Design engineers and applicators are often faced with challenging liner or coatings installations for concrete tanks or related structures in chemical or other aggressive service. Often, the challenge starts with the existing structural surface, which might be contaminated or require significant repair, resurfacing, or extensive surface preparation. When such surface conditions are not remediated completely, traditional liquid-applied linings often fail because their performance depends directly on the surface to which they are applied. Coating systems may be also susceptible to chemical attack and may delaminate or blister, compromising their performance and the tank itself.

Specifiers have required thermoplastic sheet liners in some instances as an alternative to liquid-applied coatings. The liners are seamless and don’t rely on surface preparation. In some cases, however, they become ineffective because of damage during installation or service.

Over the past ten years, the use of another alternative, polyurea geomembranes, for lining concrete tanks and other structures in aggressive service, has been increasing. The systems are formed with an appropriate combination of polyurea and geotextile. Installed correctly, the polyurea geomembranes can be an alternative to traditional liquid-applied materials and thermoplastic liners, sometimes providing higher performance and better economics.

Specifiers and contractors are often more familiar with coatings than with the variety of geotextiles available to create a polyurea geomembrane. This article, therefore, first describes the types of geotextiles available and suitable; it then briefly addresses the selection of polyurea systems. The remain-
der of the article details the steps for installing a polyurea geomembrane in concrete tanks for chemical service.

**Selection of Materials**

**Geotextiles: What’s Available, and What’s Suitable?**

Polyurea geomembranes have been in use for several years. However, case studies of the interaction and performance of combined polyurea systems and various geotextiles to create a polyurea geomembrane have not been readily available until recently.¹

The first steps in the successful application of a polyurea geomembrane are creating a proper design and then choosing the materials that best meet the established criteria for the application. To meet the criteria for a given application, the product must have specific chemical, thermal, and mechanical stress-resistance properties. Polyurea geomembranes have low permeability rates to chemicals typically found in leachate, and they can withstand large swings in ambient temperatures without cracking or becoming brittle over time. Depending on the combination of polyurea and geotextile chosen, polyurea geomembranes can resist moderate concentrations of acids, more concentrated alkalis, some fuels, wastewater, and other liquid chemical products or byproducts.

The type of geotextile selected to create the polyurea geomembranes is critical to the design of the system. One reason the geotextile is critical is that it, rather than the concrete tank, becomes the substrate to which the polyurea must adhere.

The predominant configurations of geotextile commonly used for polyurea geomembranes are woven, non-woven, and spunlaid made of polypropylene or polyester. In general, most polyurea systems undergo loss of physical properties (elongation and tensile strength) when combined with geotextile. However, data² have shown that woven polypropylene consisting of a single monofilament strand running in one direction and fibrillated strands running perpendicular to the monofilament strand (Fig. 1) may offer increased tensile strength to the complete system (approximately 40%) and the least amount of elongation loss (approximately 17%).

Adhesion of polyurea systems to woven geotextile is usually less than adhesion to non-woven. However, the monofilament/fibrillated woven configuration typically offers two to six times the level of adhesion seen with other woven geotextile. The increase in adhesion is due mainly to the specific construction of the geotextile: the monofilament strand arches up on one side, allowing liquid polyurea to envelop the strand and creating good mechanical adhesion. The applicator must be careful to spray the proper side of the geotextile. The monofilament arches up on only one side of the geotextile. (Spraying the wrong side will produce very poor adhesion of the polyurea to the geotextile.)

Overall, combined with the monofilament/fibrillated woven geotextile, the polyurea system offers superior tensile strength and puncture resistance over that of the non-woven systems. Furthermore, with the woven, there is less initial absorption of polyurea before it solidifies, in contrast to the non-woven (typically 80% less). If less polyurea is absorbed, the coverage rate increases. Also, the workability of the woven is easier, or rather more pliable, than most geotextile, which facilitates application.

**Polyurea Systems: What Basic Requirements Are Needed?**

With regard to owner’s requirements in the selection of the polyurea system, careful consideration should be given to mechanical stress, thermal differentials, and chemical exposure. The term “polyurea” refers to a type of coatings technology, not a specific coating. Therefore, there are many different formulations of polyurea systems in the industry. Some exhibit excellent chemical resistance, mechanical properties, or a combination thereof. Not all polyurea systems will work for every situation.

One characteristic that polyurea systems should have for this particular application is a gel time of 15 to 20 seconds, which has been found to be beneficial, ensuring enough time for workability, yet keeping the polyurea’s advantage of rapid application. (Gel time is the time a coating takes for the system to go from liquid to solid.) The 15 to 20-second win-

---

¹ Selecting Materials—What's Available, and What's Suitable? by Unknown

² Polyurea Systems: What Basic Requirements Are Needed? by Unknown

---

www.paintsquare.com

JPCL August 2008 21
dow allows enough time to physically set seams and work the geotextile, but keeps the gel time short enough to move ahead with installation at a reasonable pace and to minimize absorption into the geotextile.

As for other properties of the polyurea system, the intended use of the system will determine what is necessary. It is, however, not uncommon to see formulations that have tensile strengths at a minimum of 2,000 psi (138 bar) and a minimum elongation of 500%. That is not to say that given a specific situation, these property values cannot be lower; these values just offer sound protection against general mechanical stresses that may occur.

Another common characteristic among these polyurea systems is that they are typically spray-applied with a plural-component, high-pressure, and high-temperature proportioner. These proportioners are typically sprayed at 2,000 psi or higher to allow for adequate coverage of the geotextile with good production rates. Furthermore, the plural-component spray equipment is equipped with either mechanical purge or air purge impingement mixing spray guns that deliver material by simply triggering the gun. The impingement spray gun's design allows the applicator to start and stop spraying without having to purge into a waste container (unlike low-pressure proportioners with a static mixer). Other polyurea systems include brush-grade or roll applied systems, which would not be suitable for these applications.

The Fundamentals of Application
The process for applying polyurea geomembranes over concrete is basic but requires attention to detail.

The concrete tank in question should be dry and free of loose debris. Generally, no other preparation, such as filling bugholes, is necessary.

It is helpful to precut the necessary sections of geotextile, roll them up, and stage them in an area that is quickly accessible and within reasonable distance of the exact area where the particular section is to be installed. The approximate length and width of each section depends on the size of the tank.

The sidewalls will be done first, and then the floor will be finished, with the same affixing and overlapping of segments as the walls (Fig. 2).

Start with One Section at a Time

Each section of geotextile can be applied to a vertical surface by a method similar to wallpapering. Due to the rapid gel time of most spray-applied, high-pressure polyurea systems, the
When you need to hold the blast at the lowest possible cost, look to the new HCU™ Dehumidifier and PowerPurge™ technology from Munters!

The HCU’s revolutionary design combines a desiccant dehumidifier with cooling. At the same time, the HCU recycles the system’s waste heat to reactivate its desiccant wheel.

The result of this patented engineering breakthrough is an extremely low dew point, cooler working conditions, and energy consumption reduced 40%. That means you’ll work faster, avoid coating failures and cut thousands of dollars from fuel costs.

PowerPurge technology reduces the energy required for re-activation while also reducing the discharge temperature of the process air, resulting in lower energy costs for post cooling.

Let’s do the math!

It’s likely Munters HCU can save you $4000, or more on your next project. So, to reduce coating costs, call Munters for a quote. We’ll show you how the energy efficient HCU can put the money you would normally spend on fuel back in your pocket!
Bredero Shaw continues to invest and develop innovative products and technologies to meet your pipeline coating requirements. Bredero Shaw has been instrumental in introducing over 40 leading technologies for cold climates, rugged terrains, high operating temperatures, deep water environments and many other unique applications.

Bredero Shaw is the world leader in pipe coating solutions, with more than 75 years of experience, over 27 pipe coating facilities on 6 continents and the largest team of technical and service specialists in the business. Bredero Shaw offers technologically advanced solutions for anti-corrosion coatings, protective and weight coatings, thermal flow assurance coatings, internal coatings, custom coatings and field joints for both onshore and offshore applications.

the GLOBAL LEADER in pipe coating solutions.

www.brederoshaw.com

Click our Reader e-Card at paintsquare.com/ric
Polyurea can be used to temporarily adhere the geotextile to the concrete surface. A light tack coat of polyurea can be sprayed on the top edge of an area where the geotextile section is going to be applied.

After spraying the tack coat where the top edge of the geotextile will be adhered, the applicator must press the top edge into the tack coat, taking care to make sure the geotextile is properly aligned and smoothed out by hand to avoid wrinkles and fishmouths (unadhered raised edges) in the geotextile. Applicators should therefore take care to wear protective gloves and coveralls to avoid getting liquid polyurea on their hands and arms. In addition, applicators should use other personal protection equipment as specified by the polyurea system manufacturer (e.g., respirators).

The degree of adhesion should be such that the section of geotextile is able to hang free on the vertical surface to which it is being applied. The section of geotextile not yet adhered to the wall can then be rolled up to the affixed top edge and held in place by hand. (It is helpful but not required to have another worker hold the geotextile in place.) Another tack coat of polyurea can then be sprayed to the remaining surfaces of the section the geotextile is to cover (Fig. 3). For particularly long sections of geotextile, it is advisable to tack down the geotextile in horizontal segments that are reasonable in size to work with, given the gel time of the polyurea system specified.

Once the additional tack coats are sprayed, the rest of the section of geotextile can be rolled down over the vertical surface of the concrete. Again, the applicator must be careful to smooth the surface of the geotextile, ensuring that there are no wrinkles or large areas of geotextile protruding from the surface.

It is common to have multiple small areas of geotextile that don’t completely adhere to the surface. These areas should be no more than a couple of inches in diameter. In some instances, the small areas that do not adhere may bulge to the point that they give the appearance of a blister. Generally, the bulging areas do not compromise the integrity of the containment system, because the polyurea geomembrane does not depend on adhesion to the concrete to function properly, unlike conventional liquid-applied coating systems.

Applying Polyurea over the Adherent Geotextile Section

Once an entire section of geotextile is adhered to the vertical surface of the concrete tank, the section can be sprayed with polyurea at the specified dry film thickness. Adhered sections of geotextile should initially be sprayed from the bottom to top. This spray technique helps keep the polyurea coating free of runs, which can lead to voids or uncoated areas of the geotextile.

Subsequent coats should be applied in a crosshatching method to minimize the effects of any shrinkage, but all horizontal passes should always, as previously stated, start from bottom to top. Advances in the engineering of polyurea systems have greatly reduced their shrinkage factor compared to earlier formulations. Shrinkage of the polyurea, thus, does not generally become a significant factor in the application. For extremely large jobs, however, specifiers and applicators should be aware of possible shrinkage factors that could cause the polyurea geomembrane to pull itself too taut, placing undue tension on the system.

While spraying the various sections of geotextile, it is critical to use the proper spray technique. The applicator should align the spray gun so that it is perpendicular to the geotextile surface being coated. Movement of the spray gun should remain parallel to the substrate, and care should be taken to avoid any arcing movement of the gun. Improper spray technique may result in poor coverage of the geotextile. Inadequate coverage of the geotextile may result in voids in the lining system. Accordingly, any fishmouths or bulges in any geotextile sections need to be sprayed at all appropriate angles to avoid the effects of shadowing, which can cause inadequate coverage and voids in these areas as well.

Installing the Rest of the Sections

Subsequent sections should overlap by a minimum of three inches (7.5 cm) to...
ensures sound continuity of the lining system and should be installed within the recoat window of the polyurea (Fig. 4). When spraying the tack coat of polyurea for subsequent sections, it is beneficial to spray slightly on the coated geotextile to help hold the geotextile in place. The additional polyurea will help ensure that the edge of the overlapping geotextile is completely adhered to the section. When spraying subsequent sections of geotextile, the applicator should take care to spray against the direction of the overlapping edge to ensure it is properly sealed. This may require the applicator to spray at an angle that may deviate as much as 45 degrees to the substrate.

To further ensure the integrity of all seams, an architectural-grade urethane caulk may be applied over the seam. (High-quality architectural-grade urethane caulks contain minimal amounts of solvent, which does not cause blistering under the polyurea.) It is suggested that the color of the caulk should contrast with the color of the polyurea system to visually aid the applicator by indicating proper coverage. A bead of caulk can be applied to the seam and then brushed smooth with a small bristle paint brush. Application of the caulk helps ensure that any possible voids or hard-to-seal areas of a seam will be filled.

Once the caulk is brushed smooth, it can immediately be sprayed over with polyurea, encasing the caulk into the lining system. This practice creates a situation where all seams are triple sealed.
Handling Terminations
Terminations of the lining system along the top edge can be handled in several ways. One technique is to adhere the top edge of the geotextile sections a few inches below the top edge of the concrete tank, thereby leaving an area of concrete exposed. Adhesion at the top edge will therefore be between the concrete and the polyurea system (Figs. 5 and 6).

The degree of adhesion should exceed the tensile strength of the concrete, and some surface preparation along with applying a primer is typically required to achieve this level of adhesion. In some applications, minimal surface preparation is performed, and primer is not used on the bare section of concrete that is sprayed with polyurea. As expected, outgassing does occur, and these sprayed sections of concrete cause pinholing in the polyurea coating. There are often bugholes that are not filled, as well. To rectify the situation, the same architectural-grade urethane caulk as described above can be applied and brushed over the entire area, filling pinholes and bugholes and smoothing over the transitions from the geotextile to bare concrete. The area is then coated with polyurea a second time.

For transitions requiring a more secure method of termination, saw cuts into the top edge of the tank can be utilized to anchor the polyurea system in addition to its adhering to the concrete. Mechanical fastening with sheet-metal strips can be used as well. After the polyurea geomembrane is applied, strips of one- to two-inch-wide (2.5- to 5-cm) sheet metal can be fastened approximately one inch below the top edge of the tank, over the polyurea. The strips can be fastened with concrete nails or anchoring bolts. Once the strips are in place, they can be encapsulated with polyurea. Voids or exposed edges, bolts, and nail heads can be sealed with urethane caulk and recoated with polyurea.

What To Do with Penetrations
Incorporating piping and other penetrations into polyurea geomembranes is often easier than with conventional systems, with regard to achieving proper performance. Due to the versatility of polyurea systems, penetrations can be handled through various methods. Because of the uniqueness of each project, some methods may function better than others. For common penetrations such as piping, one method used in applications is mechanical clamping. The base of the piping, where it enters into the containment system, should be clean and free from contaminants and other impediments such as weld spatter and burrs. Polyurea should be sprayed around the entire circumference of the pipe near the base, taking care to build up an appropriate thickness without runs or drips.
After the polyurea coating has gelled, mechanical clamps, such as stainless steel hose clamps, can be placed over the pipe, clamping the polyurea coating to the pipe. This technique works well for pipes constructed of polyvinyl chloride or polyethylene, to which polyurea will not generally adhere. It should be noted that, depending on the polyurea system’s formulation, adequate time should pass between spraying the pipe and placing the clamp. Placing the clamp over the pipe too early can damage the polyurea coating.

The integrity of the seal is based on the polyurea being clamped to the pipe. However, further assurances can be taken by spraying over the clamp once it is installed. Applying the polyurea coating over the clamp will protect it against loosening and corrosive attack. Urethane caulk, as used previously, can be built up around the sprayed clamp and beveled out from the pipe toward the wall of the structure. The caulk is again sprayed over, as with its use in any seams or terminations. Pipes can extend wherever the design requires, or they can be cut off just before the clamp.

Other types of transitions found in these situations are sometimes handled by using compressive flanges or faceplates, and a free film of polyurea. Free films can be created by spraying polyurea to a surface it will not adhere to, such as polyethylene panels. The film can then be peeled off of the panel and used as a gasket between flanges or faceplates. There has to be enough free film extending beyond the exterior perimeter of the flange or faceplate, so that it may join up and bond to the rest of the polyurea geomembrane.

Other methods of handling penetrations may also be used, and are up to the imagination of the applicator or design engineer. The versatility of polyurea coatings and polyurea geomembranes allows for customized methods that would not normally be possible with simple liquid applied coatings or precast materials.

Summary

When considering the maintenance and/or repair costs associated with conventional methods, the durability and reduced application time of polyurea geomembranes often out-weight their higher material costs, in contrast to traditional liquid-applied linings or sheet liners. Surface preparation, which is arguably the most time-consuming process of a conventional coatings project for concrete tanks (and other structures), is almost completely eliminated by the use of geotextile, which becomes a suitable substrate for application. Also, the rapid cure of polyurea systems allows for quicker return to service, often a major concern.

---

**PosiTector® 6000 COATING THICKNESS GAGES**

- **Tougher, Smarter features and still...**
- **Simple. Durable. Accurate.**

- Tough probes, robust housing, strong warranty
- High resolution and accuracy
- Free Certificate of Calibration traceable to NIST
- Powerful SSPC-PA2 feature available

**DeFelsko® 40 Years of Quality**

1-800-448-3835
www.defelsko.com

DeFelsko Corporation • Ogdensburg, NY • Phone: 315-393-4450 • techsale@defelsko.com

---

**Tough probes, robust housing, strong warranty**

**High resolution and accuracy**

**Free Certificate of Calibration traceable to NIST**

**Powerful SSPC-PA2 feature available**

Made in U.S.A.

**DeFelsko Corporation** • Ogdensburg, NY • Phone: 315-393-4450 • techsale@defelsko.com

---

www.paintsquare.com
for facility owners. Depending on the exposure service, polyurea geomembranes are capable of offering excellent physical properties and chemical resistance based on the polyurea coating and geotextile chosen for the application. Polyurea geomembranes provide facility owners with a completely seamless liner that is very durable and requires minimal surface preparation compared to traditional liquid-applied coatings or thermoplastic liners.

Reference

Robert M. Loomis has been with Willamette Valley Co. in Eugene, OR, since 1995. Currently he is a group leader at WVCO, and his efforts include leading the development of products for new markets and providing technical support for existing product lines. He holds patents on polyurea and polyurethane systems, and he has authored several technical publications and presentations. He is a member of SSPC, NACE, and is currently president of the Polyurea Development Association (PDA).

Sean Boeger is the owner of Poly-Pro Industrial Coatings, a contracting firm that specializes in polyurea applications. Sean has been working in the polyurea industry for the last eight years. He is heavily involved in the Polyurea Development Association, serving as an instructor with the PDA, as well as chairman of the organization’s Training Committee, where he has co-authored several instructional courses. He has also sat on the PDA board of directors for the last three years.
"NLB water jet pumps are the best we've used."

Reliability is critical, especially at sea. That's why U.S. Coatings, an Alabama-based specialist in marine painting, uses NLB UHP water jet pump units for coating removal.

"We had lots of downtime with other UHP units, but not NLB," says Cecil Williams, president. "They run at a slower rpm, which I think is key to long part life."

Williams says his two NLB 40201D pump units help U.S. Coatings:

- work more productively and stay on schedule
- control operating costs
- avoid environmental and containment problems

On steel or concrete, NLB water jet pumps and accessories are the contractor's choice for surface preparation. They are available for rent or purchase nationwide, with full field support. Call today for a free demo — 1-877-NLB-4420 — or visit www.nlbcorp.com.