



Low-Pressure Applied Polyurea -The Next Generation

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Introduction

Since the invention of fast set polyurea spray during the mid-1980's by Mr. Dudley Primeaux of Texaco Chemical Company® (now Huntsman Chemical®), it has been necessary to apply this newly discovered technology through the use of a plural component high-pressure pump system which could consistently maintain processing temperatures ranging from 140° F to 160° F. It was also essential that the material remain heated until it was discharged through an impingement gun where the polyurea was finally mixed. However, for proper mixing it was mandatory that the polymer maintain these temperatures through a lengthy set of material hoses (up to 315 feet). The main purpose of heating the material was to reduce viscosities of both components (Iso and Resin) to improve mixing in the high-pressure direct impingement gun. This heated material and high pressures resulted in excellent atomization of the polyurea.

Invented and developed by Elastomer Specialties, Inc, the technology now exists to process certain aromatic and aliphatic polyurea systems using a low-pressure pump with no external heat applied to the cylinders or hose. In low-pressure polyurea applications, the use of direct impingement mixing is eliminated and a static mixing wand is used resulting in an application that requires considerably less equipment maintenance and monitoring. With the invention of the "Condor" low-pressure polyurea application system, it is possible to spray pure polyureas at several different



Low-Pressure Polyurea Being Utilized on Concrete as a Fish Pond Liner

volume ratios thereby allowing a wide range of formulation capabilities.

Current Polyurea Application Problems

One of the main problems associated with the application of polyurea coatings and standard high-pressure plural component application equipment is the continued maintenance required to maintain a good operational condition. This maintenance can include:

- Breaking down and cleaning of the direct impingement spray guns
- Monitoring of drum transfer pumps and replacing internal packing and seals
- Constant monitoring of high-pressure pumping equipment, heat range, and pressure to ensure proper volume ratios.

Another common issue associated with polyurea applications is the large amount of over spray caused by spraying highly pressurized and heated polyurea systems. Utilizing low-pressure applied polyurea can

virtually eliminate the majority of the aforementioned problems.

Pin-Holing, Air Entrapment

When spraying an elastomeric coating system, it is usually desirable to have as little air entrapment as possible. In other words, it is preferable to have a smooth, continuous membrane. When spraying polyurea by high-pressure methods, it is common to see a phenomenon known as “Pin-Holing”. Pin-Holing is small voids (or craters) in the polyurea coating most generally associated with spraying on concrete substrates. Our research has shown this phenomenon is caused by highly heated and pressurized material coming in contact with ambient temperature concrete. The air/moisture present at the surface (or in structure) of the concrete will try to escape the coating system by migrating to the area of least resistance (i.e.- 160° F polyurea). The polyurea system usually gels prior to the escape of the air/moisture resulting in a “pin-hole”. There are some primers available on the market that reduces this phenomenon; however, we are not aware of a primer that eliminates this phenomenon completely.

Polyurea applied by low-pressure application techniques can virtually eliminate “pin-holing” because of the lack of heated material and high pressures. The applied material temperature is usually near the same temperature as the substrate thereby eliminating the migration of air/moisture to the path of least resistance.

Research and Development

Just within the last two years, a research project was initiated to investigate the possibility of spray applying pure polyurea systems utilizing low-pressure spray equipment. It is common knowledge that hybrid polyurea and polyurethane caulking systems dispense very well utilizing commercially available low-pressure dispensing equipment through a static mixing wand. However, these caulking systems cure significantly slower and usually cannot be applied on a vertical substrate and be continually “built-up” as is common with high-

pressure equipment applications. Another benefit of the high-pressure spray equipment was that it allowed polyurea systems to be at temperatures ranging from -40° F to 250° F with virtually no effect on tack-free times.

During the development phases of the equipment, it was determined that the gel time of the pure polyurea systems presented a significant problem. Another significant problem was the difference in viscosities of the Iso and Resin sides. It was thought that proper mixing could not be achieved using a static mixing wand. It has been quite common for polyurethane and hybrid polyurea systems to be applied via the low-pressure method. Polyurethane and hybrid polyurea systems use polyols as the main reactant to slow the initial gel time of the reaction. When formulating these systems, it is common to use a metal catalyst to send the reaction to completion. The problems associated with catalyzed systems have been well documented and generally include some reactivity to moisture as well as several other issues. The polyurea’s have become popular during the past decade because they eliminate many of the problems associated with standard urethane applications. Formulations were discovered that significantly slowed the gel time of the pure polyurea systems and allowed processing through the low-pressure spray equipment.

A Low-Pressure Pump with Horsepower

It was soon discovered that the key to proper displacement of the polyurea systems required a pumping system with thru-put. Actions were taken to ensure that the low-pressure pumps



The ESI “Condor” Low-Pressure Dispensing Machine Being Used to Apply Polyurea Caulk

would not produce an off-ratio material when fast gel times caused increased resistance in the pumping mechanisms. One of these actions included a chain and sprocket drive. This chain drive is similar to a chain and sprocket drive on a bicycle. Volume ratios can be changed very easily by simply changing the sprocket sizing. However, the main reason for the chain and sprocket drive is the resistance to slip that this mechanism provides. The chain and sprocket drive allows a wide range of viscosities to be processed with virtually no volume ratio problems.

Ease of Application, Less Headaches

One major advantage offered by low-pressure applied polyurea applications is the elimination of constant cleaning and monitoring of the application equipment. The static mixing wands utilized are disposable and are inexpensive. The volume ratios can easily be verified prior to application by placement of material in containers. This material can then be poured back into the supply containers. Another method of monitoring volume ratios is by the displacement of material in the supply containers. The spray gun attachment is very easy to clean and contains few parts to replace.

Another advantage of the low-pressure polyurea pumps is the lack of bulkiness associated with them. The pump was designed to pass thru a standard door width of 36". The pumps also generate approximately 50-90% less over spray therefore making cosmetic applications such as balcony decks and parking



Roadside rest areas, such as this one in Texas, are a perfect size application for low-pressure applied polyurea

garage decks more appealing. Any small application is ideal for the Condor machine.

What About Small Areas?

Another discovery made during the research of low-pressure polyurea application was the ability to apply small amounts of polyurea through a common pneumatic cartridge gun. This patent pending invention allows a contractor to spray small areas such as shower stalls and pick-up bed linings without the cost of purchasing expensive application equipment. The polyurea is simply plunged at equal pressures though a static mixing wand and atomized at the tip using a small amount of air.

Physical Properties Comparisons

The formulations analyzed showed comparable results when compared with conventionally applied aromatic and aliphatic polyureas. The following physical properties results were achieved by applying various formulations by low-pressure spray techniques:

Aromatic 100% Polyurea Formulation

Equipment: Low-Pressure Spray
 Gun/Tip: 3/8" ID Mix Wand/Halo
 Processing Temps: 75°F
 Gel Time: 15 Seconds
 Tack-Free: 35 Seconds
 Cure Procedure: 230°F 18 hr Post Cure

Test	Method -	Results
Tensile	ASTM D 412	3250 psi
Elongation	ASTM D 412	480 %
100% Modulus	ASTM D 412	1074 psi
200% Modulus	ASTM D 412	1364 psi
300% Modulus	ASTM D 412	1753 psi
Die C Tear	ASTM D 624	446 pli
Shore A	ASTM D 2240	50
Shore D	ASTM D 2240	96

Hybrid Polyurea (Wastewater Lining)

Equipment: Low-Pressure Spray
 Gun/Tip: 3/8" ID Mix Wand/Halo
 Processing Temps: 75°F (ambient)
 Gel Time: 15 Seconds
 Tack-Free: 25 Seconds
 Cure Procedure: 230°F 18 hr Post Cure

Test	Method -	Results
Tensile	ASTM D 412	6250 psi
Elongation	ASTM D 412	420 %
100% Modulus	ASTM D 412	1250 psi
200% Modulus	ASTM D 412	1864 psi
300% Modulus	ASTM D 412	3231 psi
Die C Tear	ASTM D 624	371 pli
Shore A	ASTM D 2240	96
Shore D	ASTM D 2240	43

Conclusion

The polyurea industry has undergone dramatic growth during the last decade. It is apparent that polyurea is gaining in popularity and formulators are becoming more familiar with the chemistry of polyurea resulting in more user-friendly formulations. Another advantage of the increased use of polyurea coating systems is the continual design improvement concerning dispensing equipment. Although polyurea has enjoyed increased popularity in the market place, it has also been hampered somewhat by the bulkiness and cost limitations of high-pressure processing equipment. The invention of low-pressure polyurea spray will allow contractors and common laymen to apply a superior elastomeric coating system without the high costs generally associated with polyurea application start-ups.

It is obvious that low-pressure applied polyurea will never replace high-pressure applied polyurea, especially when dealing with low temperature applications and larger applications. The smaller, less demanding applications which are applied at ambient temperatures will be the forte of the low-pressure applied polyurea. It is for this reason that low-pressure applied polyurea is truly the next generation of spray-applied elastomers.