

Pushing the limits of plasticisers in outdoor applications

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Technical Marketing Plasticizers

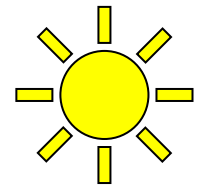
Cologne, 25.02.2020

Outline

- Limitation Number 1: Hydrolysis of Plasticizers
 - Polymeric Plasticizers in outdoors: Combined exposure of heat and humidity

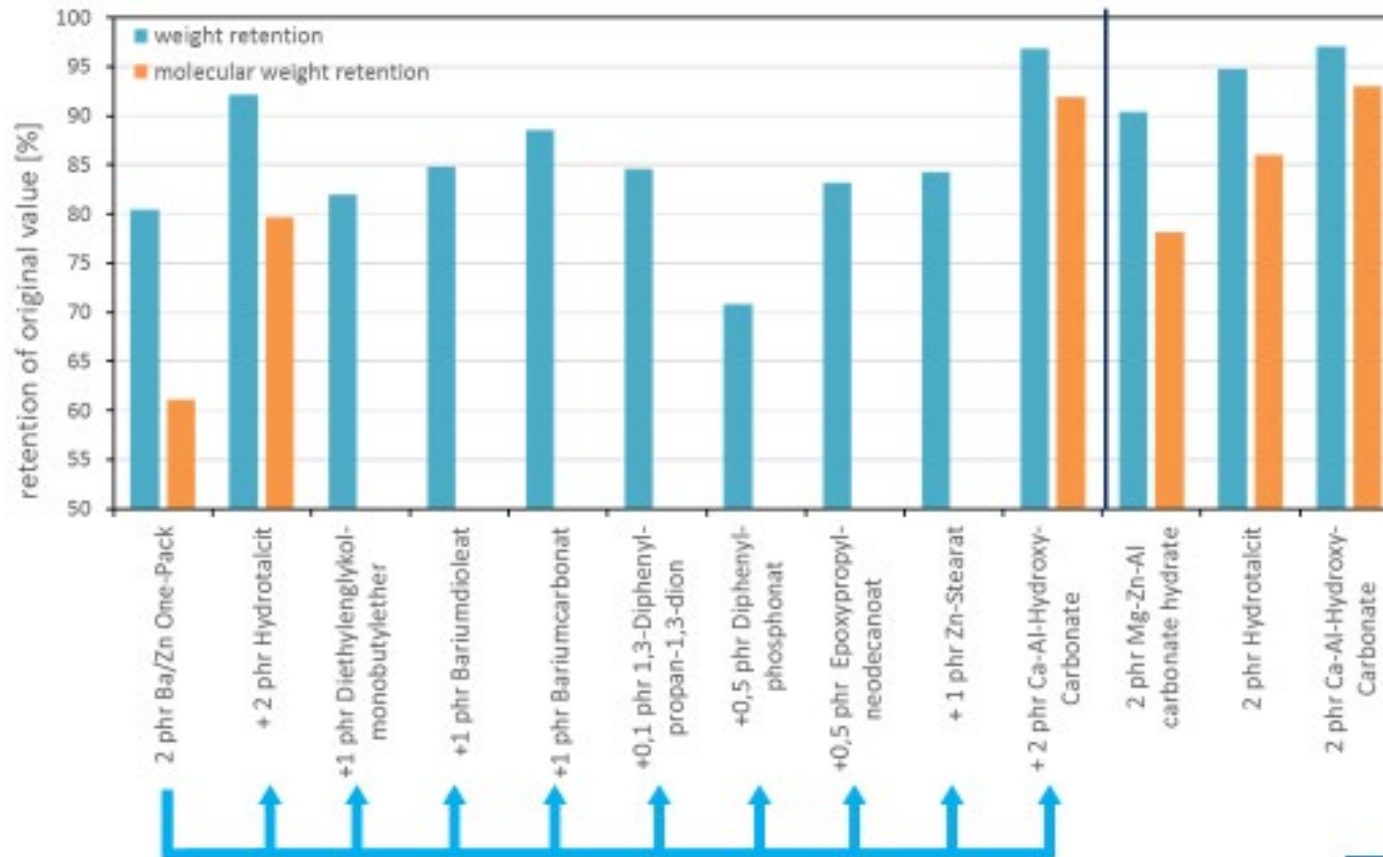


- Limitation Number 2: Weathering of Flexible PVC
 - Why is it so important to have the correct testing protocol?



1. Polymeric Plasticizers in outdoors

At PVC-Formulation 2018: Right choice of stabilizer improves hydrolytic stability



100 phr Palamol® 638 in Solvin® 2715P with 2 phr of Ba/Zn one-pack stabilizer as base formulation, after 28 days of tropical test at 70°C/100 % rel. humidity

24 11.04.2018 Improvements of long-term Stability of plasticised PVC, AMI Conference "PVC-Formulation", 11. April 2018



1. Polymeric Plasticizers in outdoors

Applications and performance loss

Use of polymeric plasticizers in hot and/or humid environment



Roofing membranes



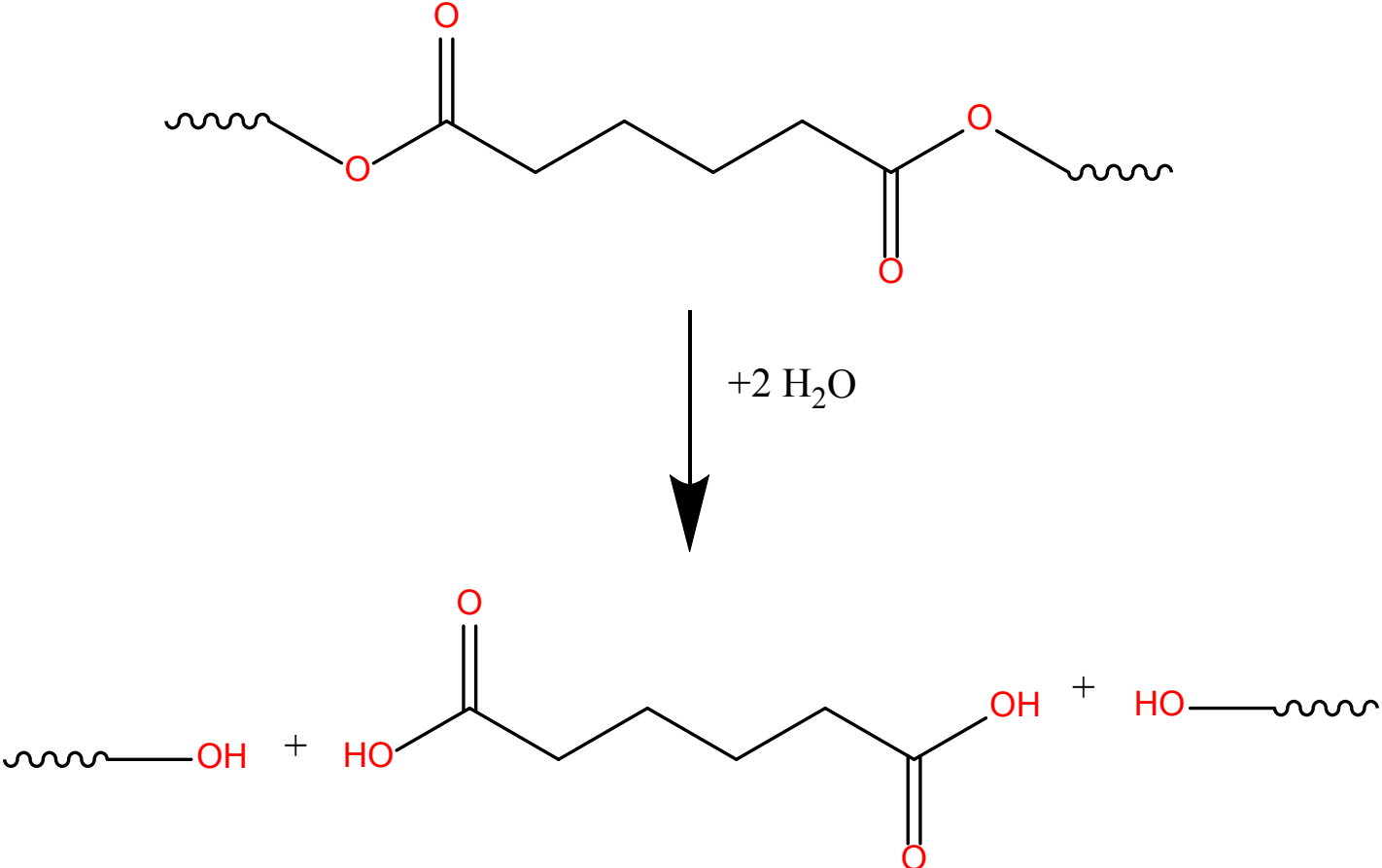
Fuel hoses



Self-adhesive film

1. Polymeric Plasticizers in outdoors

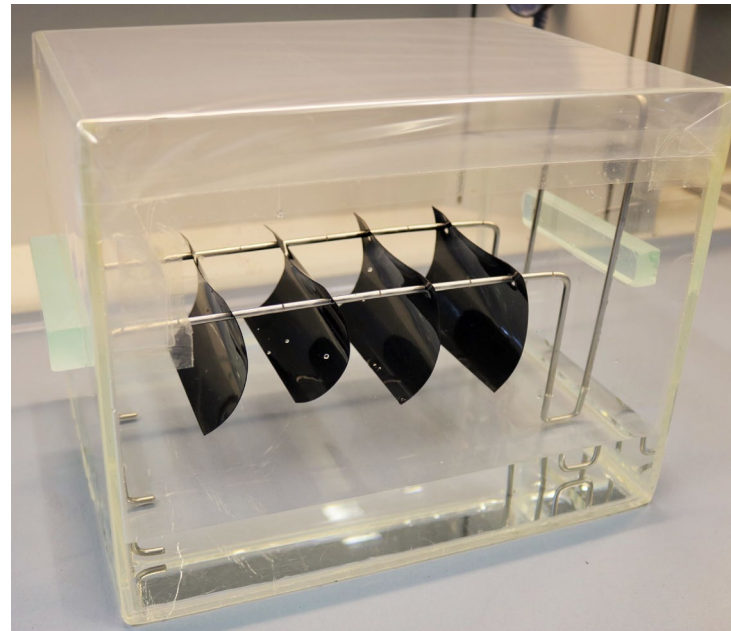
Hydrolysis of polymeric plasticizers leads to chain scission and molecular weight reduction



1. Polymeric Plasticizers in outdoors

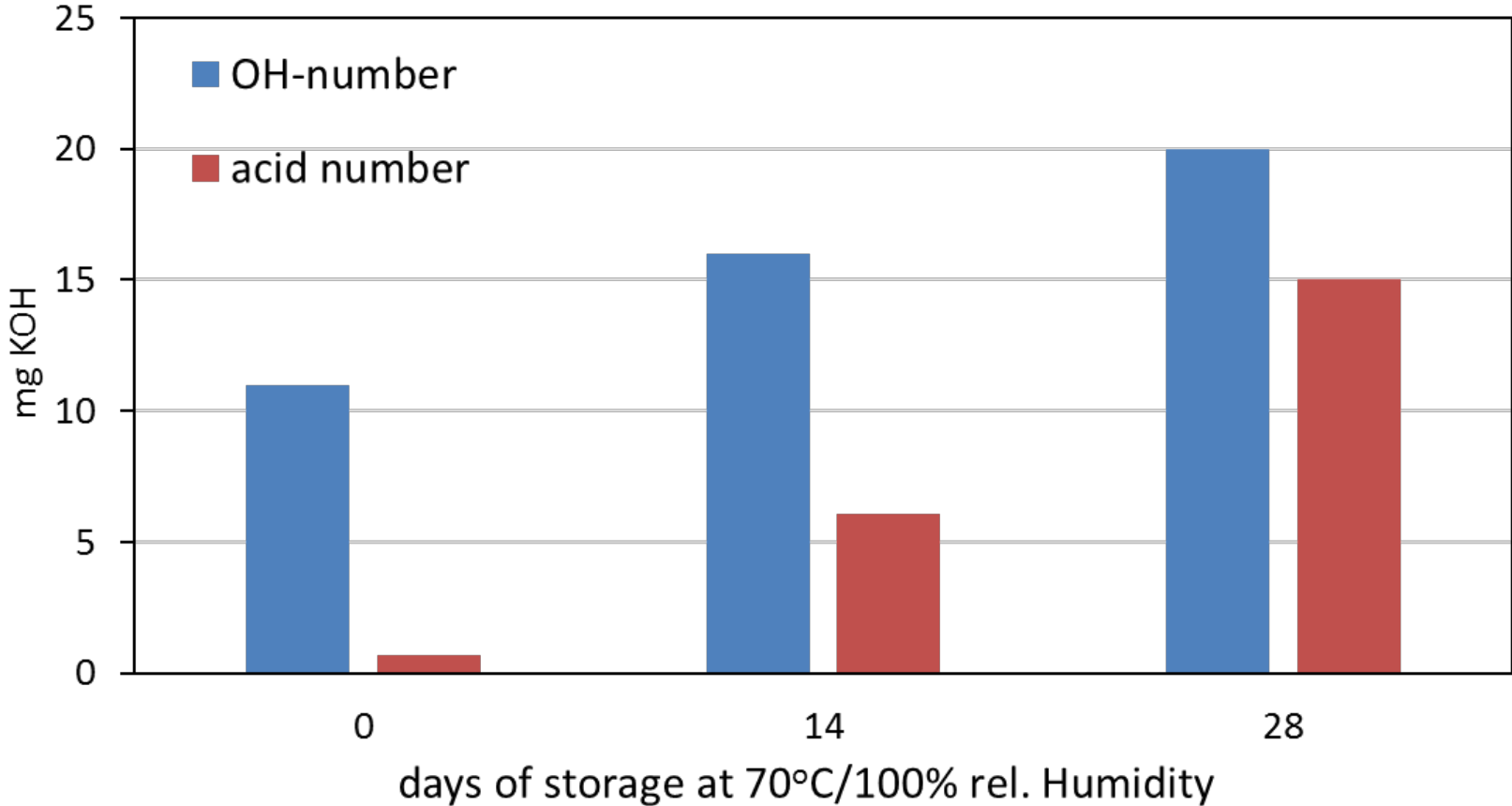
How is the test performed?

- p-PVC film, 0.5 mm thick, size 75 x 110 mm.
- 10 samples, one metal rack and one glass tank per test formulation.
- Exposed for 1, 3, 7, 14, and 28 days in water vapor at 70°C, sealed glass tanks.
- Weight loss after drying, average of two samples.



1. Polymeric Plasticizers in outdoors

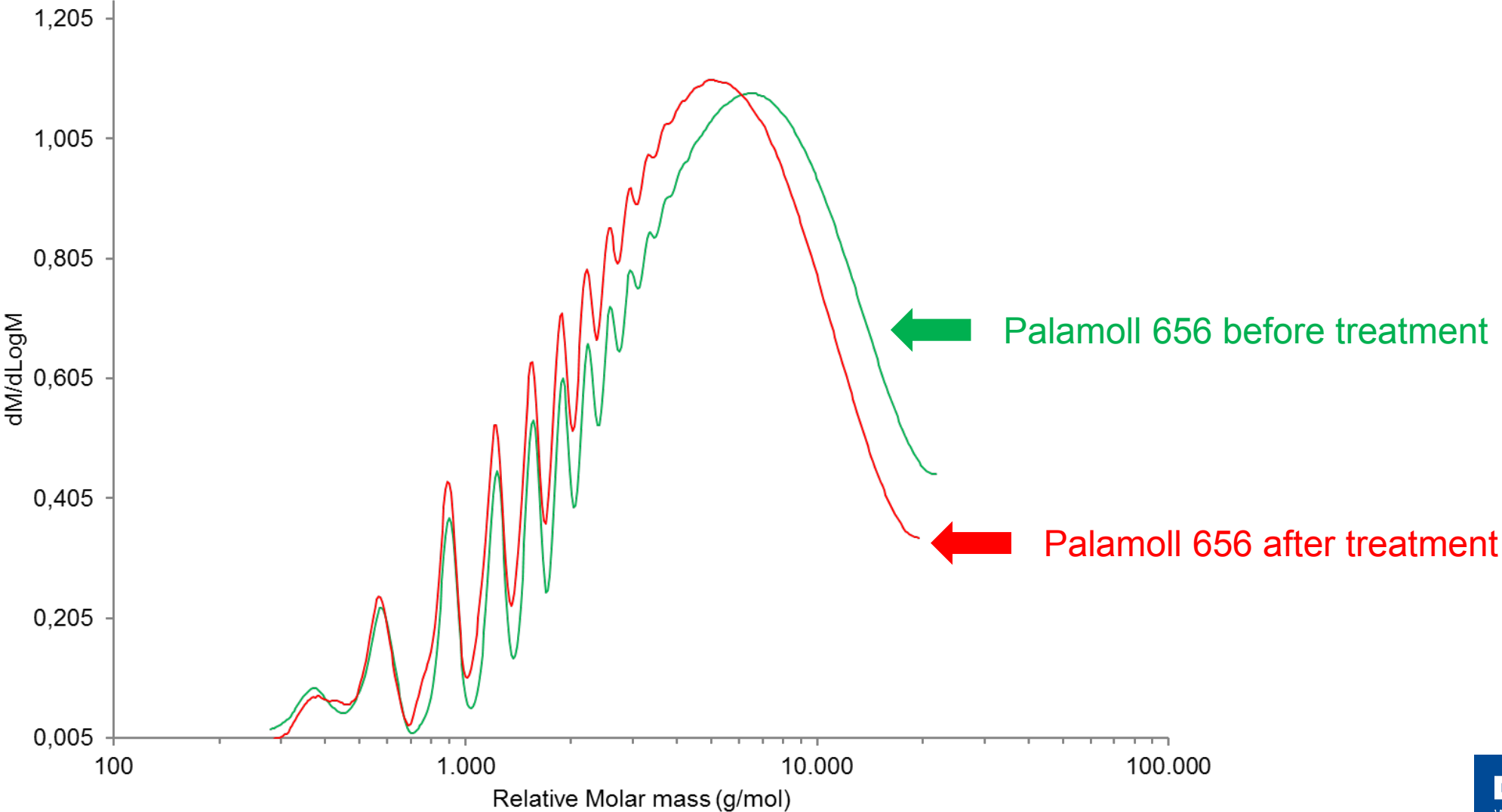
Strong increase of OH- and COOH-end groups prove hydrolysis of polymeric plasticizer



Formulation:
100 phr Inovyn PVC 271PC,
100 phr Palamoll 638
2 phr Reagens 781/SLX

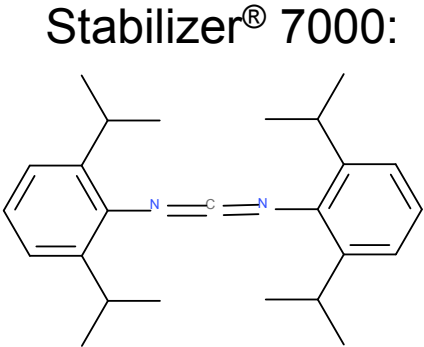
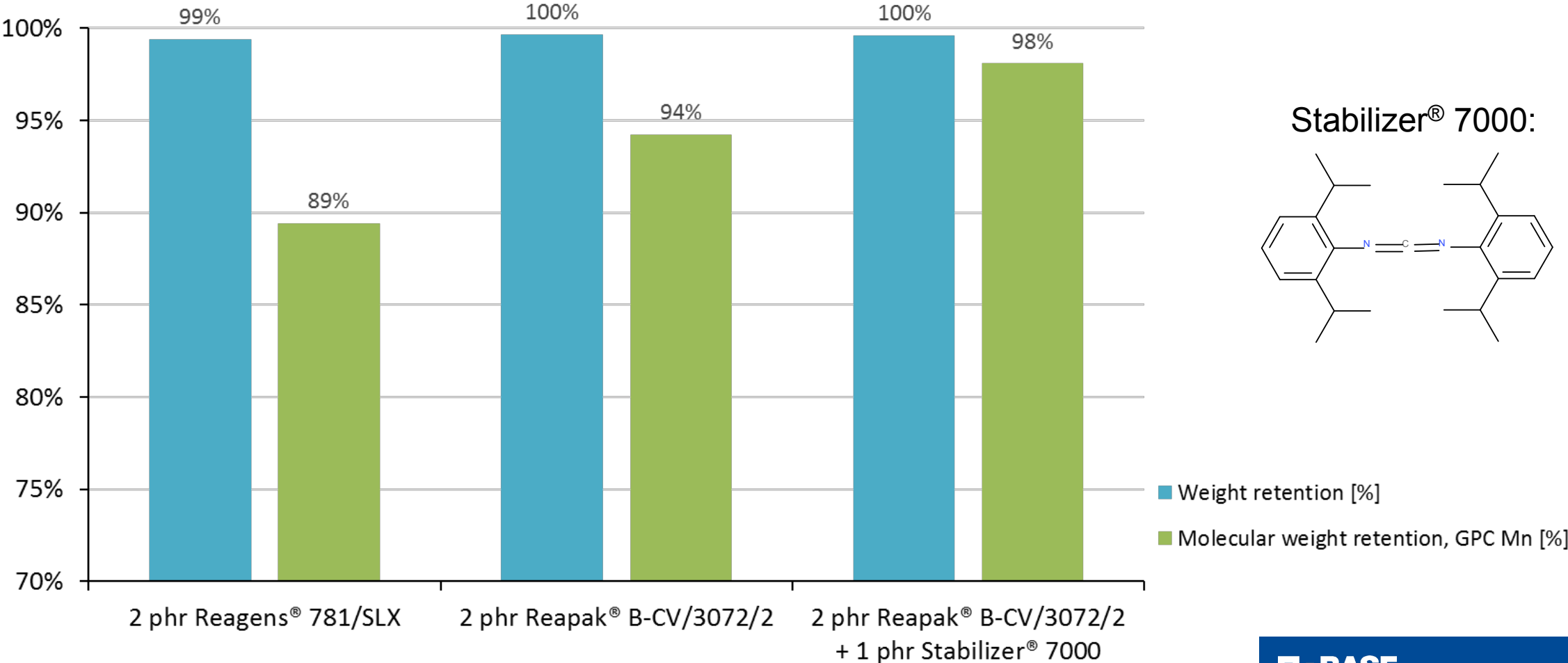
1. Polymeric Plasticizers in outdoors

Gel Permeation Chromatography (GPC) is a powerful tool to measure polymer degradation



1. Polymeric Plasticizers in outdoors

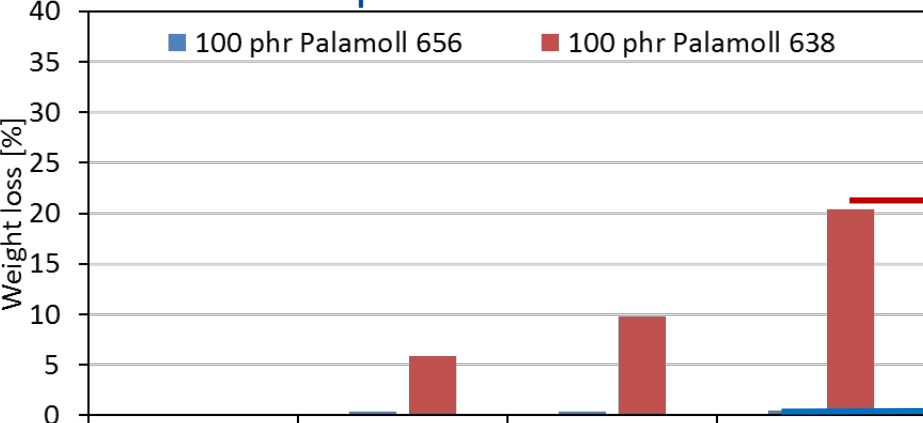
100 phr Palamoll® 656 after 28 days @ 70°C/100 % rel. Humidity:
 Carbodiimides improve Hydrolytic Stability



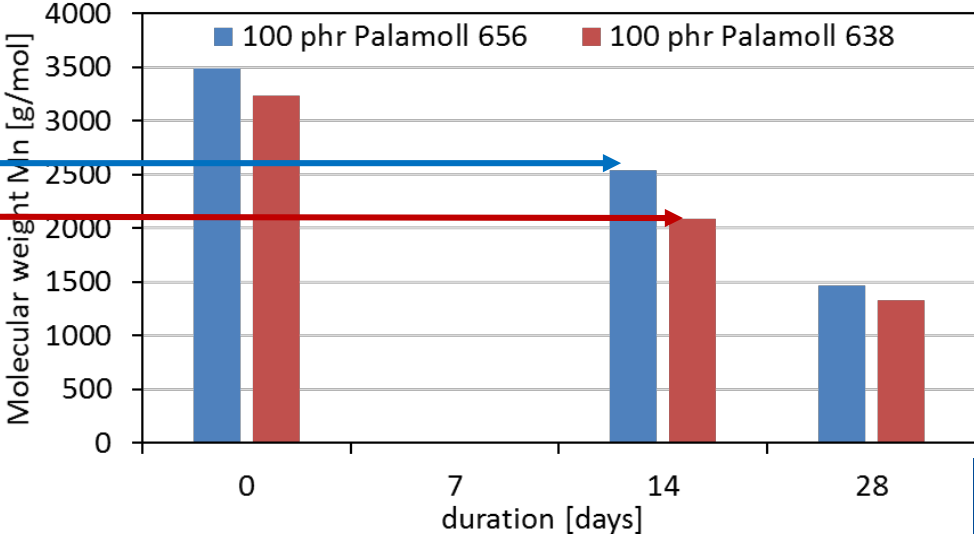
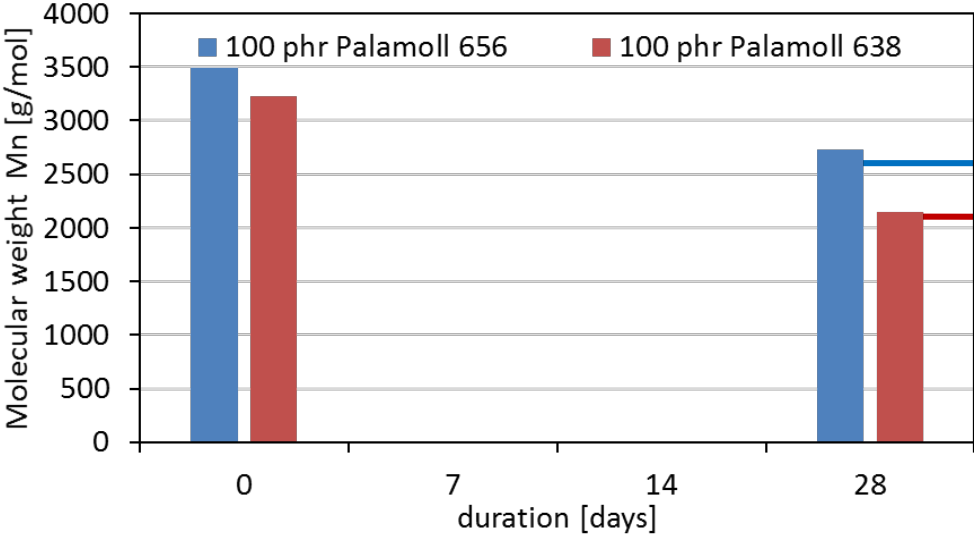
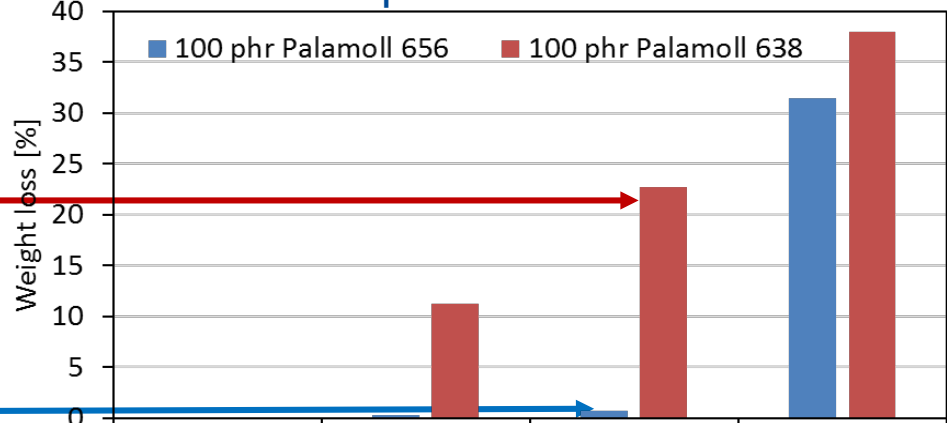
1. Polymeric Plasticizers in outdoors

Hydrolysis is thermodynamically controlled and follows Arrhenius law:
 Increase by 10°C doubles the rate of hydrolysis

Tropical test at 70°C

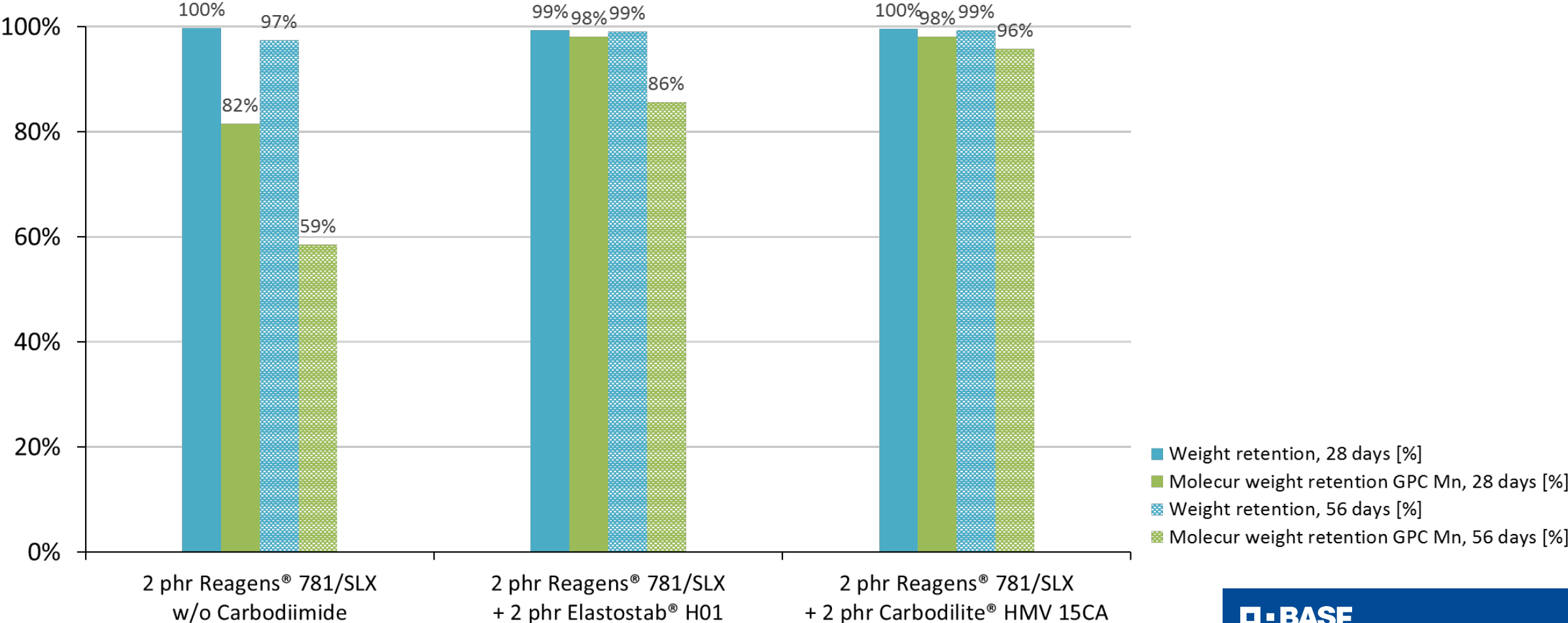


Tropical test at 80°C



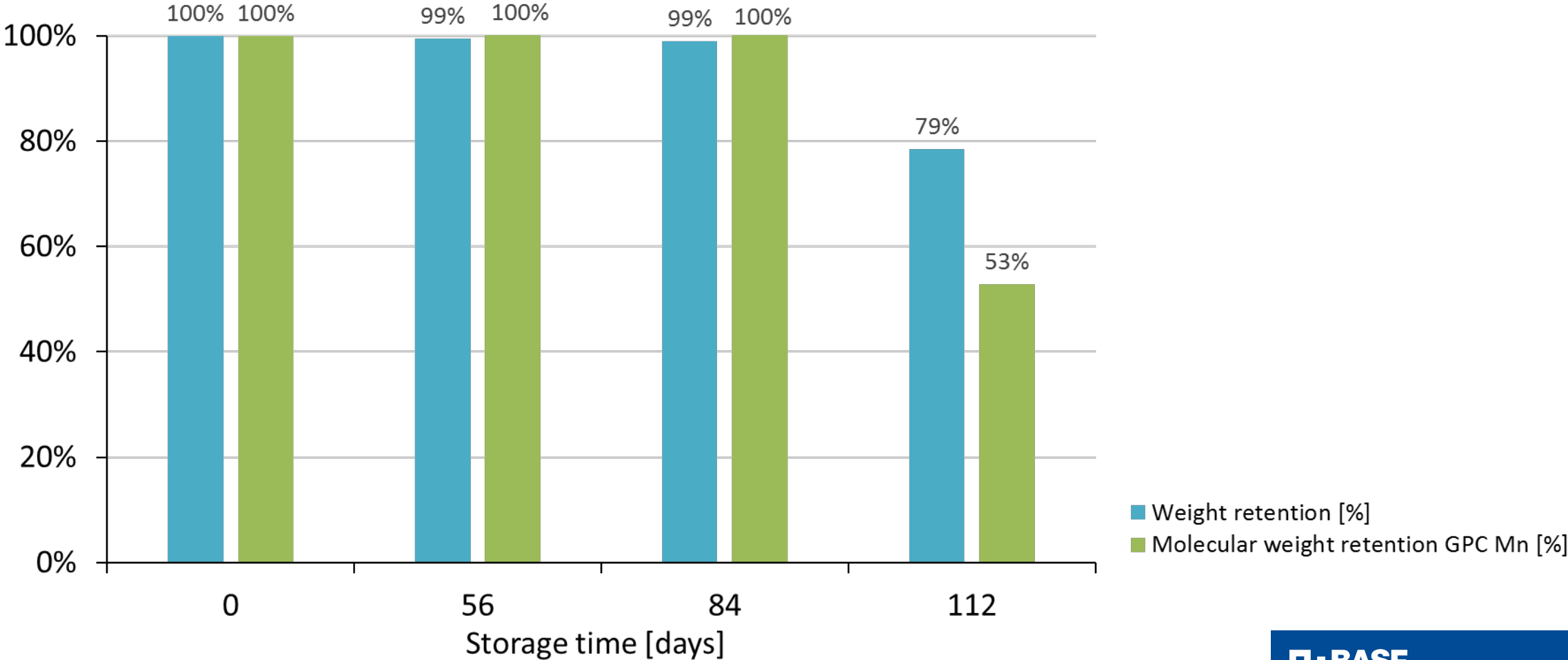
1. Polymeric Plasticizers in outdoors

100 phr Palamoll® 656 after 28/56 days @ 80°C/100 % rel. Humidity:
 Aliphatic Carbodiimides improve Hydrolytic Stability by factor of 4



1. Polymeric Plasticizers in outdoors

80 phr Palamoll® 656 after 112 days @ 80°C/100 % rel. Humidity:
Elastostab® H01 improves Hydrolytic Stability by factor of 6-8



2. Weathering of Flexible PVC

Why is it so important to have the correct testing protocol?

Goal of weathering testing:

Predicting the performance of your material in the real world by accelerating it to the outmost

Real behavior



Duration: 15-20 Years



Outdoor weathering testing
e.g. Florida or Arizona



Duration: usually 3 Years



accelerated weathering testing
e.g. QUV-A or Xenon-Weathering



Duration: usually 3000-6000 hrs.
(equal to less than 1 year)

Source: Q-Lab
www.Q-Lab.com

In all testing very important:
Use the correct protocol to have the same failure mode as in real life

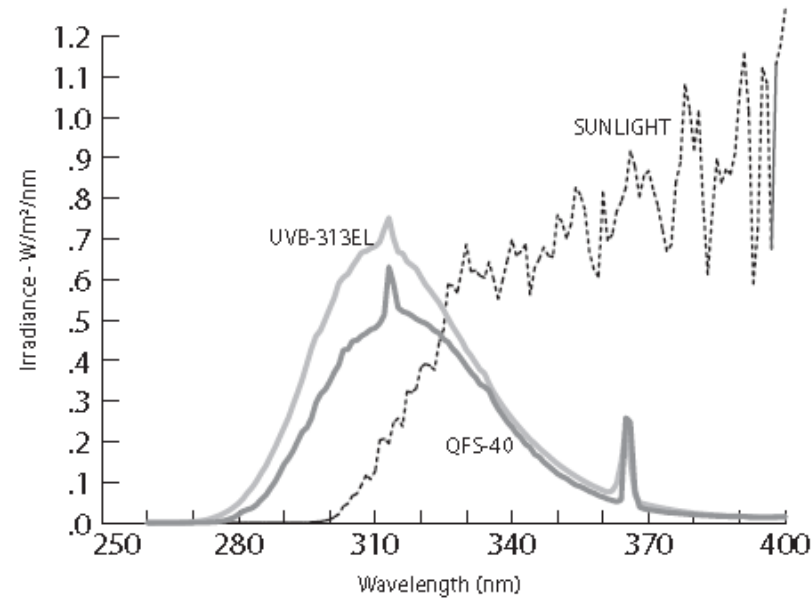
2. Weathering of Flexible PVC

Two different QUV-test protocols exist

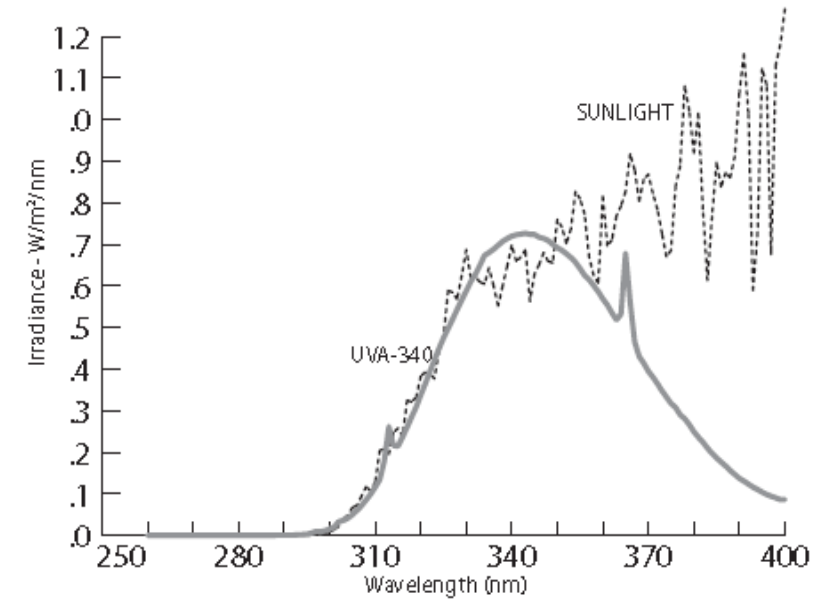


Source: Q-Lab
www.Q-Lab.com

UVB Lamps vs. Sunlight



UVA-340 Lamps vs. Sunlight



Quote (J.L. Gerlock, engineer with Ford Motor Company):
UVB-Exposure is suitable to test the weathering behavior of a Ford Taurus in a low orbit in space.

2. Weathering of Flexible PVC

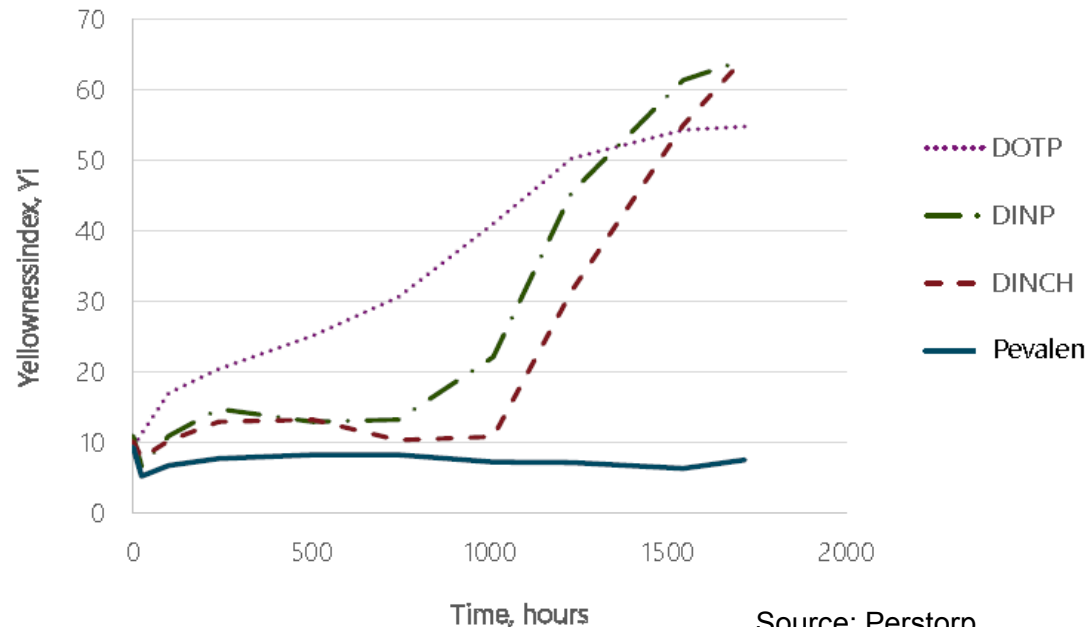
Failure of reporting the correct test protocol results in misleading conclusions

UV stability

Product advantages

Pevalen™ is unaffected by QUV environment
→ Material will maintain it's properties over time

Yellowness Index

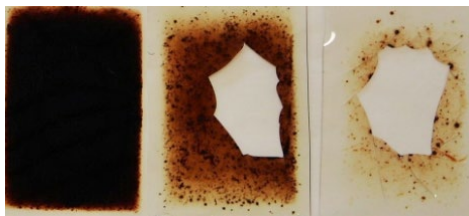
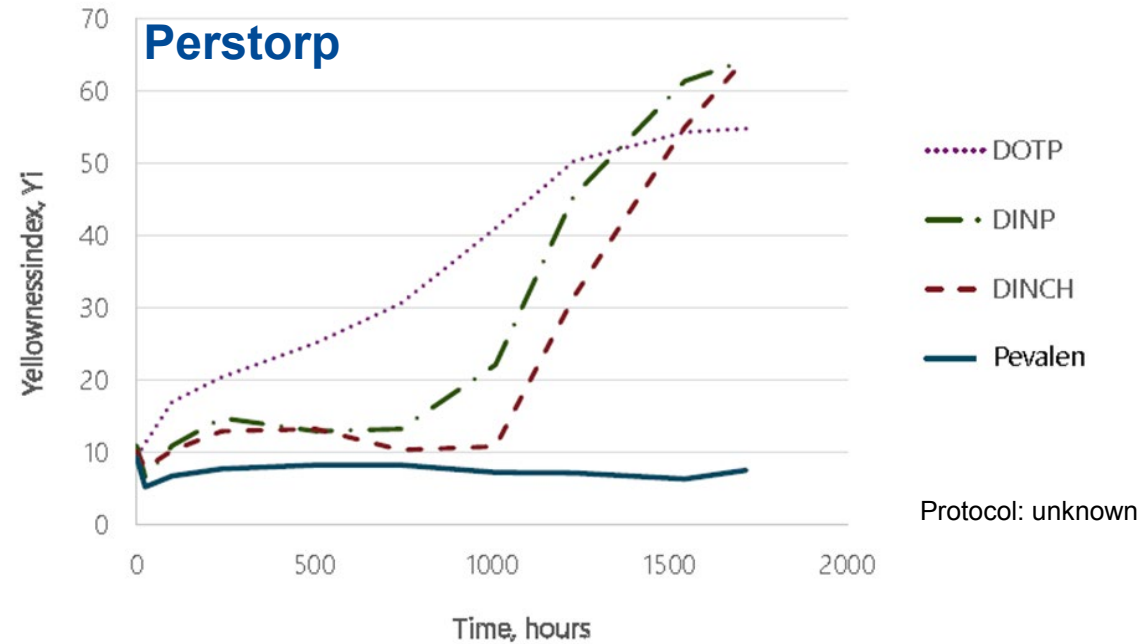
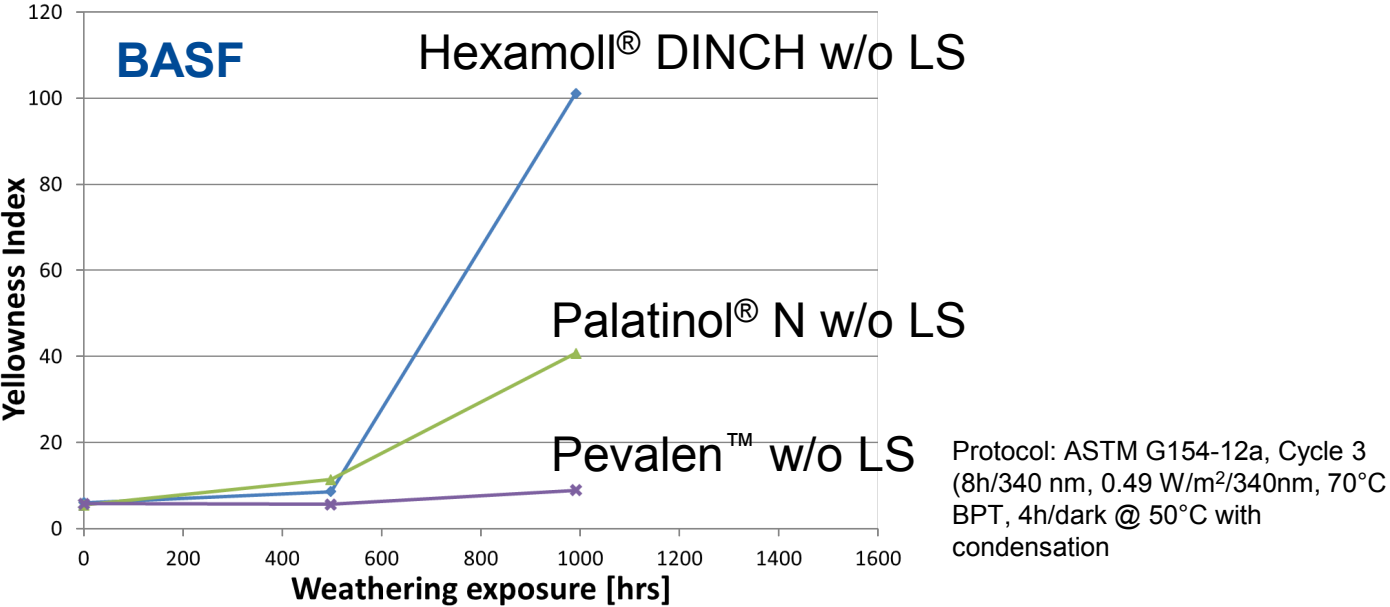


Source: Perstorp

- Picture source: Perstorp Presentation, April 2019, PVC-Formulation in Cologne
- What kind of QUV Light has been used?
- What exact test protocol has been used?
- What is the exact formulation?
- What kind of DOTP is used?
- With or without UV-Stabilizer?
- What about the other parameters like weight loss and ΔE ?

2. Weathering of Flexible PVC

Why is it so important to have the correct testing protocol?



Images of weathered samples after 1500 hrs

Hexamoll®
DINCH

Palatinol® N

Pevalen™

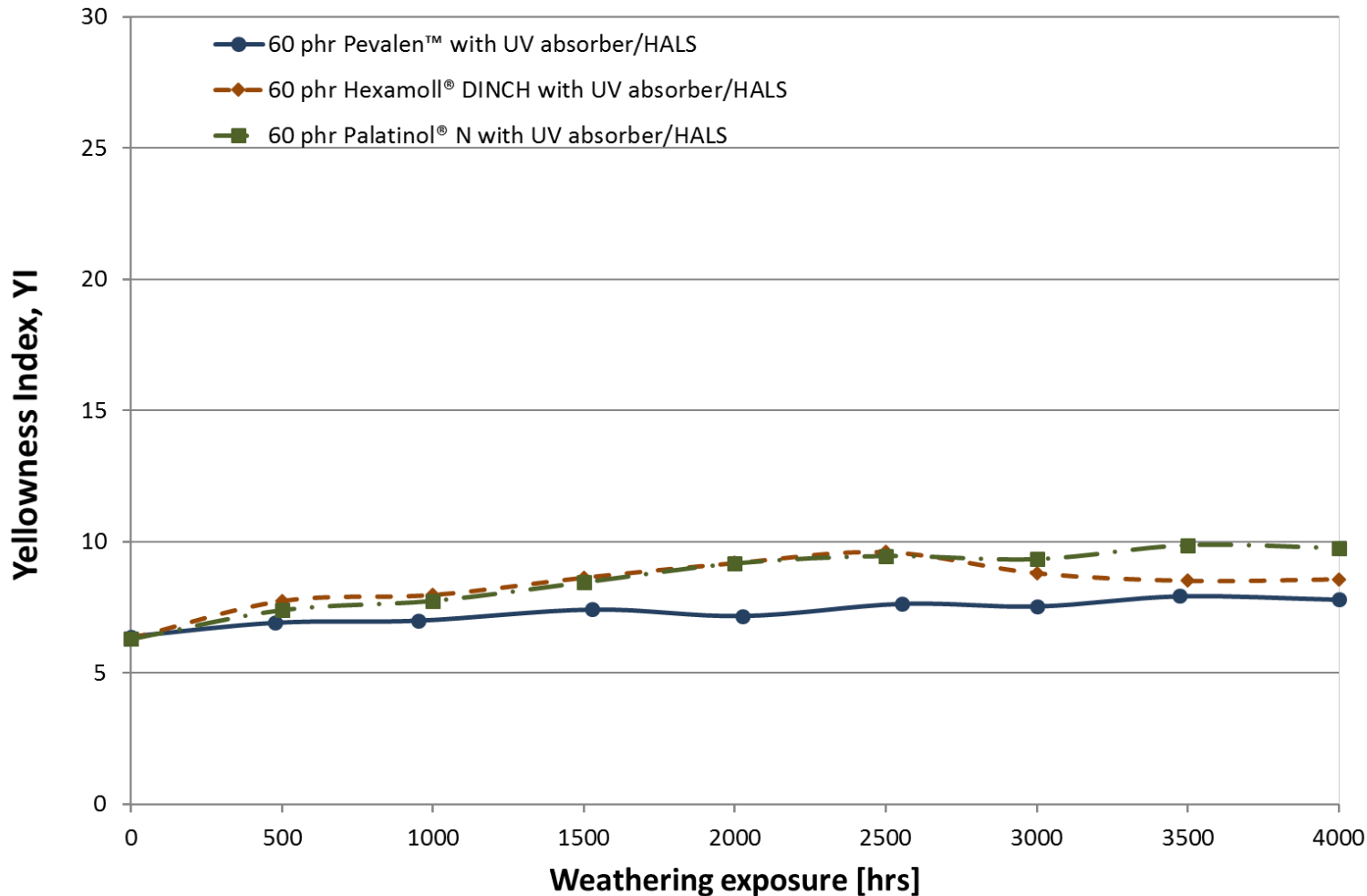
Similar change of Yellowness Index over time. Perstorp has tested with less harsh conditions

But:
Palatinol® N and Pevalen™ samples are brittle after 1500 hrs, Hexamoll® DINCH is still flexible

2. Weathering of Flexible PVC

Why is it so important to have the correct testing protocol?

Comparison of plasticizers with 0.4 phr Uvinul® 3039 and 0.4 phr Uvinul® 5050



Conclusion:

Industry standard is the use of a light stabilizer package, omitting these will always lead to failure of weathering behavior

All Plasticizers with suitable UV stabilizer package show **excellent** weathering behavior

Protocol: ASTM G154-12a, Cycle 3 (8h/340 nm, 0.49 W/m²/340nm, 70°C BPT, 4h/dark @ 50°C with condensation)

Summary

- Addition of Carbodiimides extends the lifetime of polymeric plasticizers, especially with Palamoll® 656 in humid and hot environment by a factor of 3-4.
- Extension of hydrolytic stability has been published in a PCT patent application WO 19/185409.
- Only use of a suitable light stabilizer package will ensure long weathering stability and we can provide optimized formulations for Hexamoll® DINCH and Palatinol® N based products.
- Especially, when it comes to weathering, exact testing conditions are a must in order to be scientifically sound and reproducible.



We create chemistry