Primeaux Associates LLC

Polyurea Technology & Application Consulting

Technical Note

My Poly has "Bubbles"

Pinhole Issues with Polyurea Spray Elastomer Application

Written by:

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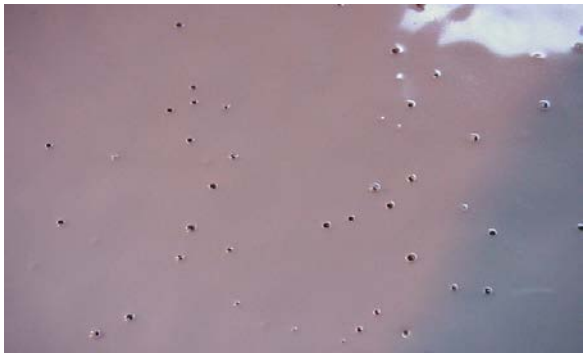
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Technical Note: Pinhole Troubleshooting



In polyurea coating applications, pinholing, or outgassing, of the coating system can always present a difficult situation for the integrity of the installation in applications over porous substrates. One can spray a coating system for an extended period of time and never experience any pinholes. Then they may appear in the very next job or even the next spray period of an existing problem free application area.

It is important that one understands the type, source and how to troubleshoot the pinhole problems that are found. The SSPC: The Society for Protective Coatings, defines Pinholes and Pinholing as follows:

PINHOLE
A holiday or discontinuity that extends entirely through a coating film, approximately the size of a pin; normally caused by solvent bubbling, moisture, or foreign particles.

PINHOLING
Formation of small holes through the entire thickness of coating; see CRATERING. [AM]

And then with the reference to Crater & Cratering:

CRATER
(1) A small, rounded depression in a coating film that does not expose the previous coat or the substrate. (2) A small hole in the surface of a metal or other material whose maximum depth is less than its maximum diameter.

CRATERING
The formation of small, shallow depressions in a coating generally resulting from foreign matter in or deposited on the wet film.

The first part of the definition about a pinhole is true, as well as that noted with pinholing. However, the second part refers mainly to thin-film coating systems, and not really for thick-film polyurea systems.

In a recent White Paper on pinholing, the author blames pinholes on the use of high-pressure, impingement mix equipment, coupled with the reaction of the Isocyanate component with water / moisture producing CO_2 gas… ***What***??? If this were completely true, then you would not see all the videos of people spraying polyurea over a water filled box to seal the water in…. This White Paper is simply and advertisement for the low-pressure, un-heated static mix applied system, which by the way can also exhibit pinholing over porous substrates.

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So what causes pinholing in these polyurea and polyurea/polyurethane hybrid spray systems? The following the mechanism for pinhole formation of a coating system when applied to a porous substrate. This type illustration has been used in the coatings industry for years….

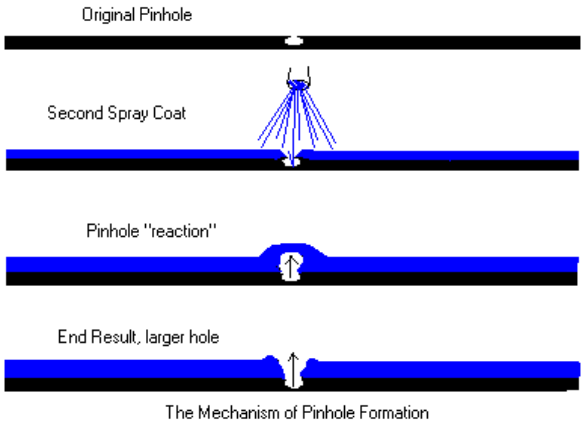
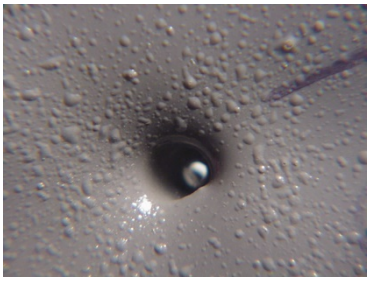


Figure 1: Surface Pinholing Mechanism

Keep in mind that you are applying a plural component system that is heated to about 150°F (66°C). In addition, these are Thermoset system, which mean they also exotherm as they react and cure. When applied over a void area or existing pinhole, the hot system, couple with the reaction exotherm, warms the air / moisture in the void causing it to rapidly expand. This gas expansion pushes through the freshly applied liquid coating system (path of least resistance). It may sometimes be noted that when a pinholed spray surface is recoated, even larger pinholes may result. The more you apply, the larger they get.

Pinholing in a polyurea coating system can be a very serious problem, especially in an immersion application. They are not an aesthetic issue, they go all the way to the substrate. This is why it is so important to perform the proper Holiday Testing in a lining application. All pinholes shall be repaired prior to turning the coating application over for use.



Normally pinholing is prone to porous substrates, such as concrete, foam, wood, EPS (expanded polystyrene) and does not normally occur with polyurea systems applied to solid steel substrates. However, if there is rusting, weld splatter, weld flux or skip welds on the steel, then pinholing may be an issue as well.

For concrete, there is entrained air, and entrapped air. Entrained air is intentional and part of the matrix. Entrapped air is due to insufficient compaction. Concrete containing a high loading of fly ash provides a higher propensity for pinholing, so learn about the concrete!

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Since we are applying the polyurea as a protective coating to a substrate, the presence of pinholes may lead to serious issues, and "attack" of the substrate by exposure. For example, the following pictures are from a polyurea waste-water project, with pinholes.

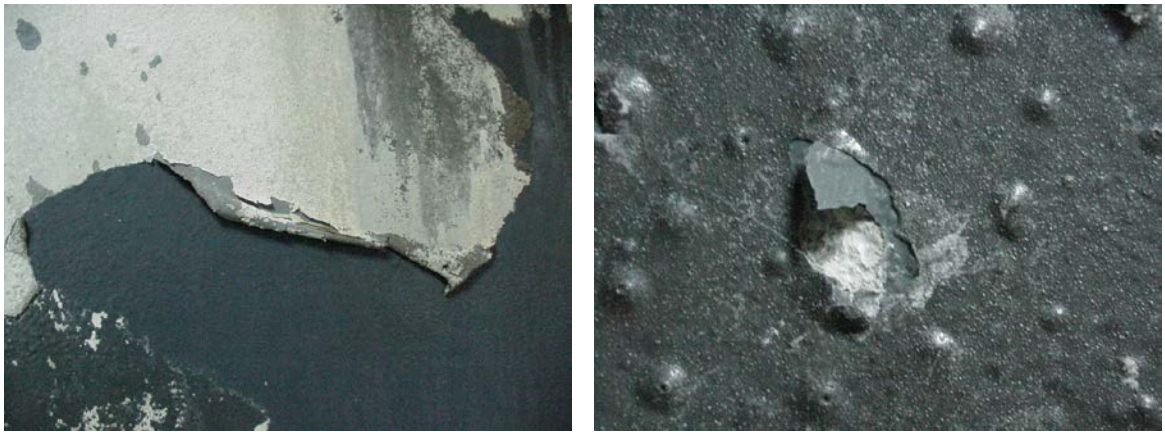


Figure 2: Delamination of Lining and Substrate "volcanoeing" at Pinhole

In the above Figure, the acidic waste-water was able to contact the concrete substrate through the pinhole. This lead to concrete attack, and subsequent delamination of the applied coating. The coating was not "attacked," just the substrate.

Pinholes can also lead to leakage from the vessel. Many may say, "Oh it is just one small pinhole. How much liquid will actually leak out?" Well, since you have asked……

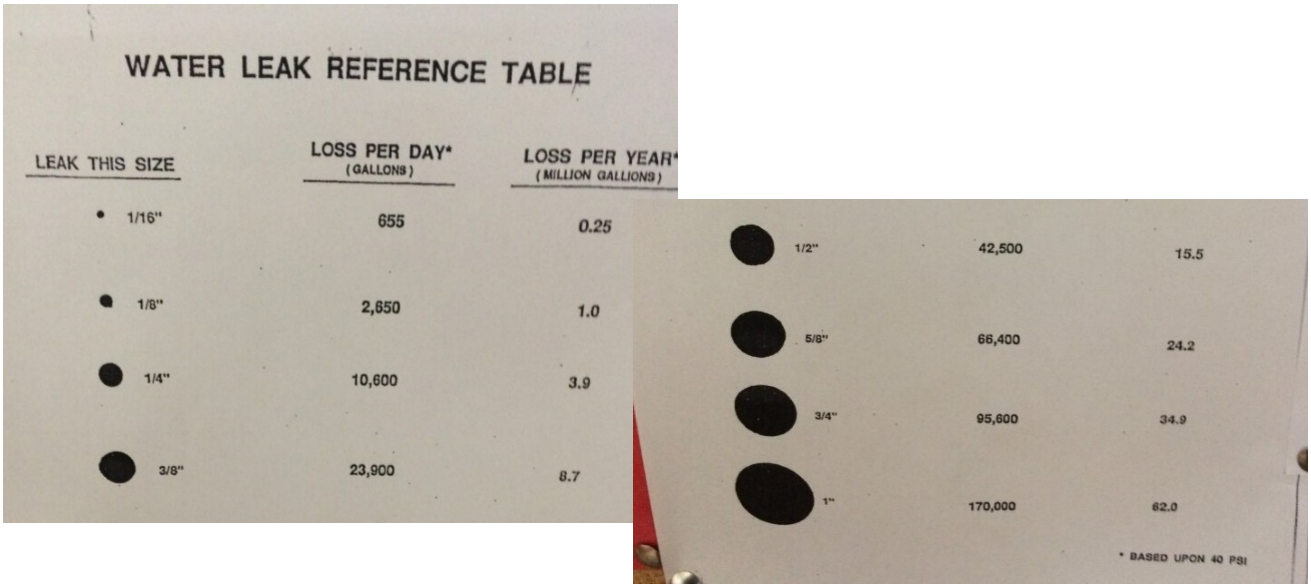


Figure 3: Water Leak Table

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In the above Figure 3, provided by The L.C. Whitford Company, Inc, New York, provides for liquid loss through various size “holes” in a liner system. These volume losses are for one pinhole per day. And a 1/16” hole is 0.0625”, 62.5 mils, or 1.6 mm is size. Imagine if the applied polyurea had hundreds of pinholes how much liquid leakage there would be?

Not only can pinholes in the coating or liner lead to substrate attack, liquid loss, they can also provide of leakage of material from the substrate into the environment. The following figure illustrates a polyurea system that was applied to a built-up roof assembly, and pinholing was present in the applied polyurea. When the sun hit the roof and heated, the bitumen soften and flowed through the pinholes…. So imagine when polyurea is used as a capping system, what if that was a substrate contaminated with a hazardous chemical or material, and leakage of that into the environment???



Figure 4: Bitumen Ooze Through Polyurea Roofing

Sometimes “pinholes” can actually be over-spray, or as some call dry-spray or texture, that land on the substrate before a uniform, continuous film is applied to the substrate. It may appear to be uniform, but will be extremely porous. This is due to improper spray technique and application.

Another phenomenon, sometimes confused with pinholing, is voids in the coating system due to a shadowing affect. This occurs when a fast set coating system is applied to a substrate that may be dirty or contain overspray. As you are spraying in one direction, the fast set coating builds on the contamination and does not completely flow around it. This dirt or overspray particles actually create a shadow for additional spray over the surface, creating a small bare spot in and around the shaded side of the substrate contaminant. While this may be a common occurrence, it should not be overlooked, as this is a point for coating failure, especially in immersion applications. An illustration of this can be seen as follows:

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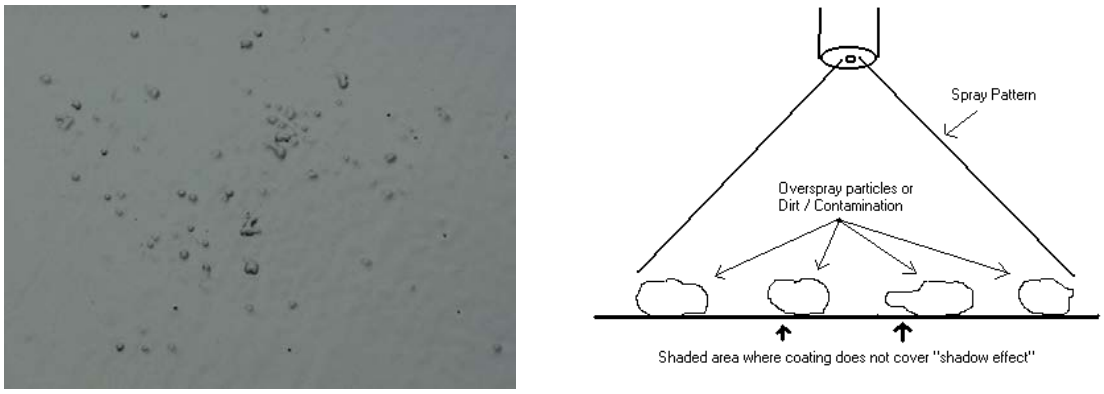


Figure 5: Shadowing Effect – Debris Coated

So how do we address this issue of pinholing? First off, need to understand our substrate. In the case of concrete (which "breaths"), as concrete is heating up during the day, the concrete itself may be exhaling, breathing out. Under this condition, pinholing can be worse. Once the concrete starts to cool (usually towards the end of the day), the concrete inhales. This "sucking in" situation may help alleviate pinhole formation during application.

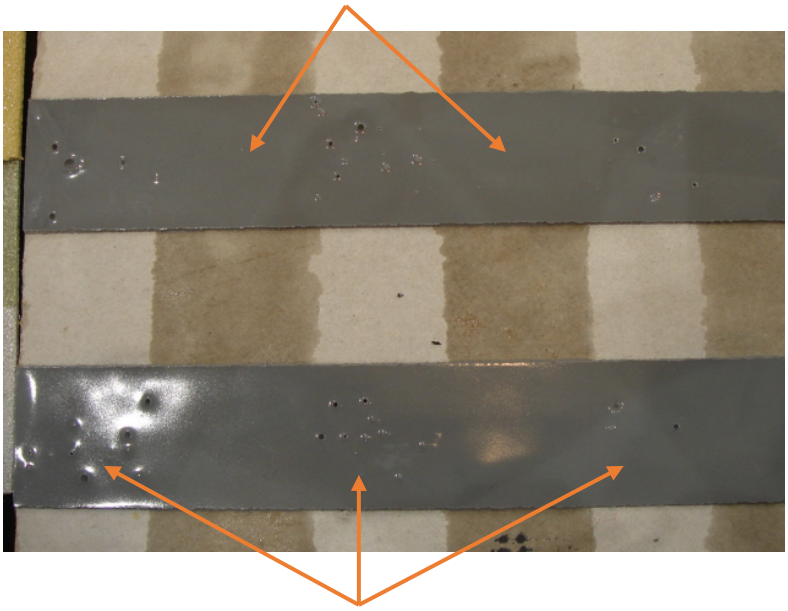
Ah but the best method of course is to properly prime that substrate with the suitable, recommended primer system. And keep in mind, you may encounter pinholing in the applied primer, so a double primer may be required in highly porous substrate.

- Seek Direction from Polyurea System Supplier / Don't Experiment
    - Epoxy Based
    - Urethane Based
    - Latex Based
- Brush, Roller, Squeegee, Spray Applied
- Thin coats
    - May require double prime
    - If primers are spray applied, back rolling may be necessary
- Be aware of re-coat window
    - Affected by ambient temperature
    - Potential for blisters

Does priming work??? Sure it does, when the proper primer is used and applied using the proper application techniques. Primer can also be applied while the concrete, or other substrate, is cooling and "inhaling," thus effectively pulling the primer into the substrate and filling the voids. The following illustration shows a porous concrete block, with sections of primer and no primer, followed by over-coating with a fast set, heated, high-pressure impingement mix polyurea system.

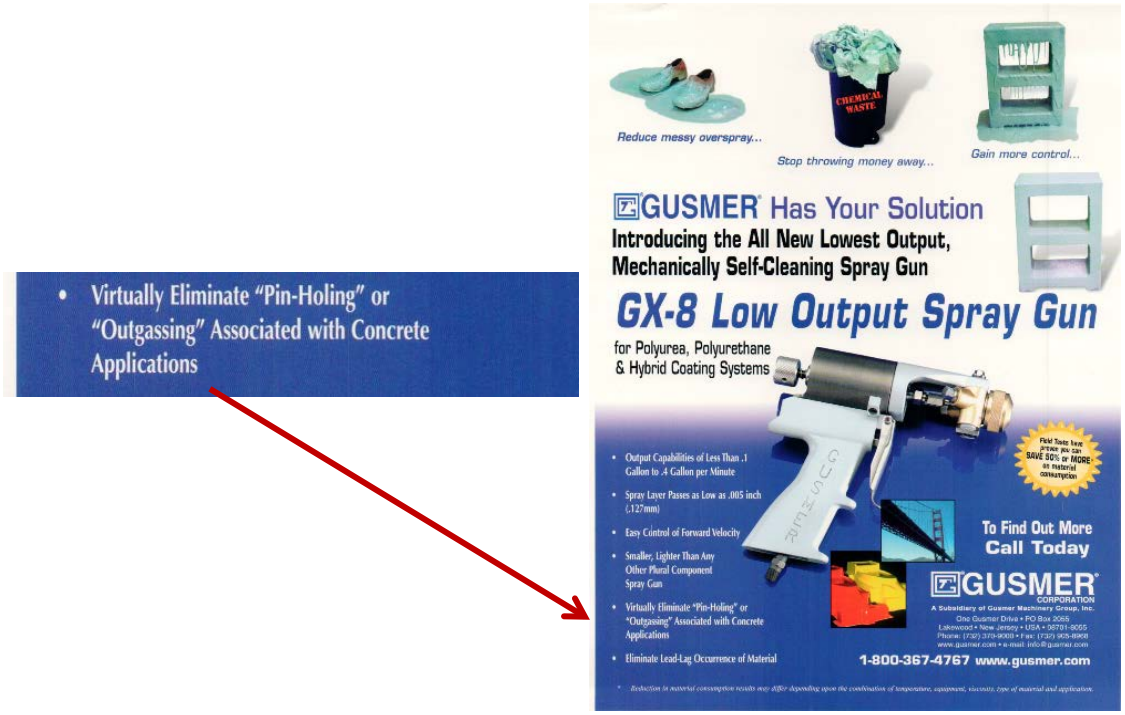
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Primed, no pinholes



No Primer, pinholes!

Back in the mid 1990's, the then GUSMER® Corporation introduced a new spray gun, specifically the GUSMER GX-8 Low Output Spray Gun. Designed specifically for polyurea and similar plural component, fast-set coating to eliminate pinholing and outgassing when applying to concrete substrates.



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So does it really work???? YES! However, since a low output spray gun, with material outputs typically in the 0.5 lbs/min (250 gms/min), compared to a conventional type spray gun at 1 gal/ min / 9 lbs/min (3.8 liters/min) it would take one forever to complete a large coating and lining project. A similar commercial low output gun is the PENTECH MG spray gun, which also works.

So why does this gun type work? Ah because you are applying at such a low output and thinner continuous film build, the exotherm is not nearly as high. Thus not warming the air voids in the substrate, leading to rapid expansion of the air, and the outgassing / pinholing.

So by using this information, one method of repair or solution would be to lower the application temperature (140°F, 60°C) and spray using a flash coat or misting application with multiple passes. Lowering the processing temperature should be a last resort, and confirmed with the system supplier. But generally can be done, until one would see an effect on a proper, full spray pattern. This is actually discussed in two SSPC documents related to Polyurea Spray Coating, SSPC-PA 14 and SSPC-Paint 45.

Also, SSPC has recently issues a new document, SSPC-PA 19, providing guidance on pinhole evaluation and acceptance. Note though that for any immersion service, no pinholes are allowed in the applied coating and lining system per evaluation spot of 1 ft^2 (0.1 m^2).

Classification	Number of Pinholes per Evaluation Spot
None	0 pinholes
Low	1 to 10 pinholes
Moderate	11 to 20 pinholes
High	> 20 pinholes

Classification	Service Environment
None	Interior atmospheric coatings applied to areas such as medical, food, drug or pharmaceutical clean rooms, or areas frequently wet or washed down
	Immersion coatings
	Floor coatings
Moderate or less	Atmospheric coatings applied to interior surfaces in general areas
	Atmospheric coatings applied to exterior surfaces in general areas

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Note: The original version of this article, written by the same author, was first published in 2001.

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