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TRUTH AND MITH OF POLYUREA

In the past five years, there's been a lot of hype on polyurea coatings and elastomers - some of it true, some of it exagerated. Polyurea systems and technology, indeed, have many unique and outstanding properties. However, the hype over a new product has gotten the actual advantages of the product lost.

All across the industry, polyurea elastomers are being promoted as a new miracle product. First, polyurea systems may be new to some coating manufacturers but Futura has been quietly using polyurea technology for over 12 years as part of its fast set solventless polyurethane product line. In other words, until recently, Futura did not differentiate between its products based on Texaco's polyether amines (polyurea component) or polyester/polyether hydroxyl (polyurethane urethane component) resins. Systems based on either resin were marketed by Futura as *"polyurethanes"*. However, in the last 5 years, Futura has begun to actively indicate which systems it has that are based on polyurea raw materials and which are based on polyol resins.

Secondly, Futura doesn't believe in miracles and would like to dispel the myths and put the *"hype"* in perspective by providing an accurate gauge to decide whether a polyurea or polyurethane is your best choice for an application.

The Kleenex Effect

So how has the term *"polyurea"* gotten so misunderstood? Simple. What is actually happening can be compared to the analogy of the name Kleenex. When you ask for a Kleenex, do you really specifically want the brand Kleenex or just a tissue? Similarly, many contractors, specifiers and fabricators are asking for a *"polyurea"* but do they really want specifically a polyurea or do they want a system that is fast cure, solventless, cures at low temperature, is tough, flexible and has high performance properties? A polyurea system and a polyurethane system both fit that description.

At Futura Coatings, we've been producing polyurethanes and polyureas for decades. In that time, we've found that the polyurethane and polyurea systems each have specific areas where their properties excel. It's our position that if optimum performance is needed for an application, one product or technology can't always be used as a universal solution. This is why Futura has developed over 100 different solventless/fast cure systems. What's more, Futura takes the time to recommend the polyurea or polyurethane which best suits the application performance criteria.

Overview Of Chemistry

There are some key differences and similarities between polyurethane and polyurea when the chemistry is understood. A general and simplified reaction of the two systems can be seen in Illustration A.

The first thing to notice is that both systems can use the same or similar "A" components. Therefore, the main properties differences are contributed by the "B" component side of the system.

The "B" component of the polyurethane system is comprised of various polyols (polyether, polyester) and normally requires a catalyst in order to cure rapidly. An advantage of the polyurethane system requiring a catalyst is that the catalyst can be adjusted to control the reaction profile to fit the application. Some applications require a smoother finish, and if the system gels too fast, a rough orange peel surface will result.

Furthermore, some applications require the material to flow into the corners or hard-to-spray areas and need a few extra seconds before gelling. This latitude can be accomplished with a polyurethane system choice of catalyst and concentration. The catalyst can be adjusted for a urethane to cure as fast as 10 secs and at low temperatures.

The polyurea system is comprised of polyether-amines or an amine terminated polyol. This polymer is a very reactive polymer and does not require a catalyst (it's an auto-catalytic polymer). This reactivity is typically always fast (in the 5-15 sec range) and cures well on cold surfaces. The reactivity is also so fast and preferential that polyureas in general are moisture insensitive and do not easily react with humidity and moist substrates.

One drawback to the speed of polyureas is that they can be too fast for certain applications that require a smooth surface or a delay time before the system gels.

A Closer Look At The Claims

There are numerous claims that many new polyurea system manufacturers or suppliers are making which need a closer look:

Moisture Insensitivity/Moisture Resistance - It's true that typical polyurethane systems can be sensitive to humidity and moisture. A urethane can react with atmospheric moisture or high humidity. The result is carbon dioxide gas which causes the foaming and/or pinholing.

The reaction of Component A and Component B (polyamines) or a polyurea system is so fast that the moisture reaction can't occur. Therefore, the polyurea systems are not sensitive to moisture and humidity and do not normally produce carbon dioxide bubbles. (The A & B components react together faster than the A component can react with moisture or water). This feature is an advantage in high humidity climates or regions.

Furthermore, this feature is also helpful if a substrate is moist or has condensation on it. However, it's a poor practice to apply any system over moisture or an unprimed substrate. (We will address the surface preparation details later in this paper).

To be fair, don't stereotype. Some polyurethane systems can be formulated to also have high tolerance to moisture. Futura has developed a second generation of polyurethanes coatings elastomers and structurals that are extremely resistant to foaming or pinholing in high humidity or most environments. Since Futura produces its own prepolymers (The "A" component) and has a high investment in innovative research, most of the moisture sensitivity of typical urethanes has been overcome on the products that we produce and market. Therefore, if moisture insensitivity is the key reason that a polyurea is being chosen over a polyurethane, then, in most cases, Futura's polyurethane technology will do the job as well.

Spraying Over Wet Surfaces - Another claim in the industry is that the polyureas can be sprayed on moist or wet substrates without any foaming, moisture reaction or detrimental effect.

Part of this claim is true. However, there could be detrimental results in regards to adhesion. It should be fairly obvious that if there is a substantial amount of water or moisture the adhesion will be compromised.

It's an industrial standard (NACE, SSPC, etc.) that all surfaces be properly prepared and primed, especially in critical applications such as containment linings, abrasion resistant elastomers and flooring. (Furthermore, once a porous surface is primed, the moist substrate issue is basically eliminated). There are a few non-critical applications where spraying a polyurea system directly to moist concrete, wood or fabric will have satisfactory results.

Consult Futura for these specific applications or approvals to do so.

Fast Cure Properties - Polyurea systems are being promoted as fast cure, which is true, and they can gel as fast as 3-10 seconds. The polyurethane can be catalyzed as fast as five seconds but when necessary can be slowed down to a few minutes or more. Both systems can be considered fast gel/cure systems and can be used to increase fabrication or production efficiency in all applications.

However, it is important to note that sometimes a polyurea can be too fast and may not produce the results required for a specific application.

Fast Cure Surface Finish - The polyurethane reaction profile can be adjusted to achieve an aesthetically smooth gloss finish. Most polyurea are so fast that the surface has a rough orange peel texture to it.

Solventless - As mentioned previously, both systems use a common or similar component A which is a low to medium viscosity resin. And while the component B sides have different terminated reactive groups on the polymer (hydrols vs amine groups), the resins are otherwise very similar in viscosity and both are solventless. As a result, either a polyurea or polyurethane can both provide some advantages in regards to having zero VOC and meeting all environmental regulations.

The Physical Properties of Polyurethane & Polyureas

The polyurea and polyurethane systems have similar properties in general when compared to different generic coatings and system like epoxies, polyester/FRP systems and other rubbers and elastomers. Both polyureas and polyurethanes have high tensile strength, flexibility, impact resistance, abrasion resistance and can be formulated into a wide variety of property ranges.

However, when one looks more closely at the polyurea and polyurethane physical properties, each has unique properties which allows one of the two systems to be more viable or optimum in an application than the other.

Elongation/Modulus - For example, polyurethanes can be formulated with higher elongation and in a lower modulus than a polyurea with a similar hardness. The modulus is the amount of force required to stretch an elastomer to its ultimate elongation. Polyurethanes typically have lower modulus than polyureas, meaning they feel softer, more elastic and will stretch with less force which could be important for specific applications. Applications like waterproofing membranes and some abrasion resistant applications require a low modulus and a high elongation elastomer.

Application Temperatures - Both polyurea and polyurethane cure very rapidly, even at ambient temperatures well below room temperature. However, the auto catalytic nature of the polyurea allows them to be applied at 20-30oF (-6.7 to -1.1oC) lower than polyurethane systems. This is an important factor when applying systems to substrates like cold steel which typically is a heat sink substrate. Many times, applying conventional urethane systems to heat sink substrates could comprise the properties or adhesion of the first layer or pass, whereas there would be no problem using a polyurea system. Typically, Futura designs a polyurea/polyurethane blend for applications over heat sink surfaces.

Abrasion Resistance - Polyurea and polyurethane have excellent abrasion resistance in general. However, in critical applications where abrasion resistance is a key requirement, polyurethane elastomers will provide 2-3 times better abrasion resistance than a polyurea system.

Heat Resistance - Polyureas have the advantage of having higher heat resistance than a comparable formulated polyurethane. Polyurea can be formulated in a structural plastic that has flexibility and high impact/toughness yet still has excellent heat distortion resistance/heat sag resistance. A structural urethane plastic can be formulated to have similar impact resistance and flexibility but would not have as good heat distortion resistance or heat sag properties.

Adhesion - There are claims that polyurea can be applied directly over steel, roofing substrates and other substrates without any primer and minimal surface preparation. If something sounds too good to be true, it probably is. And adhesion problems may occur later on. The polyureas do not have any additional adhesion characteristics than a polyurethane elastomer. They may appear to adhere well to sandblasted steel or directly to various substrates. While the adhesion may be adequate in non-critical applications, a primer is necessary for immersion applications or dynamic applications like abrasion resistant applications.

Weatherability - Polyurethanes and polyureas are available in systems based on aliphatic isocyanate prepolymers which are higly weatherable and color retentive, and systems based on aromatic isocyanate prepolymers which are not color stable and will tend to chalk and darken in color. Presently, the aromatic polyurea is the main version of Polyurea that is promoted in the market. Futura's side-by-side testing has identified that most aromatic polyurea systems will discolor and chalk sightly more than polyurethanes. The polyetheramine and other amine reactants in a typical polyurea formula have a tendency to yellow somewhat more than the hydroxyl polyol based polyurethane.

Chemical Resistance - In general, the chemical resistance of the polyurea and polyurethanes are very similar when exposed to diluted acids, alkali and salt solutions. Where they differ is in the organic solvents and oils. The polyurea systems tend to sell significantly more than the polyurethanes and there may need to be some caution in the environment.

A Final Thought

Many companies marketing polyureas are selling on the *"sizzle"* principle. They are promoting polyurea more on hype and *"sizzle"* of the properties than the "meat" of the product. Futura has made an effort to develop a full line of polyurea and polyurethane elastomers and systems. This allows Futura the versatility of recommending the most advantageous properties of both polyurea and polyurethane for the application which can most benefit from their specific attributes.

HOW THE TERM "POLYUREA" HAS BEEN MISUSED OVER TIME

The term *"Polyurea"* is very often misued because not everything containing amines or polyetheramines can be labeled as simply *"Polyurea"*. The composition of an amine or polyether "B" component can vary from as high as 100% to as little as 2%. The industry is now defining that in order for a system to be called Polyurea, the amine or polyetheramine content must be 80% or more. A product is called a polyurethane when the content of hydroyl polyol is 80% or more. When the hydroyl and polyetheramine/amine content falls in between these two parameters then the system can be considered a polyurea/polyurethane hybrid or blend system.

The cost premium of the polyurea system over a polyurethane also correlates to the control of the polyetheramines. The raw material cost of the polyurethane is 1 1/2 - 2 times the price of the polyol used in a general polyurethane system. The key factor to be aware of is to be careful when a company has a low price and still claims it is a polyurea. Make sure that it isn't a polyurethane with a few percent of a polyetheramine.

Looking Into Polyurea's Past

Polyurea raw materials first showed up in the late 1970's early 80's in automotive RIM (Reaction Injection Molding) applications. Structural polyurethanes and related materials saw their advent in automotive RIM applications because the polyurethane parts could be pulled out of the mold in a matter of minutes. The polyurea technology was intially introduced in RIM (Reaction Injection Molding) applications and produced super tough, heat resistant parts that could be used for high impact resistant applications like car bumpers and some body facia.

Initially, polyureas had problems in the RIM industry because the systems were too fast. Which means, it was difficult to inject into large parts because the material would gel before filling the larger molds. This problem was solved by first altering materials raw material chemistry. And second, higher output equipment was developed which could fill the molds before the material gelled.

In the early 80s, Futura began introducing new series of solventless, fast cure polyurethanes for a number of markets. The markets included the sprayed polyurethane foam (SPF) market, plastic composites and the industrial protective coating markets. Along with the introduction of this new, solventless technology,

(by Futuracoatings Inc. St Louis MO USA)