CODE OF GOOD PRACTICE
for the Application of Polyurea

Designed and prepared
By
PDA Europe

First Edition October 2014

Creating a manual of good practice for every type of business involved with polyurea has become an absolute necessity to keep organized, if we are to continue to provide clients with an impeccable service.

PDA Europa has commissioned the Italian Committee with this delicate task, given their experience over many years in other sectors which is reproducible in large measure here.

The second phase is to agree on a type 10966 UNI EN regulation for resinous coatings. The aim of the manual is above all to be internationally applicable and to provide correct information on both theory and practice.

This is the first edition of the Code of Good Practice for the proper use of Polyurea, does not want to be the only and definitive version. They wanted to give the information most important and essential. New developments are present, and new ones will come, but at this time can not be included in the Code. There will be future issues that will improve the code as a function of the innovations that will arise in the meantime.

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The Coordinator of the Italian Committee

Contents


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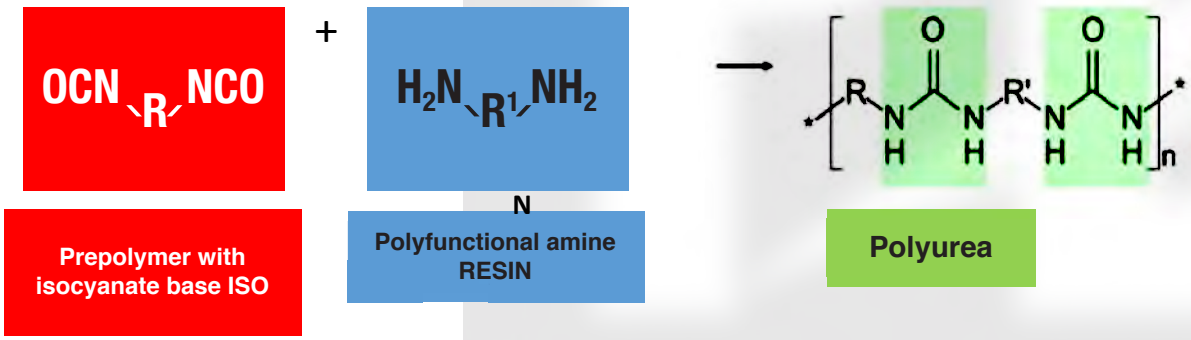
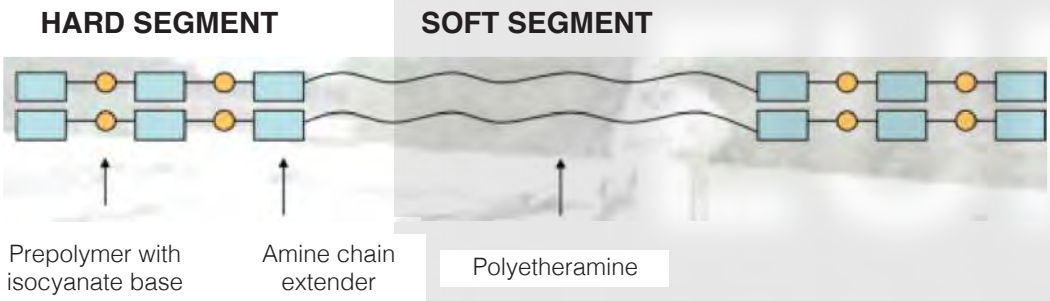
1.1 Polyurea: definition and chemistry

Polyurea is an elastomer obtained chemically by the polyaddition reaction of an aliphatic or aromatic isocyanate or of an isocyanate prepolymer with a polyfunctional amine or mixture of amines, generally in a mixing ratio by volume of 1:1.

The technology of polyurea is based on the chemical reaction of the two-component systems applied by spraying, through the use of two component pumps and is used for coatings and waterproofing.

The products were first developed and marketed in the late eighties in the United States, from which they spread rapidly throughout the world, especially in Asia, where they had a strong growth in the second half of the nineties.
At first polyurea was used as a protective layer for polyurethane foam used in roof insulation. In Europe, however, the polyurea market only began to develop in recent years.





In aromatic systems, the isocyanate component is made from prepolymers based on methylene diphenyl diisocyanate (MDI); in aliphatic systems, from hexamethylene diisocyanate (HDI), isophorone diisocyanate (IPDI) or H12MDI methylene dicyclohexyl diisocyanate and it constitutes the hard segment of the chain.

The selection of the isocyanate prepolymer influences most of the properties of the polymer.

MDI-based prepolymers, with a NCO content between 15% and 16%, are typically used in the formulation of standard polyureas.

In this range of NCO, you get a good compromise between the viscosity of the material and the reactivity of the system. With lower values of NCO, prepolymers have a higher viscosity, but give the system a greater elasticity and a lower reactivity.

The use of prepolymers with lower NCO content is certainly limited by the resulting increase in viscosity that causes a worsening of the miscibility of the two components, with consequent application repercussions.

Prepolymers with a higher content of NCO groups, and consequently of hard segments in the chain, have a lower viscosity, which facilitates the mixing of the two components, making the system more reactive, and lending it an increased surface hardness.

The use of most reactive prepolymers increases the level of stress within the system, making it more fragile during the first 24 hours following the application, and also the deriving faster gel time may result in obtaining a lower-quality surface appearance.

The percentage of NCO has therefore effect on the hardness, stiffness and reactivity.

In general, the NCO range used for the prepolymers used in polyurea varies from a minimum value equal to 8, up to a maximum of 20.

Obviously the choice of one or the other is closely related, as well as any other parameter, to the intended end use of the polyurea system.

The backbone of the prepolymer influences the chemical resistance and resistance to solvents and in general the resistance of the membrane itself.

The index of the polyurea system is typically maintained with a slight excess of isocyanate in the range of 1.05 to 1.10. Since the isocyanate group reacts with moisture, the excess of isocyanate compensates for the “loss” of the NCO groups during storage and/or application.

The amine component of the polyurea is generally much more complex than the isocyanate component, and consists primarily of:

- **high molecular polyetheramine**, due to its flexible nature, onstitutes the soft segment of the chain;
- **low molecular weight polyetheramine** used as chain extenders;
- **pigments and additives**.

The choice of the amines is crucial for the processing and subsequent performance of the polyurea.

The polyether amines are propylene oxide/ethylene oxide-based polyethers that are amine terminated, generally with a molecular weight between 200 and 5000 g/mole. The primary amino group of these molecules reacts rapidly with the isocyanate, which does away with the need for a catalyst.

The polyether amines can be bi/trifunctional, aromatic or aliphatic; the latter are used in applications where the stability of color exposed to light is obviously a priority, since they are very expensive.

The aromatic polyurea unlike the aliphatic ones are subject to yellowing due to UV rays, but this does not affect the intrinsic properties of the polyurea itself.

The chain extenders are key for the reactivity and the properties of the polyurea.
The diethyltoluenediamine (DETDA), mostly used in the formulation of aromatic polyureas, contributes to the hard segment and improves the heat resistance.

In recent years there have been specifically designed chain extenders such as secondary and/or sterically hindered amines in order to slow down the reactivity of the polyurea for particular types of application.

Pigments and additives must be used in limited quantities since the viscosity of the two components must be kept under control during the application. Any substantial amounts of fillers or reinforcing additives can be added to the system as a third component.

There is still no uniformity with regard to the denomination of components A and B of the polyurea. In Europe, the isocyanate component is commonly component B (resulting from polyurethane chemistry), while in the other countries there is an inversion of the denomination.

The two components are identified by different colors: usually red for the ISOCYANATE, blue for the POLYAMINES.

The term ‘polyurea’ is the description of a technology. There are a variety of possible formulations which can be used to achieve the desired properties and therefore the selection of appropriate raw materials is of fundamental importance.

The polyurea term has been used in the past in an improper manner, creating confusion between pure polyurea and hybrid polyurea. Pure polyurea should not contain hydroxyl groups in its formula, unlike hybrid systems which are characterized by the presence of OH groups and catalysts.

	POLYUREA	HYBRID		POLYURETHANE
Main component	Polyetheramine	Polyetheramine	Polyol	Polyol
Chain extender	Polyamine	Polyol	Polyetheramine	Polyol
Catalyst	NO	NO	YES	YES

A hybrid system has a composition that is a combination of the aforementioned systems (polyurethane and polyurea). The isocyanate component may be the same one used for pure polyurea. The mixture of resins is instead a combination of terminated amine and terminated polymeric hydroxyl resins and/or chain extenders.

The addition of one or more catalysts is required to obtain the same reactivity.
For this reason, hybrid systems, despite having a wide scope of applications, are more sensitive to moisture than pure polyurea.

Furthermore, since the catalyzed reaction between polyol and isocyanate is affected by changes in temperature at the application phase, unlike the reaction of amine and isocyanate, the system performs more poorly.

Polyurea is formed when the amine reacts with the isocyanate. The reaction is fast and autocatalytic (therefore it does not require a catalyst even at low temperatures, unlike the polyurethane and hybrids systems) and it acquires many specific properties that distinguish it from other types of polymers.

Together with this explanation the PDA has also written a definition to describe polyurea, which is as follows:

"**A pure polyurea** coating / elastomer
is derived from the reaction product of a polyisocyanate component
and an amine-terminated resin blend".

Polyurea, unlike hybrids and polyurethanes, achieves excellent performance in regard to mechanical and chemical properties.

The benefits of PURE polyurea are:

Rapid reactivity, cross-linking and commissioning;

High chemical and mechanical resistance;

Resistance to high temperatures;

Excellent elastic properties and crack bridging;

Resistance to abrasions and impacts;

High resistance to tearing;

Water resistant;

Absence of solvents (100% solids);

Thick application even on vertical surfaces;

Applicable on most substrates (see section 5).

2. SAFETY

2.1 Introduction

Health and safety is an aspect of everyday life and work, that is often spoken about but, unfortunately, also often ignored when under pressure or due to lack of information or knowledge.

This chapter is written to provide guidance and information, since specialized materials require specialized information, the PDA strongly advises you to contact you material and or equipment supplier for more detailed information.

There are various aspects of health and safety involved with the processing of polyurea, such as general aspect, resources, chemicals, high pressure equipment, personal protective equipment (PPE). These will be handled in the next paragraphs.

2.2 General aspects

The main reason to pay attention to health and safety is to prevent accidents and to prevent exposure to chemicals.

When thinking about accidents, the general belief is that accidents just happen, which is untrue!, 85% of all accidents are behavior related and could be prevented. The key in preventing accidents is very often communication, if one talks about unsafe behavior, one also thinks about it and about how to act more safely.

Keep in mind that, when someone comments on your actions as being unsafe, it is not criticize you, but it is to prevent you from hurting yourself, the people around you and the environment.
Chemicals should, by nature, be treated carefully and with the correct measures.

2.3 Chemicals

Not all chemicals are equally dangerous, but when handled correctly all can be equally safe.

2.3.1 Polyurea

The reacted product, polyurea, is not classified as dangerous in its polymerized state, and in many countries can be treated as normal waste.

However one should not forget that the reaction of polyamines and isocyanates (which forms polyurea) is an exothermic reaction. This means that while reacting the product develops heat. By example; not spraying correctly could result in reacting polymer on the skin which could lead to burns.

2.3.2 Resin side, polyamine

The polyamine used with polyurea is classified corrosive and dangerous for the environment. Therefor caution should be taken when handling and transporting. When handling the resin or parts of the equipment that could be contaminated with resin, safety glasses, chemical resistant gloves should be worn to prevent exposure.

Due to the corrosive nature of this product, spills onto the skin could lead to chemical burns. When transporting this product note should be taken that many formulations are classified “ADR” which means that special rules apply on the quantity being transported, the vehicle used and the driver.

Always think about what could happen if there is a spillage of chemicals, how to contain the spill from expanding, how to remove the chemicals and how to dispose of it in a safe way.

More detailed information can be found on your suppliers Safety Datasheet (SDS)

2.3.3 Isocyanate side

The isocyanate side used with polyurea is most often classified harmfull but in some cases can be classified toxic as well. Handling of isocyanates can be treated, in general, in the same way as handling the resin side. With the exception that it is not corrosive but it will react with moisture. In thisreaction CO2 (a gas) is formed, which could lead to pressure build-up, in closed drums for example.

Furthermore isocyanates, if exposed above the occupational exposure limits (OEL) can lead to irritation of the skin as well as the respiratory system (lungs), continuous exposure above the OEL can lead to sensitization, which means that working with isocyanates when sensitized is no longer an option.

But this scenario can be avoided when taking the correct precautions. Safety glasses and gloves, work in a well-ventilated area or wear respiratory protection.

2.3.4 Spraying

Although polyurea in its polymerized form is not harmful, inhaling the product when being sprayed is harmful. During the atomization stage (spraying) the air fills with aerosols and vapors, the only way to prevent exposure is to wear the appropriate protective clothing and respiratory protection.

This does not only apply to the person handling the spray gun, but to all personal whom can be exposed to the vapors and aerosols.

2.3.5 Solvents

Polyurea in general is a solvent-free technology, but when it comes to cleaning parts of the gun and equipment, solvents are often used. When handling solvent all safety rules should be respected as they are presented on the SDS's of those products.

2.4 High pressure equipment

When using spray machine (high pressure equipment) note should be taken that one is handling a machine designed to heat chemicals to around 75 °C and pressurize it to around 200 bars.

The equipment is designed to handle these two aspects when kept in good condition, this implies that the operator needs to take care that the spray machine is kept in this condition.

Pressure and temperature are two things, but moving parts are another, and therefor only qualified and trained personnel should be allowed to use these machines. Exact advice and guidelines can be found in the user manuals of the spray machines.

2.5 Personal Protective Equipment (PPE)

One of the factors in working safe is preventing exposure and this can be realized when wearing the correct PPE.

Summarized below is list with explanation and advise on the various PPE.

- Eyes

- Safety glasses when working with the chemicals, but not when spraying.
- Safety goggles or full face mask when spraying.

- Skin

- Chemical resistant gloves when handling chemicals
- Coveralls or clothes that offer sufficient protection, do not forget about the head / hair.

- Respiratory protection

- When spraying and when working in a not sufficient ventilated area, respiratory protection is an absolute must !
- Air purifying equipment is most commonly used, but some attention should be paid to the following details:

- Full face is always better than . face + goggles
- The filter cartridge needs to be the correct one, as indicated on the SDS, but “rule of thumb” states ABEK (coding on the side of the cartridge)
- The filter cartridge needs to be replacement as per the interval that is stated by the cartridge manufacturer.

- Air supplied equipment is also suitable and used, but in some countries specific training and certification is required to use this.

Below is an example on correct PPE usage without conflicting with the daily routine.

2.6 Resources

Apart from the information offered in this “Code of good practice” there is also a wide variety of more detailed information available from the following sources.

- Safety Datasheets from the product supplier

- Isopa, branch organization of isocyanate producing companies which offers an extensive range of presentations and flyer documentation in multiple languages on the safe handling of a variety of polyurea related chemicals

http://www.isopa.org/isopa/

3. APPLICATIONS

The fields of application or use of the polyurea are varied and it could be said that every day a new one is added, leading both manufacturer and operatives to study new products and new application technologies.

3.1 Nature of the work

Applications can be made on both new and existing substrates. In any case, you should always check every aspect before proceeding with an application of polyurea.

Due to the nature of the application and all the different elements involved, it is highly recommended that all important information on the various steps of the application are correctly documented. An example of a “spray log document” can be found in annex 1.

3.1.1 Substrate diagnostics

Whether the substrate is new or existing, it will be necessary to monitor a number of parameters that are critical to the success of the operation, in particular:

-The thermo-hygrometric conditions of the substrate and the environment;
-Mechanical conditions of the substrate (tear resistance for concrete substrates).

3.1.2 Verification of thermo-hygrometric conditions

The thermo-hygrometric conditions are a fundamental parameter and these require careful analysis before the application of the polyurea.

Due to the criticality of the system and its high rate of polymerization, the salient feature of this type of formulation, it is critical to control all aspects related to this point.

Awareness of the existence of condensation, dew or moisture in the substrate is essential. These factors cause the pinholes that create micro-craters on the coating, compromising its water-tightness as well as issues with adhesion

Instruments

Results

3.1.3 Monitoring

Monitoring the moisture both on the surface and inside the substrate permits choice of the most appropriate adhesion promoter or primer.

Knowing the dew point tells you whether you are in operating conditions: it is essential that the surface temperature should be at least 3° C above the dew point.

3.1.4 Adhesion testing

Before applying a polyurea system, especially on concrete, it is necessary to check the resistance to tearing of the substrate itself, as the polyurea is very strong and may cause delamination of the substrate if it is particularly inconsistent.

3.2 Methods

Adhesion testing always needs to be done according to a standard, otherwise values are not comparable and thus not reliable.

Therefor the industry uses for “pull-off” the following standards, ISO 4624 or ASTM D4514.

In the standard two different sizes of dollies are mentioned, 20 and 50 mm. The 20 mm dollies are suitable for homogenous substrates such as metals and the 50mm dollies are used for less “uniform” substrates such as concrete. Therefore it is highly recommended if not mandatory, to use 50mm dollies when testing for adhesion of polyurea on concrete.

There are various companies manufacturing or selling the equipment to do the tests, below are some examples of these units and the steps needed to perform such a test.

Elcometer

Sattec

3.3 Preparation Of The Substrate

The Preparation Of The Surfaces To Which The System Will Be Applied Is Of Fundamental Importance For Its Final Success.

The Preparation Of A Substrate Depends On Several Factors That Can Basically Be Summarized As:

- *Type Of Substrate*
- *State Of Substrate*
- *Coating Cycle*
- *Total Loads*

The Principal Substrates Seen When Performing A Coating Are As Follows:

- *Cement And Reinforced Concrete*
- *Metal*
- *Briquettes Of Stoneware, Clinker, Brick*
- *Wood*
- *Geotextile*
- *Polyurethane, Polystyrene*

3.3.1 Grinding

This is a mechanical action performed with abrasive wheels, or abrasive paper (sanding) in order to remove laitance, dirt or other material from the crust of the surface.

3.3.2 Scarification

This is a mechanical action carried out by a rotating or non-rotating scarifier aimed at removing the surface crust from 3 to 5 mm.
This tool removes only the material with low mechanical resistance.

3.3.3 Milling

This is the mechanical action of a rotary cutter to achieve homogeneous and total removal to a constant thickness, regardless of the resistance of the substrate.

3.3.4 Shotblasting

This is the mechanical action of metallic granules propelled by special machines with a complete recirculation, separation and recovery of sandy and other materials, all dust free.

3.4 Types of preparation

For successful coating, it is imperative to undertake some form of preparatory treatment.

- Polishing:

- For new substrates without special hardening surface treatments

- Bush hammering or scarifying:

- Old surfaces with friable parts, not spread over the entire surface.

- Milling:

- Old substrates which are particularly degraded or contaminated where it is necessary to remove a continuous and homogeneous layer:

- Shot-Peening:

- Concrete, stone, brick, metal, tile substrates

4. CONSTRUCTION DETAILS

- Vertical-horizontal or vertical-vertical fittings

- Fittings with discharges

- Connectors with any items off the laying surface

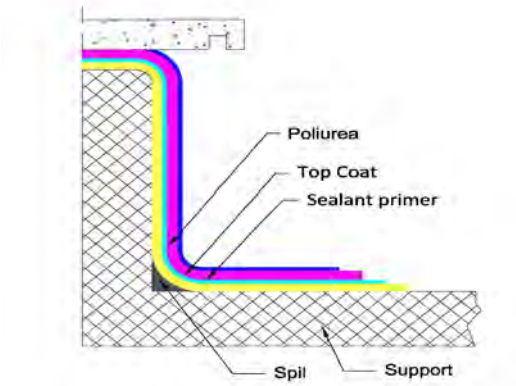
- Placement of vents

- Structural and/or control joints

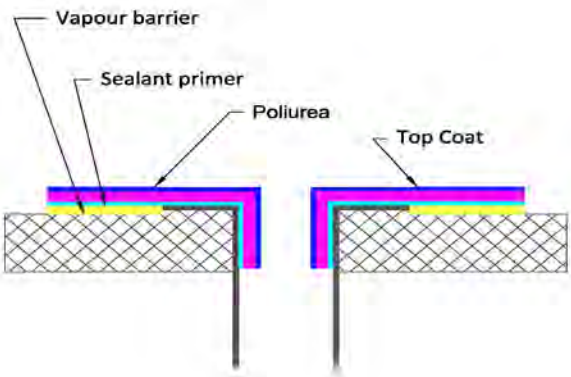
- Closing elements of the waterproofing (parapets, flashings, etc.).

In the construction details below a topcoat is displayed in every drawing, however a topcoat is only used when a color stable finish is required. Or when specifications written by either manufacturer or specifier dictates so.

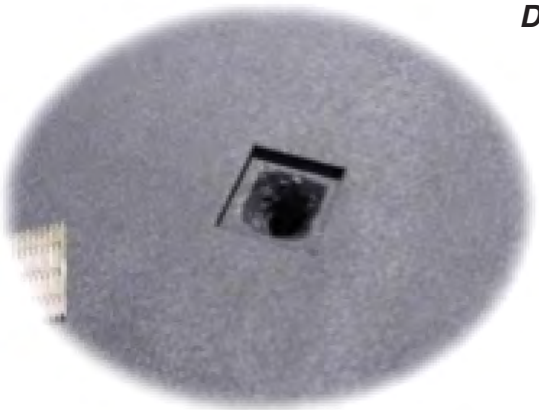
4.1 Vertical-horizontal or vertical-vertical fittings



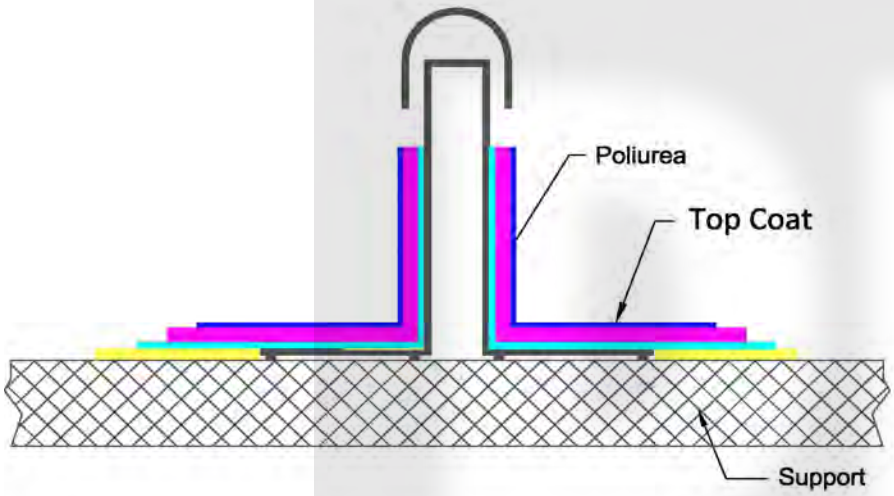
4.2 Fittings with discharges



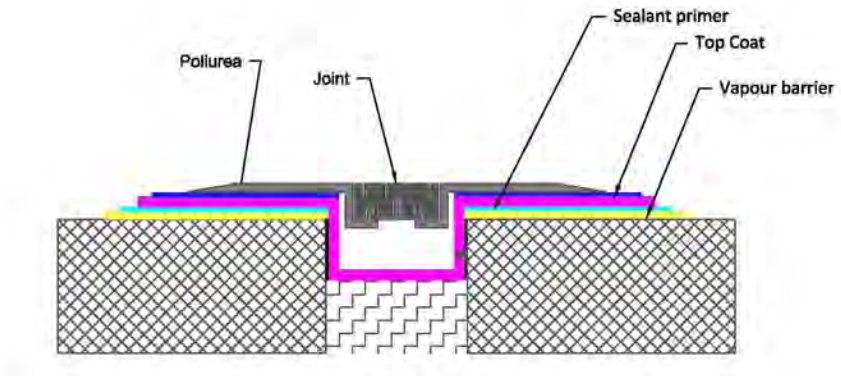
Detail shots



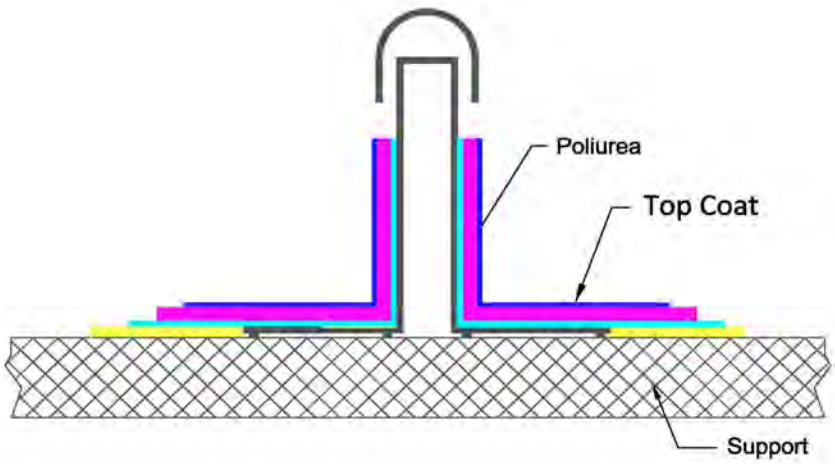
4.3 Inserted vents



4.4 Structural joints



4.5 Elevated elements



4.6 Recoating polyurea on polyurea

If it is necessary to undertake the polyurea spraying in an open field, or, if you have not finished the day's work against a wall, parapet, etc..., it will be necessary to overlap the layer applied the previous day, by at least 30 to 50 cm.

Any use of an adhesion promoter is at the discretion of the supplier.

It is intended as waterproofing specifically to seal against rain water, so any additional performance, although implicit in the nature of the product, is deemed secondary.

5. WATERPROOFING OF ROOFS

5.1 Application on to bituminous layer

Operating cycle

- Pressure hydro-wash the surface (for details please refer to the section on surface preparation).

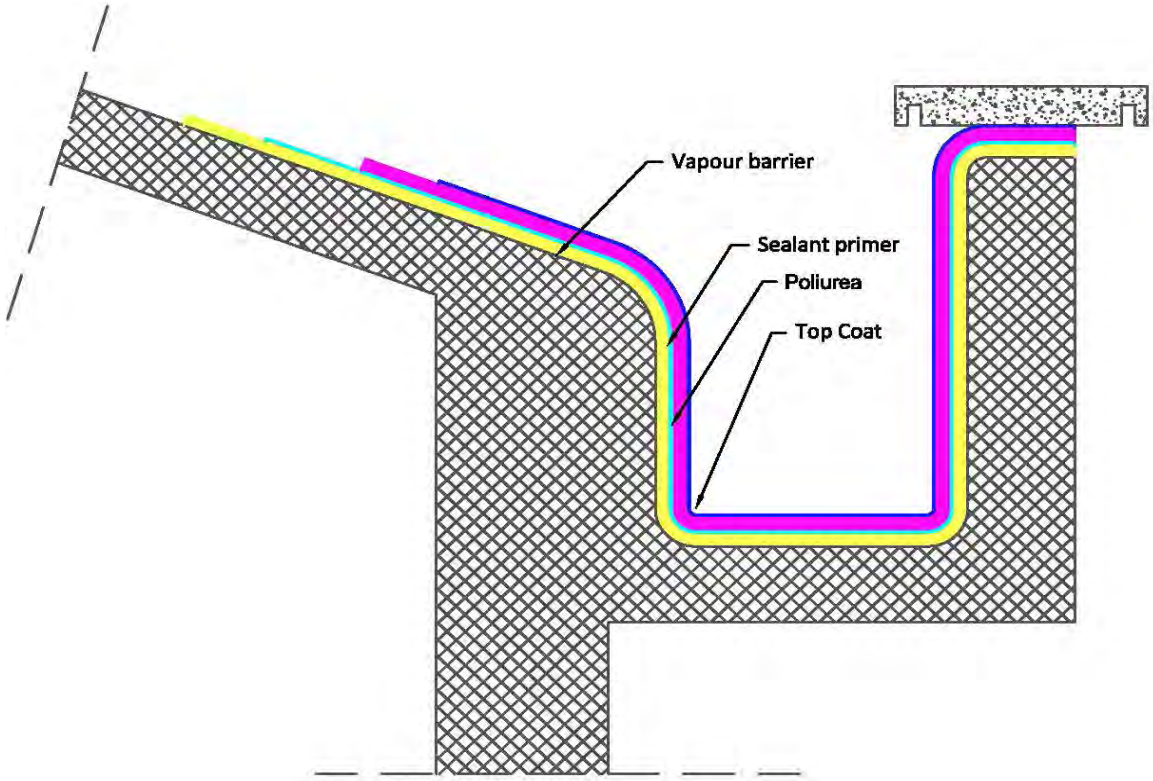
- Eliminate any wrinkles in the surface and re-adhere under heat.

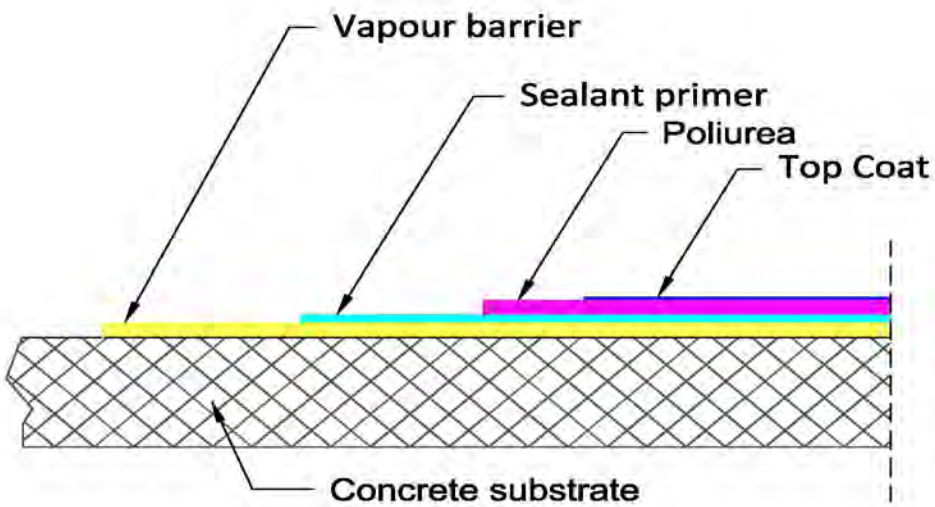
- Mechanical fasteners where needed, using PVC dowels.
  Application of a suitable primer for fixing the layer of polyurea on the substrate (normally today, solvented polyurethane primers are used, either single or two component systems).

- Spray application, in a suitable quantity of material to achieve the minimum thickness of 2 mm. of pure, low NCO polyurea.

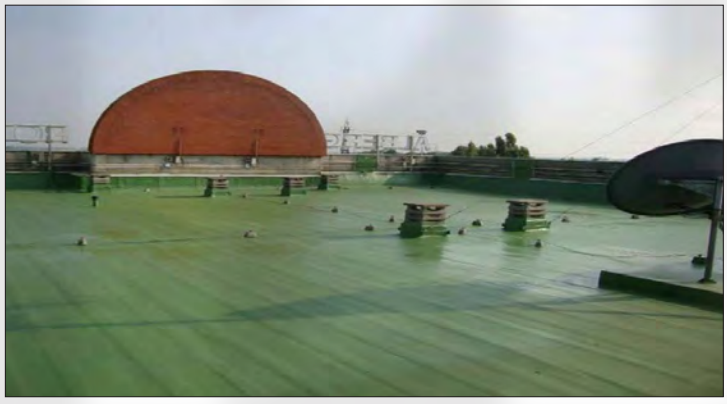
- Where an aromatic polyurea is used, a suitable flexible finish ca be applied, adapted to protect the layer of polyurea and maintain color stability.

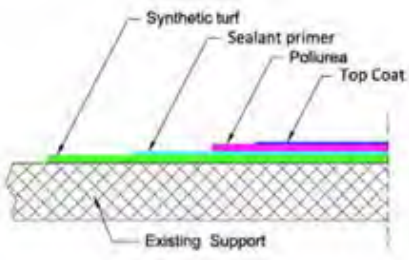
Details


Vapour barrier
Sealant primer
Poliurea
Top Coat


Vapour barrier
Sealant primer
Poliurea
Top Coat
Concrete substrate

DOWELLING




Synthetic turf
Sealant primer
PolIurea
Top Coat
Existing Support

5.2 Cement roofs

Operating cycle

- Substrate grinding and subsequent de-dusting
  (for details please refer to the section on surface preparation).

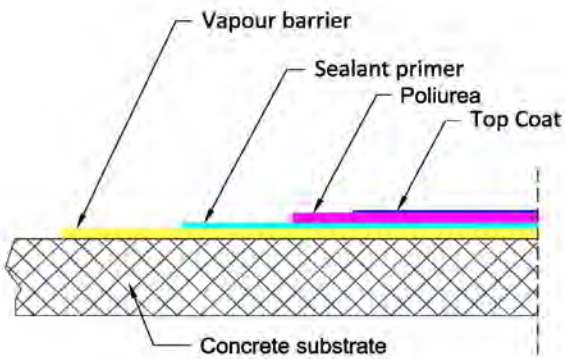
- Surface smoothing with barrier primer able to contain any rising capillary or osmotic damp, or moisture.

- Application of primers designed to completely seal the surface followed by seeding of quartz of suitable grade, while avoiding sprinkling.

- Spray application, of a suitable quantity of material to achieve the minimum thickness of 2 mm of pure polyurea.

- Where a polyurea of aromatic nature is used, a suitable flexible finishing is applied, adapted to protect the layer of polyurea and maintain color stability.

Detail



5.3 Wooden roofs

Operating cycle

Sanding of the substrate and subsequent de-dusting (for details please refer to the section on surface preparation).

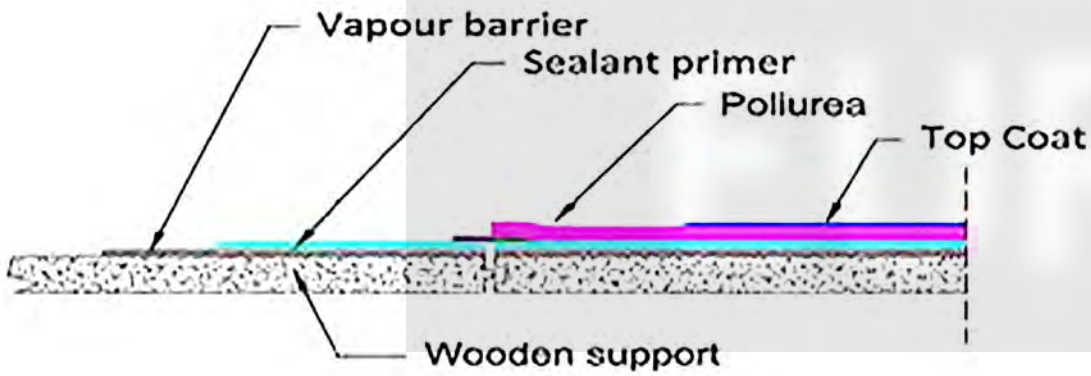
- Impregnation of the substrate until saturation with a formula compatible with both the substrate and the subsequent coating.

- Application of primers designed to completely seal the surface followed by broadcasting a suitable grade of quartz while avoiding sprinkling.

- Spray application, of a suitable quantity of material to achieve the minimum thickness of 2 mm of pure polyurea.

- Where a polyurea of aromatic nature is used, a suitable flexible finishing is applied, adapted to protect the layer of polyurea and maintain color stability.

Detail



Various phases of intervention

5.4 Car Parks and Driveways

A surface intended for use as a parking space or paved with such slabs, has as its surface a material that is exposed to the action of both atmospheric phenomena and wheeled vehicle traffic.

For this reason, the coating must possess, in addition to being waterproof, the proper mechanical characteristics in respect of sliding and rolling friction as well as surface wear. Good adhesion to the substrate must also be ensured so as to transfer to it the loads to which it is subjected (> 1.5 MPa).

Operating cycle

- Shot-blasting or grinding of the substrate and subsequent de-dusting (for details please refer to the section on surface preparation).

- Surface smoothing with barrier primer able to contain any rising capillary or osmotic damp or moisture.

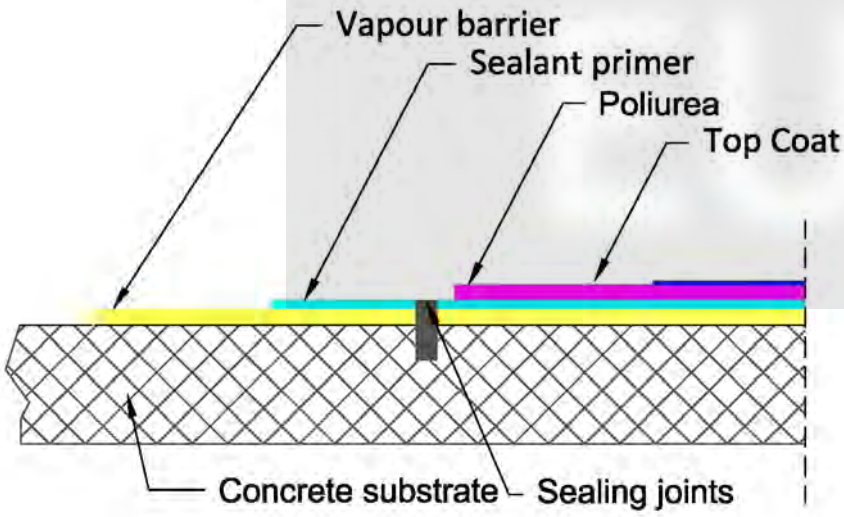
- Application of primers designed to completely seal the surface followed by broadcasting a suitable grade of quartz, while avoiding sprinkling.

- Specific treatment of any structural joints.

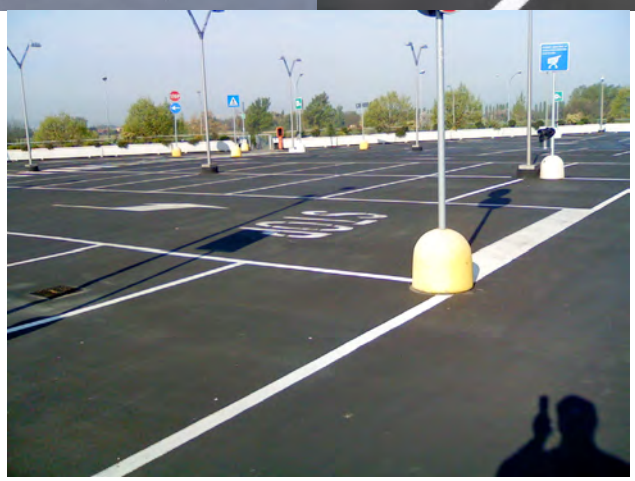
- Spray application, of a suitable quantity of material to achieve the minimum thickness of 2.5 mm of pure polyurea.

- Where a polyurea of aromatic nature is used, a suitable flexible finishing is applied, adapted to protect the layer of polyurea and maintain color stability.

Detail



Various phases of intervention for some applications



5.5 Communal Car Parks

6. PROTECTION OF CONCRETE

Protection of components means the ability to protect a structure from external attacks such as humidity, smog, and oxidizing agents that can cause corrosion.

Operating cycle

- Shotblasting, hydro-blasting or hydro-scarification depending on the type or condition of the substrate (for details please refer to the section on surface preparation).

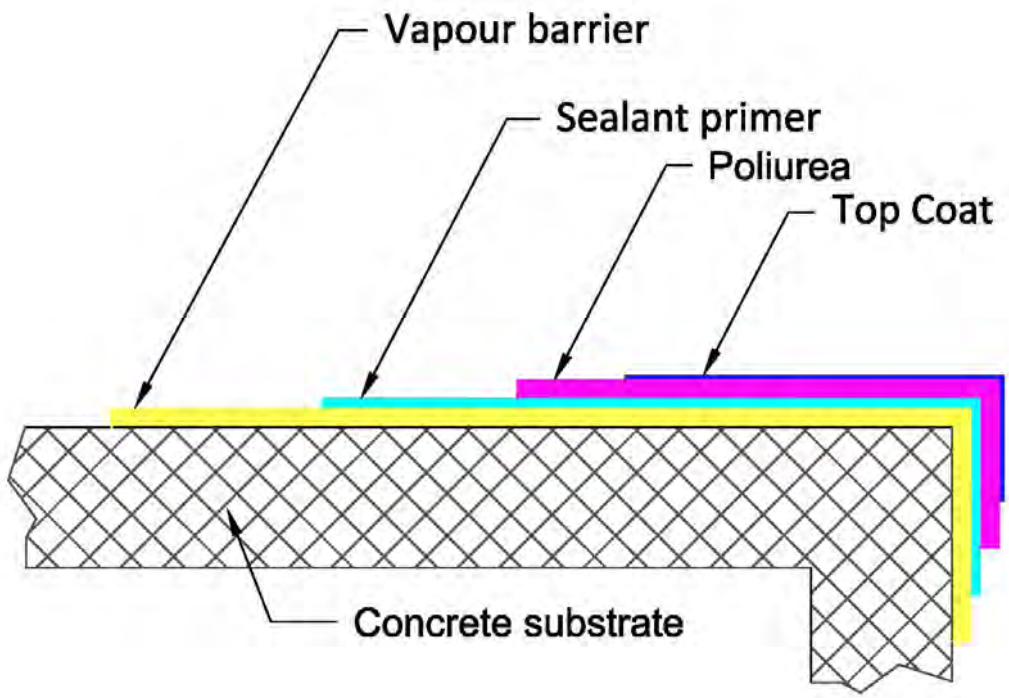
- The surface adapted to receive the protective cycle must be smooth, continuous, without pitting, etc.

- Therefore, where necessary, restoration with suitable materials should be performed.

- Surface smoothing with barrier primer able to contain any rising capillary or osmotic damp or moisture.

- Spray application, of a suitable quantity of material to achieve the minimum thickness of 2.5 mm of pure polyurea.

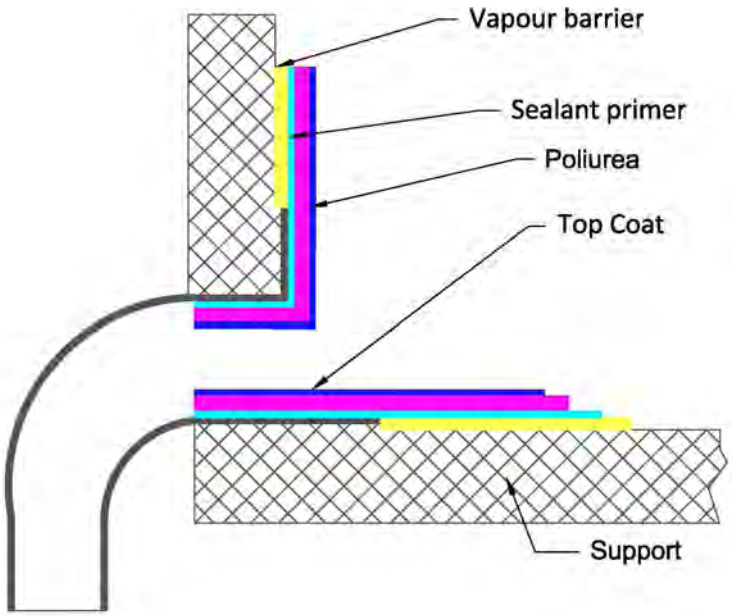
- Where a polyurea of aromatic nature is used, a suitable flexible finishing is applied, adapted to protect the layer of polyurea to maintain color stability.

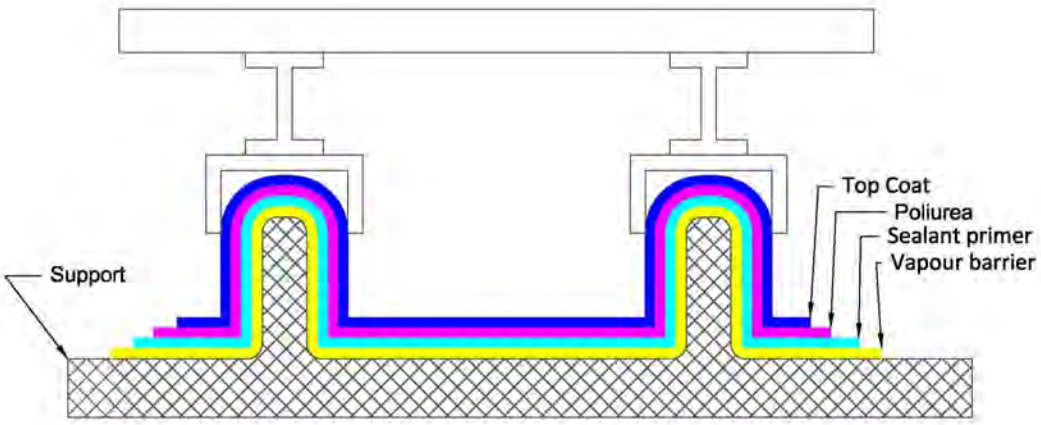


Performed treatments

Hydro-scarified and filled surfaces

Detail


Vapour barrier
Sealant primer
Poliurea
Top Coat
Support

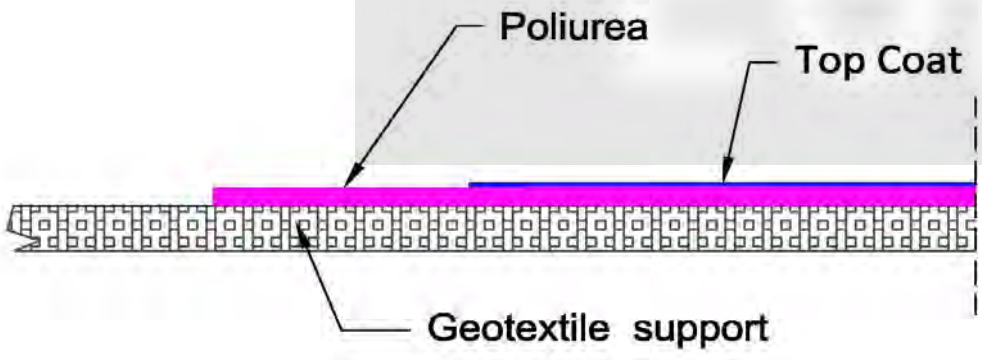

Top Coat
Poliurea
Sealant primer
Vapour barrier
Support

Various stages of application

6.1 Application with Geotextile

This system generally has no adhesion to the underlying surface.
The use of mechanical fastenings (coat dowels, screws, etc.) is recommended on roofs, soffits of tunnels, etc.

Specifically, this system allows an application where it is necessary to ensure ongoing containment and waterproofing, or where it is not possible to apply an adhesive coating (substrates on the ground, contaminated substrates, particularly deteriorated substrates, etc.).



Treatments performed

7. EQUIPMENT FOR THE APPLICATION OF POLYUREA

Polyurea is a two-component product for spray applications which requires particular mixing conditions to allow a proper chemical reaction during its application.

The machine for spraying (and mixing) is the heart of the whole system. It heats the two fluids, pressurizes them and keeps them at a constant during the spraying.

7.1 Equipment requirements

- *Two-component management system*

- *Spray pressure between 150 and 240 bars **

- *Product temperature between 50 and 80°C **

- *Product flow rate between 2 and 10 liter per minute ***

- *Measuring and mixing the products in the right ratio.*

- *Ability to produce and maintain the desired operating pressure.*

- Separate adjustment of the temperatures (A heater, B heater, heated hoses) to thin application products until correct viscosity is reached.

- *Deliver the desired flow rate at the desired pressure.*

*Pressure and temperature settings are system (product) specific. The values shown are indications but the actual settings need to be provided by the material (polyurea) supplier.

** For typical coating applications

~ Power system for 200 litre drums
~ Mixing and heating unit
~ Heated hose
~ Spray Gun

7.2 Equipment details

In order to use this equipment, general understanding how the individual parts function, is a necessity, therefor the separate parts are explained below.

Note that this “code of good practice” uses the definitions resin and isocyanate to prevent confusion between the letters A, B and R, which can be found in literature, on drums and on machines. On the equipment (and therefor in this chapter) resin is referred to as B and isocyanate is referred to as A.

7.2.1 Supply System

The supply pumps are designed to ensure a sufficient flow rate and pressure of the product from the drums to the mixing and heating unit.

The supply system is a key component of the system which transfers chemicals from the drums to the machine.

Particular attention must be paid to the choice of a correct pump for the application according to the viscosity and the management temperature of the A and B

Available Technologies:

Double-acting piston pumps
Double diaphragm pumps

Components

Sometimes agitation is required inside the drums to prevent sedimentation of materials, or to equalize the temperature of specific bands inside the drums once heated.

A supply pump which is not suitable can cause serious problems for the application, such as the wrong pressure or flow rate in the mixing unit and a series of other problems in the chain of components.

Isocyanate / ISO

A dehumidifying filter, mounted on the lid of the drum with a . inch pipe union, is necessary to prevent infiltration of humid air into the isocyanate.

Humid air can cause a reaction between water and isocyanate, the isocyanate will start to polymerize and formation of CO2 will be the side result. Both of these reactions will cause serious problems during processing.

Polyamine / RESIN

A pneumatic or electric agitator should be used to homogenize the product; not mixing the resin side sufficiently can lead to color changes and performance issues of the reacted polyurea.

There are three different available metering systems with fixed ratios:

- Pneumatically operated systems

  The pumping units for products A and B are driven by pneumatic motors.

- Electrical motorized systems

  The pumping units for products A and B are driven by electric motors

- Electro-hydraulic motorized systems

  The pumping units for products A and B are driven by hydraulic motors powered by the control unit

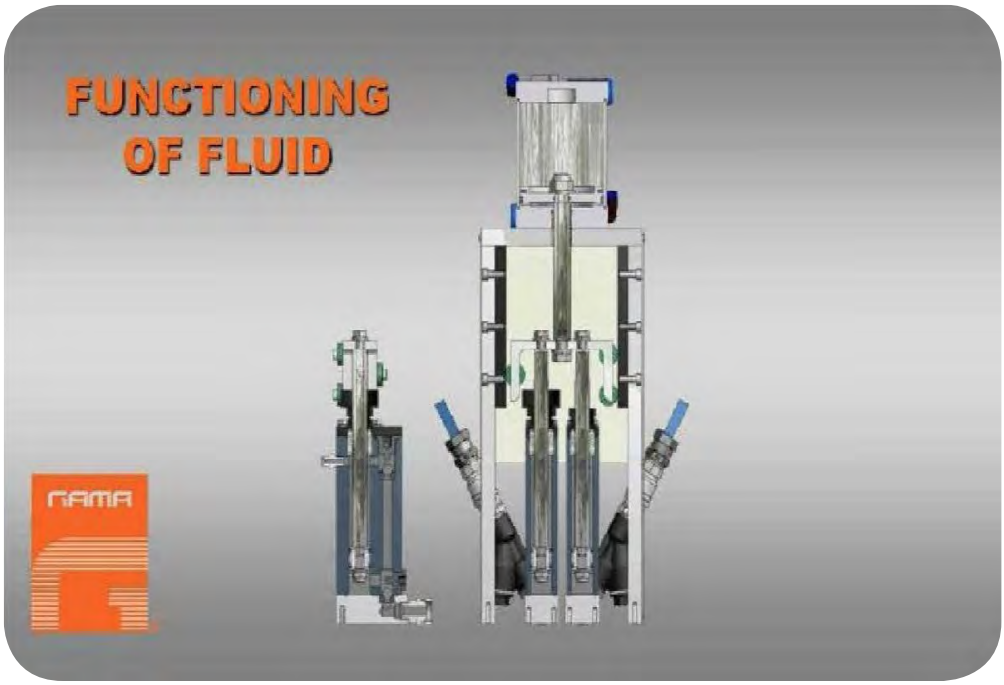
Pneumatic operating system:

An air motor drives two (or more) volumetric pumps which increase the pressure transmitted to chemicals **A** and **B.**

The volumetric pumps **A** and **B** generate the necessary pressure and measure while heaters keep the temperature suitable for spraying.

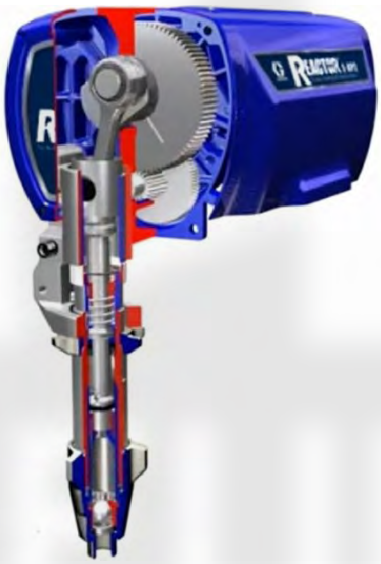
Under the effect of the pressure exerted by the pumps on the two liquids the product is vaporized (characteristic common to all systems).


WIWA


FUNCTIONING
OF FLUID
nAMA

Direct electrical motorised system:

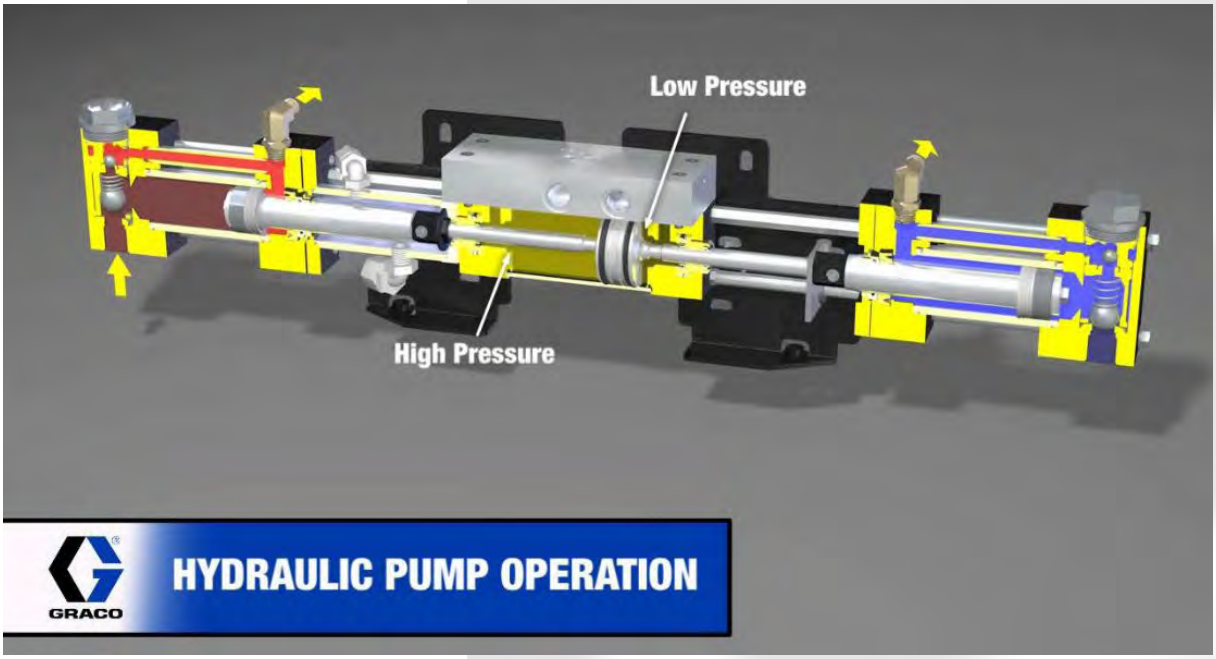
An electric motor with transmission shafts on both ends, operates two volumetric pumps A and B, which measure and heat the chemicals to create the necessary pressure for spraying.



Electro-hydraulic motorised systems:

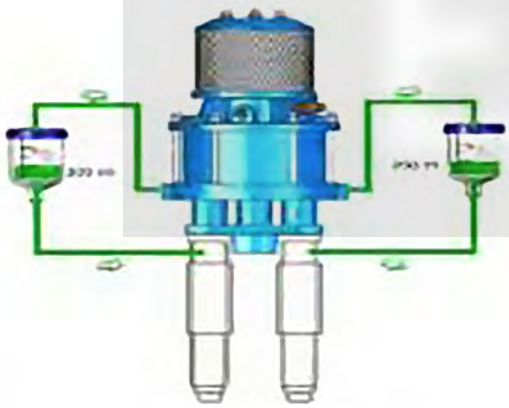
A powered hydraulic control unit operates the hydraulic pumps connected to the pumps for A and B.
The two volumetric pumps A and B, measure and heat the chemical products in order to create the necessary pressure for the spray.

Operation of Hydraulic Pump



7.2.2 Metering System

There are different technologies for metering systems with variable ratios:
Mechanical
Pneumatic or hydraulic metering systems can be modified in order to work with a different mixing ratio besides the standard 1:1.
The dosing pumps on these units can be modified to provide any desired ratio up to 10:1



Electric

An electronic variable ratio system:
Using two independent hydraulic circuits and a control system, the machine can achieve mixing ratios from 1:1 to 10:1.

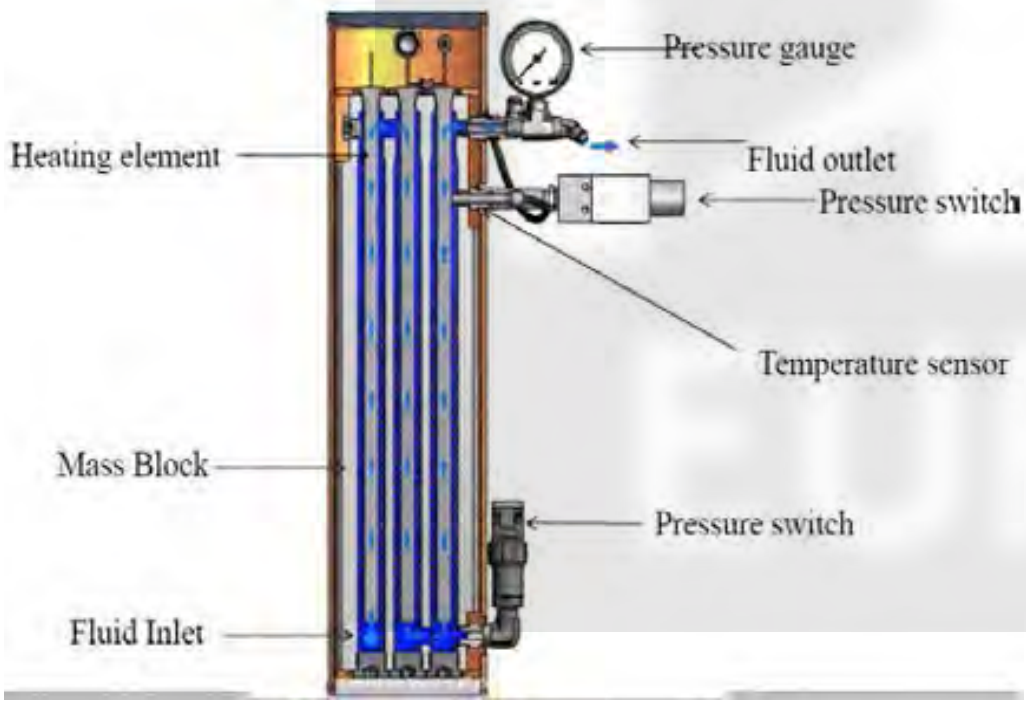
7.2.3 Heaters

The fluid heaters are a key element of the application. Heating is performed by specific electrical heaters according to the desired temperature which varies generally from 50 ° C to 80 ° C for polyureas.

They are different type of heaters, (Mass heater, Immersion Hybrid), depending of the manufacturer. All of these types work well, as long as the desired preset temperature can be reached, depending on output and the type of unit used.

The temperature of parts A and B must be maintained according to the instructions of the supplier of the materials.

For this purpose, diagrams may be issued setting out the viscosity on the basis of the temperatures of both part A and B, so that it is possible to determine the optimum temperature for the proper proportioning of the two components.



7.2.4 Heated Hoses

Heated hoses are needed in polyurea spray systems. Their function is to maintain the temperature reached by the internal heaters up to the end point where the gun is connected, further elevate the temperature and keep it constant.

The hoses are normally heated at low voltage and are equipped with a sensor that monitors the temperature of the two components.

The mixer generally carries out a series of temperature controls to enable the operator to monitor this important variable.

7.2.5 Spray guns

Because of the extremely short reaction time between the components A and B (a few seconds), a spray gun with specific mechanical characteristics is necessary in the application of polyurea.

It is important that the gun, in its internal geometry, allows the two fluids to meet immediately prior to their discharge from the nozzle.

There are different technologies available:

1. Air Purge Gun
2. Mechanical Purge Gun

7.2.6 Air purge guns

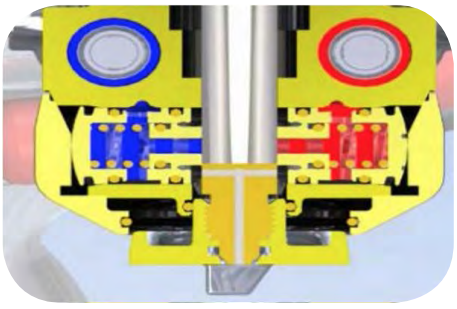
The air purge gun uses a mixing chamber in metal with 2 holes for the separate input of components A and B and an output from the mixing chamber.

A valve (side seal) is present at each inlet orifice of A and B and is used to open or close the flow of fluid accessing the mixing chamber.

When the gun is triggered, the two components A and B flow through the mixing chamber and the polyurea is sprayed onto the surface.

Gun Operation

When the gun is turned off, it stops the flow of fluids A and B and pressurized air passes through the orifices and cleans the mixing chamber.

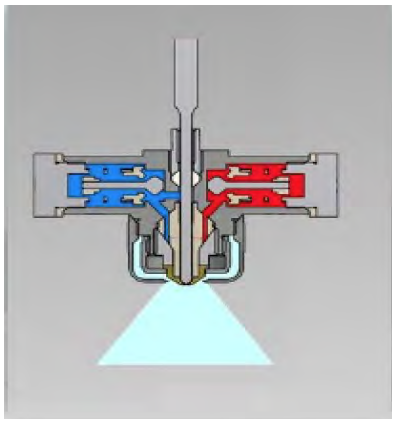


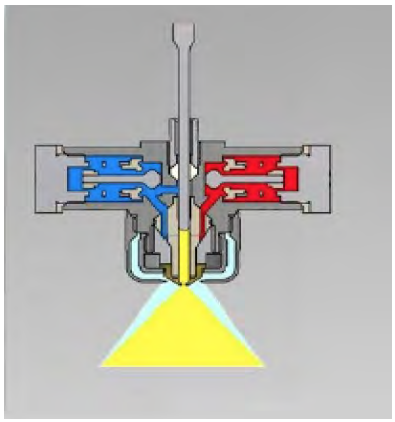
7.2.7 Mechanical purge guns

The mechanical purge guns have a mixing module and two orifices for the introduction of the two fluids A and B, plus an orifice that allows the exit of the already mixed two products to a spray nozzle.

A needle is used to mechanically open and close the two orifices of the mixing module. When the trigger is pressed, the two components A and B are mixed through the two orifices and the polyurea is sprayed on the outside.

When the trigger is released, the flow of the two fluids is stopped and the needle provides mechanical cleaning of the product inside the mixing module and spraying nozzle.





8. CONCLUSIONS

The application of polyurea requires a fine tuning of the complete system to meet the conditions of the specific chemicals.

- Supply system

- Dosage and heating units

- Heated hoses

- Spray gun

As well as:

- An electricity generator (when the network is not able to provide the necessary power to the system);

- An air compressor, essential for the functioning of the supply pumps and purging of the gun.

All components must be properly selected to meet the requirements of the desired applications regarding flow rate, temperature and pressure.

- Training is another key element for a successful application of polyurea:

- How to use the equipment provided by the manufacturer or distributor of dosage units.

- How to intervene in case of problems

- How to perform on-site maintenance.

- Training and practical tests.

9. GENERAL USE

Polyurea is obtained following the chemical reaction between the polyamine and the isocyanate at a temperature that can vary between 50° C and 80° C, a pressure of application between 150 and 200 bars and a mixing ratio by volume suitably variable according to the specifications of the manufacturer, but which generally occurs in the ratio of 1:1.

The pressure and temperature are two variables that must be carefully met in order to optimize the spraying and the reaction necessary to reach the final mechanical and chemical properties of the polyurea.

These products are generally supplied in standard 200 liter drums sealed to avoid contact with the air.

the drum of resin (component B) usually has a lid with the same diameter as the drum, while that of the isocyanate (component A) is totally closed with the exception of a 2 inch valve for the insertion of the pump and . inch nozzle for the insertion of the dehumidifying filter.

Pumps that transfer the product from the drums to the machine (for mixing) are mounted on both of them.

The drums can be both heated with the bands.

The polyamine/polyol (B) requires agitation in order to homogenize the internal pigments and at the same time reduce any extremes of viscosity.

The isocyanate (A) is extremely sensitive to moisture; therefore special attention is required when using it to avoid any contact with air. It is good practice to provide a system for reduction and control of moisture. This is generally accomplished through the use of a special filter with desiccant salts placed directly inside the drum cover.

Another important variable in the application phase, which must be suitably calculated according to the type of work done, is the flow rate. This usually varies between 3/4 liters per minute until reaching over 10 liters per minute to obtain greater thicknesses of polyurea per unit of time.

Therefore, the importance of a timely and proper management of all these applicative variables is obvious.

In order to withdraw the two fluids, then heat, pressure, transfer and mix them properly for long periods of time, there is a clear need to have properly configured specialized equipment, able to ensure the achievement and maintenance of the listed values, temperature, pressure and flow rate, regardless of conditions such as environmental temperature, relative air humidity, distance from the point of application, etc.

Summary

The application of polyurea requires a fine tuning of the complete system to meet the conditions of the specific chemicals.

Supply system

Dosage and heating units

Heated hoses

Spray gun

As well as:

An electricity generator (when the network is not able to provide the necessary power to the system);

An air compressor, essential for the functioning of the supply pumps and purging of the gun.

All components must be properly selected to meet the requirements of the desired applications regarding flow rate, temperature and pressure.

Training is another key element for a successful application of polyurea:

How to use the equipment provided by the manufacturer or distributor of dosage units.

How to intervene in case of problems.

How to perform on-site maintenance.

Training and practical tests.

10. DURABILITY

10.1 Surface finishing of the polyurea

Thanks to its mechanical resistance and resistance towards environmental aggressions, polyurea performs very well even without any surface coating.

However, one of the fundamental characteristics of aromatic polyurea is its poor resistance to ultraviolet radiation, which causes a marked yellowing of the surface, with consequent effects on any color used.

The change of color may be more or less visible, depending on the original hue, but it can be measured with a variation of E on the scale of yellow that can reach over 4.

To avoid any problems, when it is necessary to maintain color stability, the polyurea can be covered with an aliphatic polyurethane resin-based film in solvent to be absolutely stable under ultraviolet rays.

10.1.1 Top coat properties

The topcoat should have the following characteristics:, which are typically found in 2 component, solvent based color stable polyurethane

- Excellent adhesion onto polyurea, not less than 2 MPa according to ASTM D4541 (pull-off method)

- Elongation should be compatible with the polyurea being used.

- For trafficked areas, a good abrasions resistant product is highly recommended. Abrasion resistance: weight loss <80 mg according to the TABER ASTM D 4060 method.
- CS17 volume, weight of 1000 g, endurance 1000 rpm).

- Excellent stability to ultraviolet rays: And not exceeding 1 after 1500 E and not more than 1 after 1500 hours of QUV exposure according to ASTM G 53.

Topcoats used should tested for compatibility prior to use or application

10.1.2 Method of application

The application must be made at least 2 hours after the application of the polyurea coating and where possible, within 72 hours of it. In fact a good formulation will provide excellent adhesion even after the polyurea has aged a long time, provided it is suitably cleaned and de-dusted.

However, it is best to apply it as soon as possible and avoid having a surface that is dirty or similarly unsuitable. In any event, before the application, the surface has to be clean and free from dust or other foreign matter that may affect the adhesion of the coating.

Consideration will be given to the environmental conditions at the time of application: in fact, while the polyurea, being preheated upon application, can be applied at low temperature, the polyurethane finishing requires a substrate temperature of not less than 5° C. This is good practice for all two-component polyurethane solvent formulations.

In any case, the constraint that the substrate temperature is at least 3° C above the dew point must always be complied with, to prevent the formation of condensation (a constraint which also applies to the polyurea). The application can be performed with airless spray, roller or brush, if necessary with appropriate dilution. The recommended consumption is around 200 g/m. to obtain a dry DFT thickness of 60-80 µM.

The formula, in the indicated thickness, must be applied dust-free fairly quickly, within 1-2 hours, and be dry to the touch in 3 - 4 hours. A second coat can be applied the following day after application (16 hours at +20° C) and without any abrasion for at least 3 days. Normally only one coat is required, but a second may be required (e.g. for road markings).

Sometimes a non-slip finish is required. This can be obtained in two ways: when you apply two coats, give the first coat, while still wet, a sprinkle of quartz of the appropriate grain size, usually from 0.3 to 0.7 mm.

The next day, after hardening and aspiration of the hardly adhering quartz, the second layer of the formulation is applied in the same way. Alternatively you can add to the formulation, before application, a special anti-slip additive consisting of polypropylene beads or hollow glass beads in a ratio of 5-10% (obviously this depends on the characteristics of the additive employed).

This material, much lighter than quartz, remains in suspension during application and tends not to fall to the bottom of the container.
Obviously this treatment will not give such a good non-slip effect.

Always follow the recommendation of the supplier of material, when provided.

11. INSPECTION AND TESTING

8.1 Surface finishing of the polyurea

The end of this manual could not leave out the final phase of testing.

Any conclusion to the work typically has to include the following: verification of
- Contractual specifications

- **Thickness**

- **Adhesion to the substrate**

- **Construction details**

- **Mechanical properties of the polyurea, by means of testing a sprayed free-film sample**

- **Stratigraphy of the applications**

- **Any leakage tests, where there are tanks or other containers**

This report must be the only final document regarding the conclusion of the work and must be countersigned by the parties concerned.

The guarantees may be those under Civil Code 1667, or if it exceeds two years, Civil Code 1669, for the italian market.

Ten year insurance cover is increasingly required for defects in the installation or products.

For this type of guarantee it is essential that there is a third party acting between the Contractor and the Contracting Party. This body will confirm and certify the compliance and aptitude of the Contractor and of the supplier of the materials.

Their certification will make it possible to obtain cover from a suitable insurance company.

Quality Control Daily Report Log

Date		Applicator	
Project Description			

1. Environmental Conditions:

Time of day	Air temperature °C	Relative humidity	Wind velocity	Substrate temperature °C	Substrate moisture	Dew point

Description of general weather conditions	

2. Substrate Preparation

Substrate		Square meters	
Equipment		Air pressure	
Surface preparation standard			
Surface profile			
General comments			

Adhesion testing	Method used		
Adhesion test unit		Adhesive	
Value (MPa)	Failure modo / comments		

5. General comments / remarks

6. General drawing / layout

Version 0611

Adhesion testing	Method used		
Adhesion test unit		Adhesive	
Value (MPa)	Failure modo / comments		

5. General comments / remarks

6. General drawing / layout

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