Weathering Performance of Cable Ties for Solar Wire Management

Adapted from NREL PVRW 2018

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INTRODUCTION

Cable management is an important aspect of construction of safe and reliable power plants.

Polymers are commonly utilized for cable management and this paper compares a few commonly used materials against a new material Kynar® PVDF.

Choice of material is a critical consideration when the cost of replacing a failed cable tie is almost 10 times the initial cost of the wire tie in terms of labor and material costs alone.

In this paper we compare commonly used materials that are rated UV grade such as Nylon 6.6 and Nylon 12 and a new material Kynar® PVDF, with high lifetime potential (25+ years) utilizing a suite of durability tests for polymeric cable ties developed by First Solar.

MATERIALS & METHODS

Methods

Chemical treatment before testing

Un-tied cable ties soaked in one chemical before weathering: Aqua-tex, Poly-tex, Chlor-tex, Ecco-tex, Milestone Herbicide, $ZnCl_2$.

Materials

- 8 inch long cables ties
- Kynar® PVDF ties from Nile Polymers
- Nylon ties from HellermannTyton

Short Term Environmental Testing

Thermal Cycling :

200 cycles of 6 hours, from -40 °C to 90 °C with a ramp of 100°C/min

Damp Heat :

1000 hours of conditioning at 85 °C and 85% relative humidity

Humidity Freeze :

30 (for Kynar® PVDF) or 10 (for nylon) cycling between -40 °C and 85 °C with a relative humidity of 85%

Accelerated Indoor Weathering

Accelerated weathering performed in a Xenon Chamber: temperature of 65 °C, irradiance at 0.8 W/m^2 at 340 nm, 20% RH and water-spray for 18 min out of the 120 min cycle.

Mechanical Testing

Un-tied cable ties mechanically tested after every exposure.

ACCELERATED INDOOR TESTING

Equivalent in years (UV exposure in Arizona)	Hours in Xenon Arc	Dose (MJ/m^2)
1	1300	3.7
3	3900	11.2
5	6500	18.7

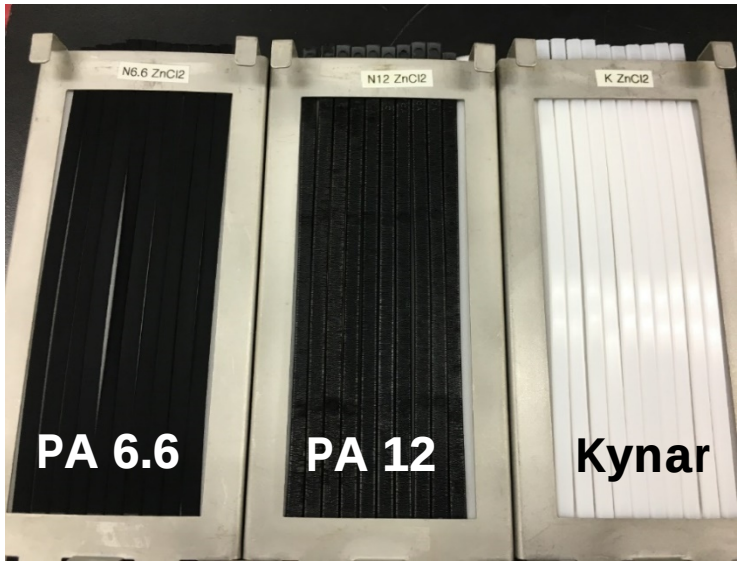
Testing includes pristine and chemically treated ties with either :

- Aqua-Tex
- Milestone Herbicide
- Zinc Chloride

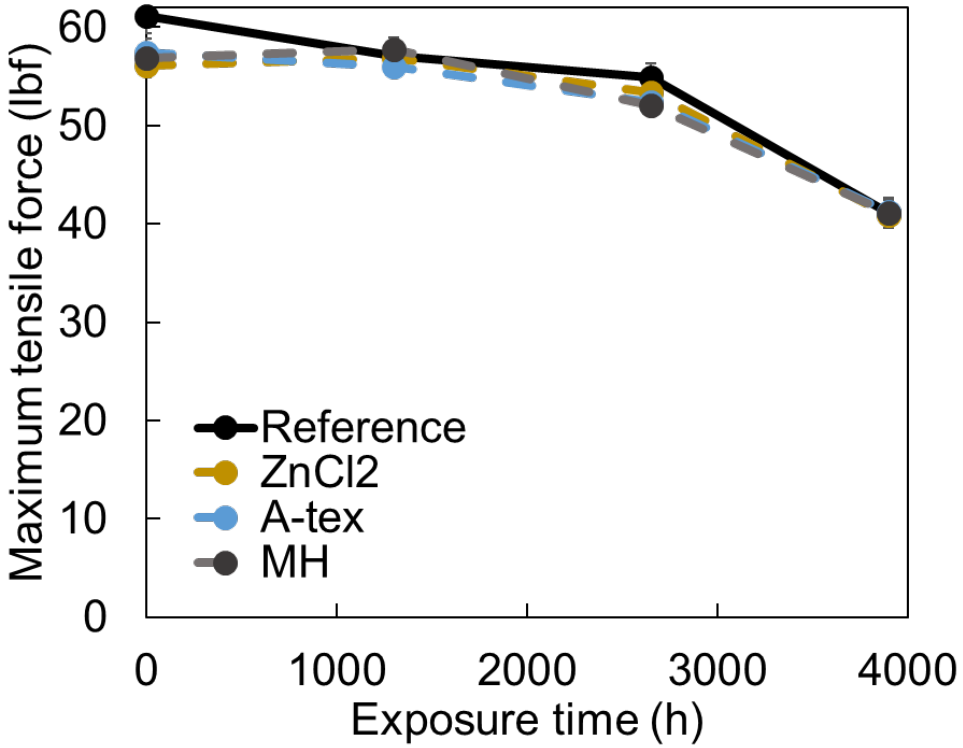
After 2600 hours in the chamber:

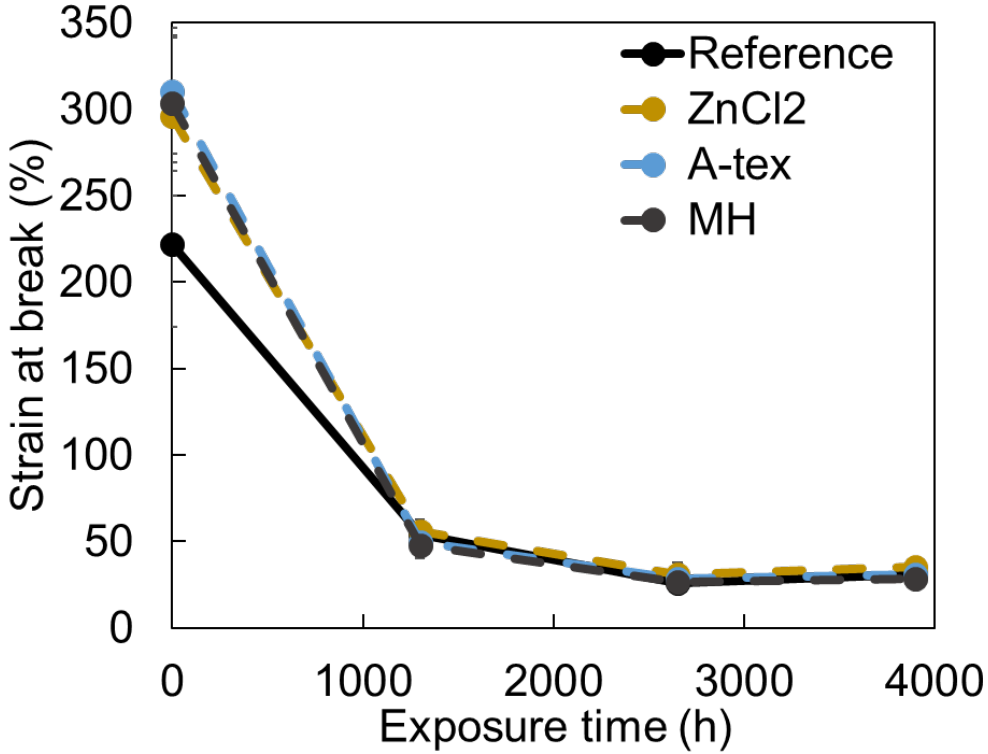
Nylon 12 ties: matte, brittle, surface cracking, gloss loss

Nylon 6.6 ties: matte and dull surface, gloss loss



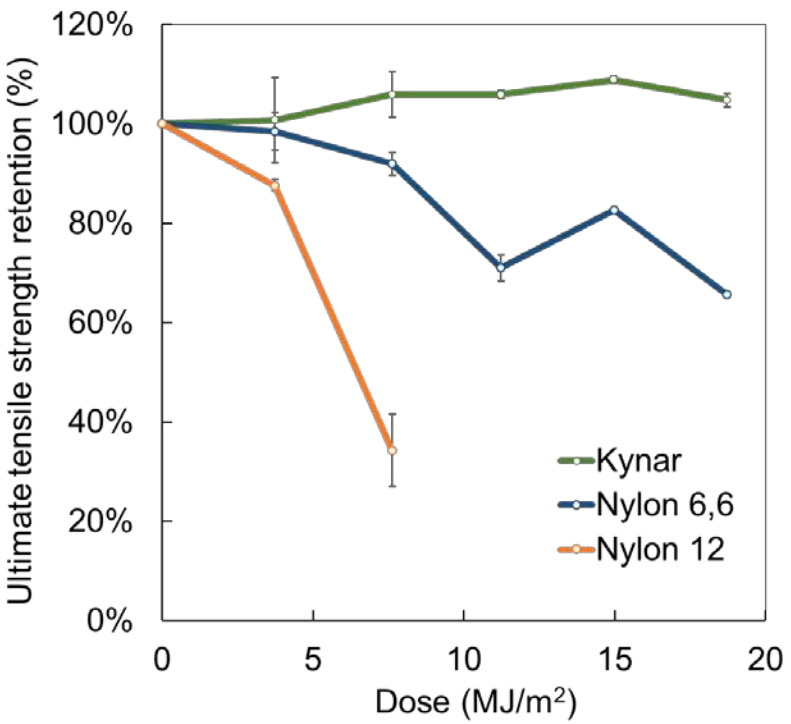
EFFECT OF CHEMICAL TREATMENT BEFORE WEATHERING (NYLON 6,6)

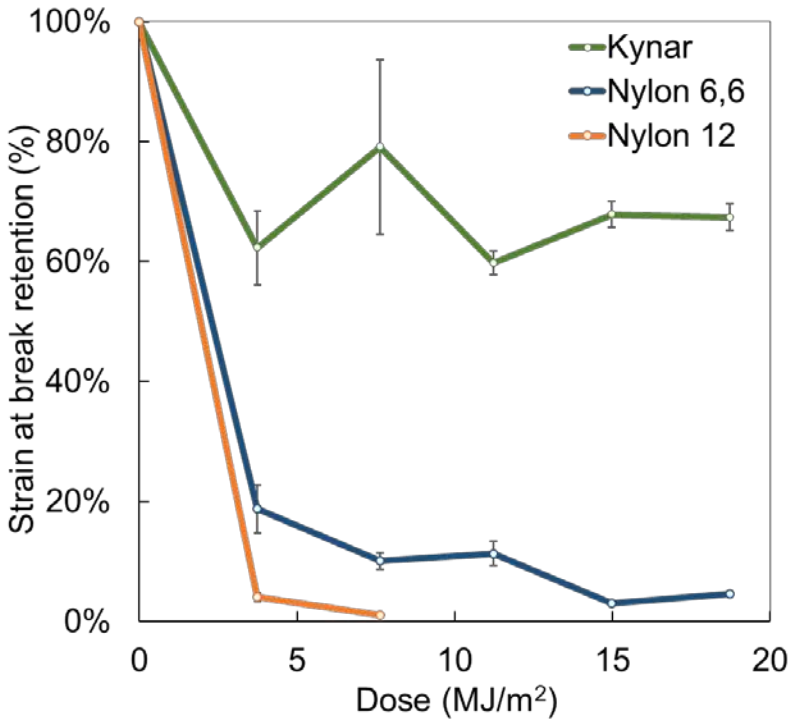




- In all materials, mechanical property retention was unaffected by the pre-soaking of chemicals
- $ZnCl_2$ causes stress cracking in nylon 6,6, but does not appear to have a significant effect in the unstrained state

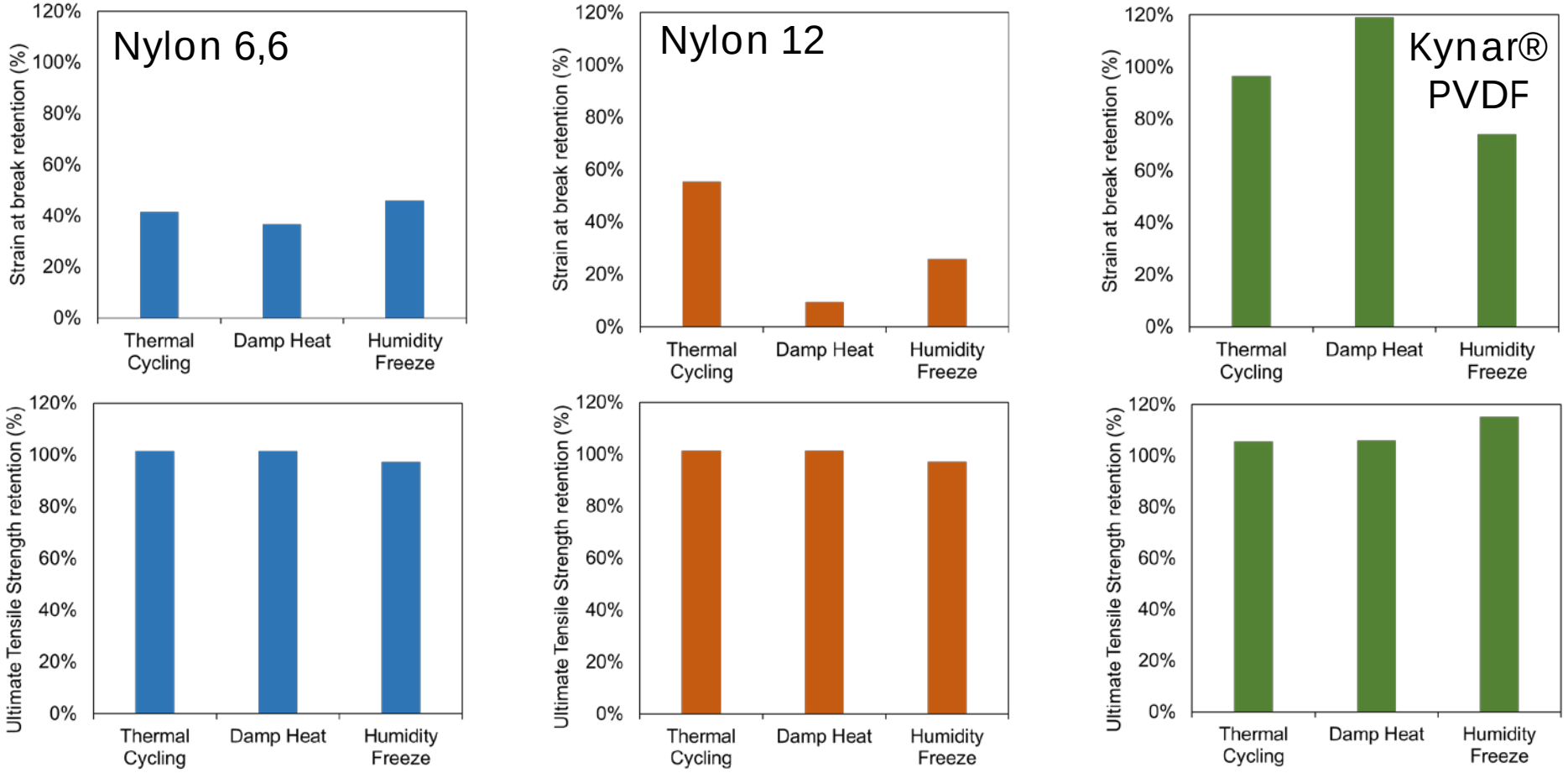
PROPERTY RETENTION





- **Nylon 12:** stopped after 2600 hours due to intensive brittleness and cracking. Failure of the material after an equivalent of two years of exposure.
- **Nylon 6.6:** good tensile strength retention, still > 40lbs. but an elongation dropped at 5% of its original value.
- **Kynar® PVDF**: little impact of weathering. Maximum tensile load still > 50 lbs.

SHORT TERM ENVIRONMENTAL TESTING



- Significant decrease of strain at break for nylon 6.6 and nylon 12
- Water can plasticize and cause mechanical property loss in Nylon
- Kynar® PVDF cable ties are not significantly impacted

OUTDOOR REAL TIME WEATHERING

- Failure of nylon 6.6 cables ties after 1 year of service in southwest US desert climate.
- Failure analysis revealed the presence of corrosive ingredients at or near line artifacts which caused stress corrosion cracking.
- In May 2017, 8000 Kynar® PVDF cables ties were installed in various positions and mechanical stress levels, monitored every 6 months.

→ After 1 and ½ years, no Kynar® PVDF failures reported

CONCLUSIONS

- Early field failures most likely caused by mechanical strain and chemical exposure that leads to stress cracking
- Poor UV resistance of nylon 6.6 and nylon 12 despite being UV grades.
- Excellent durability of Kynar® PVDF, compared to nylon 6.6 and 12.

- **Kynar® PVDF cable ties supplied by Nile Polymers:** https://nilepolymers.com/
- **First Solar:** http://www.firstsolar.com/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