Polyurea, waterproofing system at the Huntsman site : seven years later

In 2010, Huntsman refurbished the roof on one of the site buildings located in their European Head Quarters in Everberg (Belgium).
It was decided to install a green roof based on Vydro® foam technology and to use polyurea as a fast setting seamless membrane securing the water tightness of the whole system without the need to remove the existing 20 year old and worn bitumen layer.

Execution of the project in a nutshell (2010)

The old bitumen slabs (fig. 1) had to be repaired at some spots due to blisters, cracks and delamination at the seams. The roof was thoroughly cleaned by water jetting and critical details (drainage holes, safety anchors, seams,….) were primed with a 2K-epoxy by roller or brush.
After the surface preparation, polyurea (fig. 2) was hot spray applied at a dry layer thickness of 4 mm in one go, spraying vertical walls and existing bitumen seams first.


Fig.1


Fig.2

Shortly thereafter, a black root resistant PE foil was rolled out over the polyurea followed by a 40 mm thick light weight Vydro® foam matt (fig .3) needed for a proper water management of the future vegetation. Lava stones (fig. 4) with different particle size were distributed across the Vydro® foam at a layer thickness up to 40 mm followed by sedum and planting grasses (fig 5).


Fig.3


Fig.4


Fig.5

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All of the work, covering more than 600 m², was successfully completed in just three days (fig 6).

Fig.6

Polyurea

Polyurea is the reaction product of an isocyanate with amine terminated polyethers and amine chain extenders. It is the exothermic quick reaction of the isocyanate with the amines that provides a fast cure (ranging from a few seconds to several minutes), a low temperature cure ability (<0 °C) and a high film buildup of 100% solids.
The advantages of this technology are: a seamless and jointless film application, quick turnaround time for detailing, the possibility to formulate solvent free, a high elongation, an excellent impact resistant coating / membrane and a fast return into service.

The aromatic polyurea specifications are:

Properties	
Color	*RAL 1002*
Degree of gloss	*Mat finish*
Volume ratio ISO / amine	1 / 1
Cure time	few seconds
Volatile organic compound in g/l	0
Elongation in %	350
Tear strength in N/mm	70
Tensile strength in MPa	20
Water vapour permeability	**10 mg/m² per day**

Source: Technical data sheet (2010)

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Processing of polyurea requires high pressure/ high temperature impingement mix equipment. The capability of heating the components prior to mixing is a key attribute of the spray equipment, as heating of the materials before spraying is necessary to reduce system viscosity. Viscosity reduction improves the mix, flow, and leveling of the applied material and leads to significant improvements in the performance and appearance of polyurea. To ensure proper mixing, a high-pressure proportioner and a spray gun are essential.

Weathering

Degradation of polyurea can manifest itself, like with other materials (plastic, coatings,….) in various ways depending on the way of exposure, the used raw materials and the product end use. Day light may lead to discoloration, loss of gloss, chalking and embrittlement. Moisture may cause blistering and loss in adhesion. Heat and oxygen can lead to embrittlement, flaking and cracking. All these elements contribute individually as well as in combination to a decrease in physical and aesthetical properties over time.

Accelerated weathering is often used to predict the life time of a given system. This test has the advantage of getting results within a few weeks rather than years when performing outdoor tests. Accelerated weathering is however still a prediction as there is no precise correlation with natural weathering. Accelerated weathering comes at its best when comparing systems one to another during product developments, for quality control and material certification.
Outdoor test results are the real deal but care needs to be taken when comparing test data. For a certain test site, weathering conditions vary year over year. The test site location plays an important role as well. Exposure testing at the coast provides more harsh conditions than inland. The climate in Spain is completely different than for example in Norway.
The Everberg site is situated in Western Europe, has a temperate maritime climate and is located in a rural area near a forest. Mid 2017, our technical team decided to evaluate the polyurea after an outdoor exposure of 7 years. Easier said than done though, as they had to mount on to the roof and try to cut out the required test specimen.

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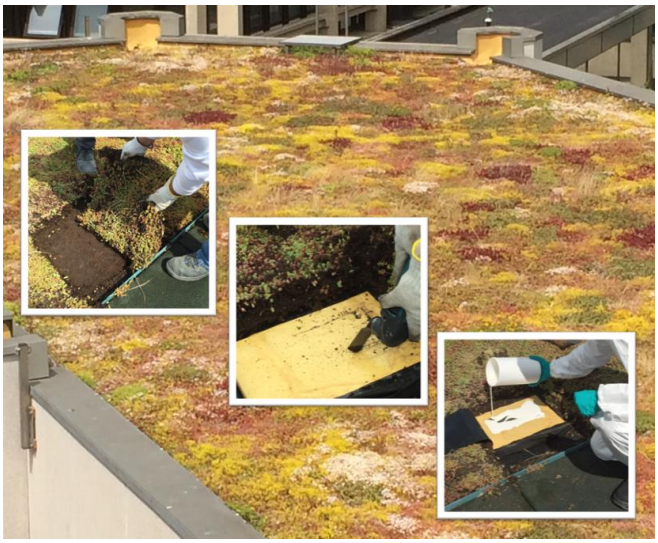
Stand the test of time : sampling

A small part of the polyurea membrane was cut out on the green roof after removal of plants and subsequent layers. The damaged area was directly repaired by using a cold-applicable polyurea with a cure time of about 7 minutes, giving the team enough time to mix the isocyanate and the amine blend on site, to pour it out and seal it again with the root resistant PE foil (see fig 7.)
Another polyurea sample was taken on an upper area of the roof (fig 8.) which is not a part of the green roof. The polyurea functions as a roof coating having direct weather exposure. Inspection of this roof coating revealed no defects like blisters or adhesion loss except for one single crack of 10 centimeters.



Stand the test of time : data

Three polyurea specimen were evaluated on their properties at the Huntsman lab facilities. One of the roof coating (upper area), the membrane (green roof) and a seven year old polyurea reference slab sprayed at that time of application and stored in the lab for seven years.
The outdoor specimens were carefully and thoroughly cleaned to remove all of the bitumen and dirt. All samples were conditioned during 7 days at 21 degrees Celsius and at a relative humidity of 50% prior physical testing.

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Properties	Lab (reference)	Roof coating (UV exposed)	Green roof membrane (not UV exposed)
Elongation, %	368	340	351
Tear strength, N/mm	85	79	78
Tensile strength, MPa	26	20	21
Shore D after 10 s	47	48	48
Abrasion H18, 1000 cycles, mg	**90**	**350**	**155**

Compared to the reference slab, there is a reduction of physical properties except for the shore D hardness. Elongation and tear strength properties went down with maximum 10%.
Tensile strength reduced on average with 22%. Although not subjected to wear and tear, the team evaluated the taber abrasion as well. Weight loss is higher with the roof coating due to the daily exposure of the coating surface to the destructive UV-rays.

To conclude, we at Huntsman are very pleased with the performance of the polyurea water proofing system year to date and are looking forward to our next sampling exercise within 7 years.

Huntsman has continued development of SUPRASEC® isocyanates and JEFFAMINES® amines to enable formulators to fine-tune polyurea systems to fulfill the needs of applications even far beyond roofing membranes e.g. park-decks, secondary containment, tunneling, trunk-liners, piping, etc.
Leveraging the excellent properties and fast curing inherent to the polyurea technology, many other demanding application will be able to benefit of a proven long lasting performance… just like our green-roof.

This paper was presented by Stijn Roekaerts, Team leader Technical Service Coatings, Adhesives & Specialities, at the annual Polyurea Development Association conference held in London, November 13-15, 2017.

About the author : Steven Buvens graduated as industrial engineer chemistry in 1991 and worked for 19 years as R&D paint formulator for several Belgian coating companies in the industrial and decorative sector. In 2012, he joined the Huntsman Performance Products division (HPP) and provides technical support for amines used in CASE and polyurea applications.

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