

# Longevity of Uretek Resins

Dr ir Allard van der Wal,

*R&D manager Baysystems BV, Foxhol, The Netherlands*

**Summary** Based on experience of polyurethanes in general and Uretek Resin in particular in combination with accelerated ageing testing regarding chemical, mechanical and biological degradation, it was concluded that the longevity of the Uretek Resins will be at least 60 years.

## 1. Introduction

With the Uretek method heavy structures can be lifted and stabilized and the bearing capacity of the supporting soil can be improved, by using the expanding force of a two component polyurethane rigid high density foam [1,2].

Polyurethanes are known and applied since the second world war, mainly as an insulation material for the construction industry but also for refrigerators. Polyurethanes are also being used in the car interiors and for mattresses [3].

The Uretek Resins are the result of a more than 30 years continuous development between Uretek and Baysystems. Like all construction materials polyurethane can degrade and lose its properties. For concrete carbonization is a well known phenomenon, metals are susceptible for corrosion and wood can rot. Based on experience the lifetime of the polyurethanes for insulation purposes is expected to be at least 50 years [3], polyurethanes have been applied as grouting materials since the last 30 years [4].

## 2. Literature overview

The degradation of polyurethane has extensively been studied [4-11, 14]; by burial [7] tests and by accelerated aging testing [14]. With the latter the following degradation mechanisms were distinguished: mechanical (creep and fatigue), thermal, chemical and radioactive and biological degradation. The long term durability of grouts has been researched via accelerated ageing tests. Credible work has been done by the Swedish National Testing Institute [8]. Accelerated ageing tests by Naudts [4, 9] revealed that in

highly acidic environments polyurethane is anticipated not to break down more than 10% over a 100 year time period. In an alkaline environment (such as in concrete or in limestone formations), a weight loss of 35% has been projected over a 45 year period because of hydrolytic degradation of the cured polyurethane. Soils grouted with polyurethane, according to Takenaka [10] and research work by Oshita, et al. [11], do not display signs of long-term degradation.

Also, a comprehensive performance testing program was conducted for Bechtel Jacobs LLC (BJC) by the Argonne National Laboratory (ANL) to BJC/OR-2725/R1 determined the aging behavior of PU for Infiltrating Contaminated Process Gas Equipment (PGE)

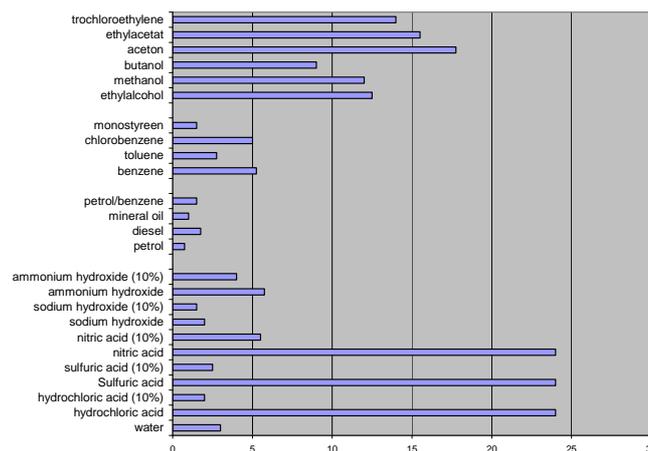
and Piping [14]. The study included aging effects due to mechanical stresses, heat, moisture, temperature cycling, biodegradation, and radiation exposure. The study and tests concluded that the foam integrity is maintained over more than 1000 years under landfill conditions and is suitable for use as void filler.

### 3. Experimental

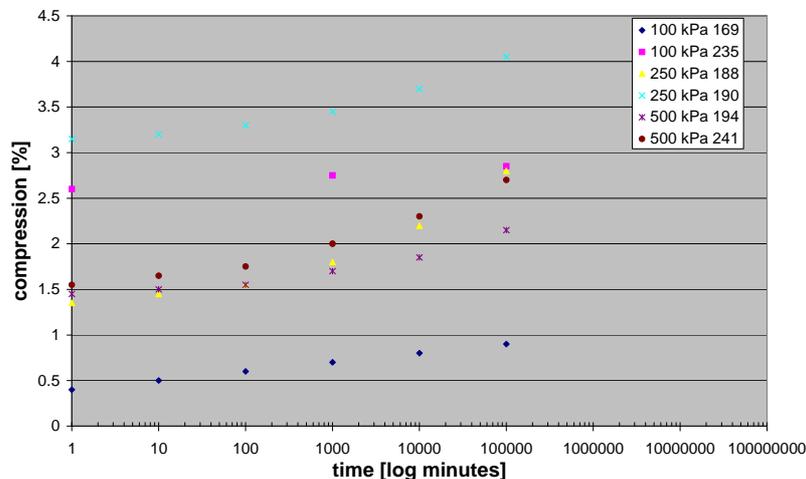
The longevity of the Uretek Resin has also been studied by a 4 years burial test and by accelerated ageing tests.

Chemical degradation was tested according to DIN 53428. Creep was tested according EN1606 by the Delft University [15]. Biological degradation was tested bij Wageningen University according to ASTM G21-76 and G22-76. 4 years burial test: the material was injected below a foundation in a clay soil below the water level [12]. After 4 years the sample were excavated and the properties were determined.

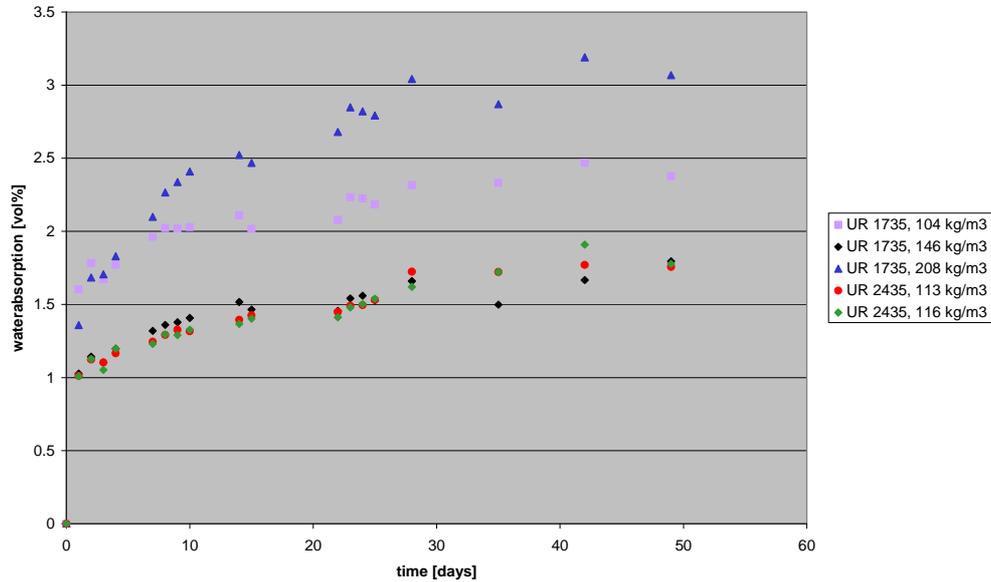
### 4. Results



**Figure 1:** the chemical resistance of the polyurethane resins tested according to DIN 53428 (28 days immersion test). Resistance < 3%: excellent, < 6%: good



**Figure 2:** Creep behavior according to EN1606, at different densities [169 – 241 kg/m<sup>3</sup>] at different stresses [100 – 500 kPa].



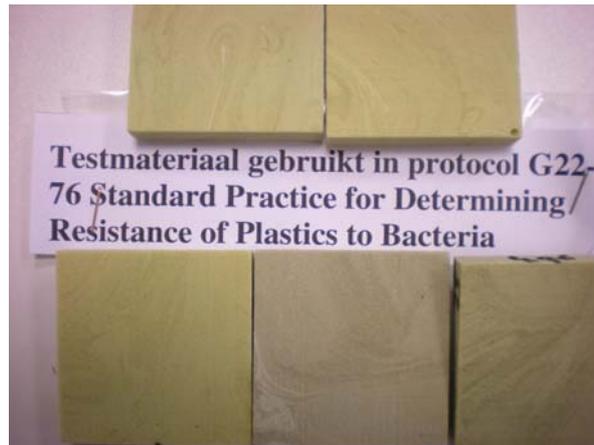
**Figure 3:** Waterabsorbtion according to DIN 53428, for different systems [ Uretek Resin 1735 and Uretek Resin 2435] at different densities [104 – 208 kg/m<sup>3</sup>], full immersion test.

system	density [kg/m <sup>3</sup> ]	Waterabsorption [wt%]	comp. Strength before [kPa]	comp. Strength after [kPa]
1735	104	22,3	890	892
	146	11,4	1661	1788
	208,2	14,6	3514	3485
2435	113	15,3	1268	1176
	116	14	1442	1207

**Tabel 1:** Effect of water absorbtion on the compressive strength, for different systems [Uretek Resin 1735 and Uretek Resin 2435] at different densities [104 – 208 kg/m<sup>3</sup>].

Density		Kg/m <sup>3</sup>	300
Compressive strength			
Parallel	wet	kPa	984
	dry	kPa	971
Perpendicular	wet	kPa	490
	dry	kPa	438

**Tabel 2:** Results from the 4 years burial test. Samples from 2 meters below the foundation.



**Figure 4:** Samples after being exposed to bacteria according to ASTM G22-76.

From the obtained results it is concluded that the test material (Uretek Resin 2409/Uretek Hardener) is resistant to bacteria and fungi as determined according to ASTM Standard Practices G21-96 and G22-76 with respect to:

- visual observation of bacterial and fungal growth,
- compression behaviour measured according to EN 826.

#### 4. Discussion and Conclusion

At stress levels of 25% of the compressive strength the creep is insignificant. Water absorption is taking place. However this is not giving a significant loss of mechanical properties. No deterioration by bacteria and fungi could be observed. The 4 years burial test did not show any loss of properties.

Life time testing and accelerated ageing testing on polyurethane suggest a lifetime of polyurethane longer than the 60 years building lifetime. The Uretek method has been in use since the mid 1970's. From these experiences we can state a lifetime of at least 35 years. The accelerated aging test didn't show any significant loss of properties. Based on these results we expect that the life time of the Uretek Resins will exceed 60 years.

## 5. References

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All information in this report is based on our practical experience and reliable laboratory evaluations. Nevertheless, we cannot accept any responsibility for its utilisation because the circumstances under which the products are stored, handled and used are beyond our control. For further information and advice please contact our technical staff.

The values of the foam properties are to be interpreted as a guideline. The on-site conditions may influence the results.