resin systems.

With the emphasis being placed on renovating drinking water systems using the CIPP method, much work has been placed on resin manufacturers to develop resin systems that are user friendly and that will pass ANSI 61 requirements to be drinking water certified. Epoxy resins are currently used in drinking water and other pressure applications. Vinyl ester resins with newer reactive diluents are also being used in UV cured systems and will soon be used in heat cured systems.

Over the past 40 plus years, resin formulations have evolved to work better in the CIPP process. With new initiators, sustainable raw materials, non-VOC additives and other improvements, working with the CIPP process has become easier and more reliable. Pressure pipes are being renovated successfully. Drinking water lines are being renovated. Concerns about environmental contamination are being reduced. And resin producers won't stop there. There will be more and better developments in raw materials and processing for the CIPP industry in the future.