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Test report

Aging test of monofilament fishing line

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TEST OBJECT
Monofilament fishing line (nylon and PBSAT)

TEST OBJECT RECEIVED
Week 13

TEST PROGRAM
n.a.

TEST LOCATION
Oslo

DATE OF TEST
April-Mai

ABSTRACT
Two types of monofilament fishing line were received. One line was made of nylon (polyamide-6) and the other was PBSAT (polybutylene succinate co-adipate-co-terephthalate). Both materials were aged for about 1000 hours in a weathering test, simulating outdoor condition. Compared to a previous test run in autumn 2018, this test was performed at higher relative humidity. The degradation of the materials was characterised by FTIR spectroscopy and mechanical testing. The analyses reveal that both materials show signs of degradation already after 200 hours of exposure, which is identical to the previous test. PBSAT degrades faster than nylon and thus shows a stronger reduction in mechanical strength and material integrity. Compared to the previous test, PBSAT seems to be slightly affected by the higher humidity as its mechanical properties are reduced slightly more. FTIR analysis has not shown a significant difference when comparing the results with the previous test. In conclusion, the results indicate that the wetter aging conditions did not have a significant impact. Hence, the effect of photo oxidation as aging mechanism is stronger than hydrolysis.

The test results relate only to the items tested

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CLASSIFICATION

1 Experiment

Two types of monofilament fishing line were received. One line was made of nylon (polyamide-6) and the other was PBSAT (polybutylene succinate co-adipate-co-terephthalate). From both lines, 36 pieces of approx. 35 cm length were cut for the weathering test, yielding 72 samples in total. One set of 6 pieces from each material was kept aside as reference. The other pieces were fixed on to the sample holders of the weather-o-meter in groups of 6. The weathering was done using an Atlas Xenotest 440 weather-o-meter and a modified weathering cycle, which was based on ISO 4892-2 (outdoor). The total exposure time was about 1000 hours and the parameters for the weathering cycle are summarized in Table 1.

Table 1: Weathering cycle.

Exposure period	Irradiance		Black-standard temperature [°C]	Chamber temperature [°C]	Relative humidity [%]
	Broadband UV300-400 [W/m²]	Narrowband [W/m² nm)]			
2 min water spray	60 ± 2	0,51 ± 0,02 (@340 nm)	65 ± 3	38 ± 3	80 ± 10
8 min dry	60 ± 2	0,51 ± 0,02 (@340 nm)	-	38 ± 3	-

The frequent water spraying and the high humidity in the chamber ensured that the samples were always wet during the weathering test. The length of the spraying and dry cycles had to be adjusted slightly during the test to match the water supply rate of the water purifier. Spray cycle lengths varied between 2-3 min and dry times between 7-9 min. The values in Table 1 are the final ones.

During the weathering test one set of samples (6 pieces) from each material was removed after 176h, 434h, 567h, 757h, and finally after 998h for further analysis.

Tensile testing of the fishing lines samples was performed using a Zwick/Roell Z250 universal test machine and three parallels from each set of samples were analysed.

2 Results and discussion

2.1 Tensile test

The strain at break is reduced after aging, i.e. the material loses ductility, which is an expected sign of degradation. This aging effect is strongest for the PBSAT fishing line. The change in tensile strength and strain at break are shown in Figure 2a and b, respectively. The strain is the engineering strain, $\Delta L/L_0$, where L_0 is the initial grip-to-grip distance.

Before aging, the tensile strength of nylon is about 24% higher than the one of PBSAT. Already after 200 hours exposure the tensile strength of both materials starts to decline, and the deterioration is strongest for PBSAT. However, after 600 hours exposure the values for PBSAT seem to level off whereas those of nylon continue to decline.

The elongation at break of the pristine material is about 9% higher for PBSAT compared to nylon, indicating that this material has a slightly higher ability for plastic deformation. For both materials the elongation at break increases slightly during the first 200 hours of exposure and then declines significantly. Like the tensile strength, the elongation at break for PBSAT seems to level off after about 600 hours exposure whereas nylon continues to decline until about 800 hours before it seems to level off as well.

(a) (b)

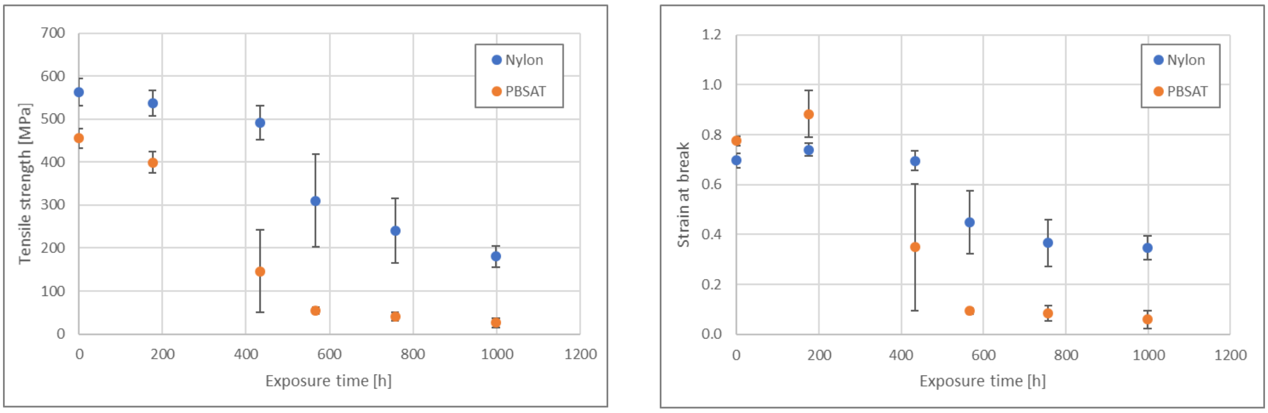

Figure 1: Change of tensile strength (a) and strain at break (b) during aging.

In a previous aging test, which was run in autumn 2018, identical samples of these fishing line materials were used. The test in 2018 was according to the weathering cycle described in ISO 4892-2 (outdoor), which has a much longer dry cycle (18 min vs 8 min) and a lower relative humidity (50% vs 80%) than the one used for this recent test. Figure 2 shows the new results in comparison to the results from last year.

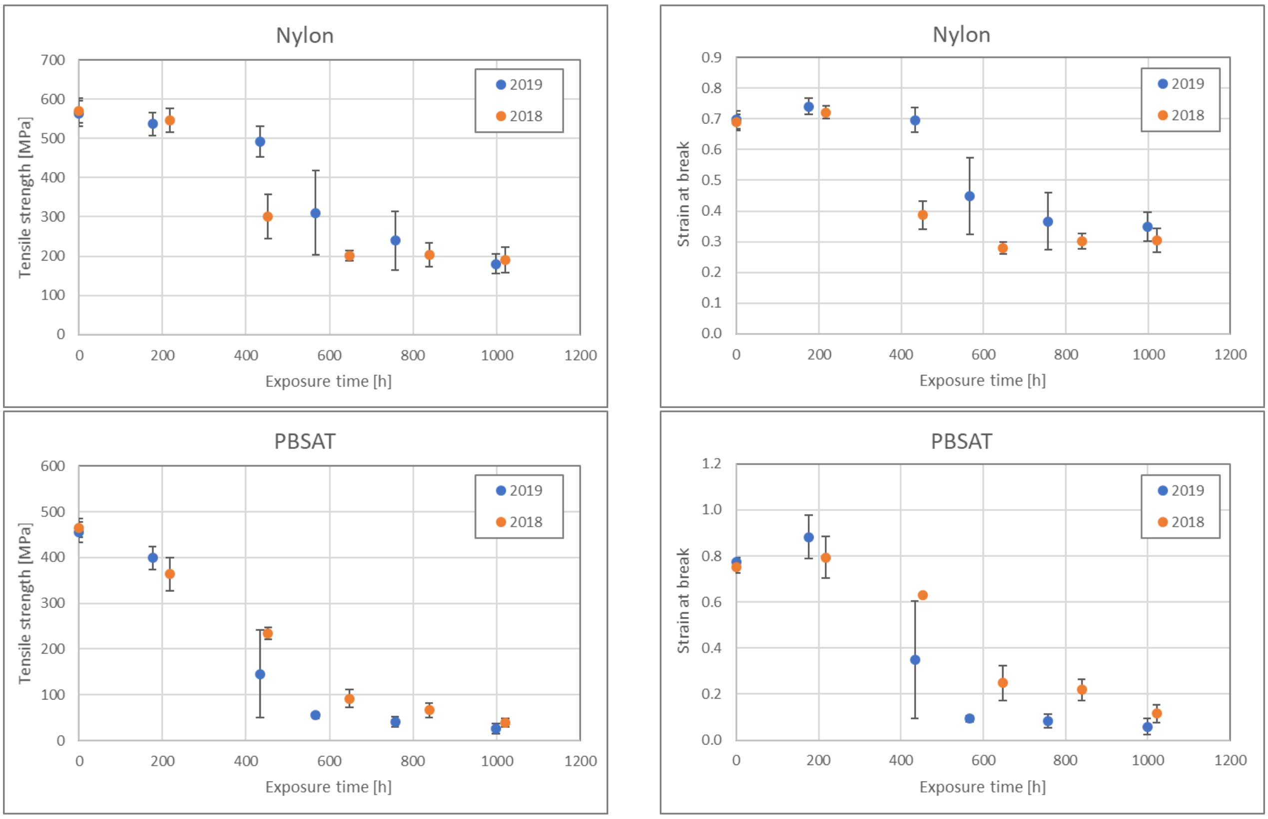

Figure 2: Comparison of the two aging tests, autumn 2018 and spring 2019. Change of tensile strength (left) and strain at break (right) during aging.

Overall, the samples show a very similar aging behaviour in both tests. The latest test was much wetter than the previous one and PBSAT seems to be slightly affected by that. Its tensile strength and strain at break decreased more compared to the previous test but the time until a decline was observed was about the same. Nylon seems to be less affected by the higher humidity and it looks like it even degrades a bit slower.

2.2 FTIR

Figure 3 shows FTIR spectra of nylon and PBSAT after 1000h of aging. In comparison, the spectra from the respective samples from last year are shown. The spectra look very similar, which is in line with the results from mechanical testing. That means, the wetter aging conditions did not have a significant impact on the degradation process of nylon and PBSAT.

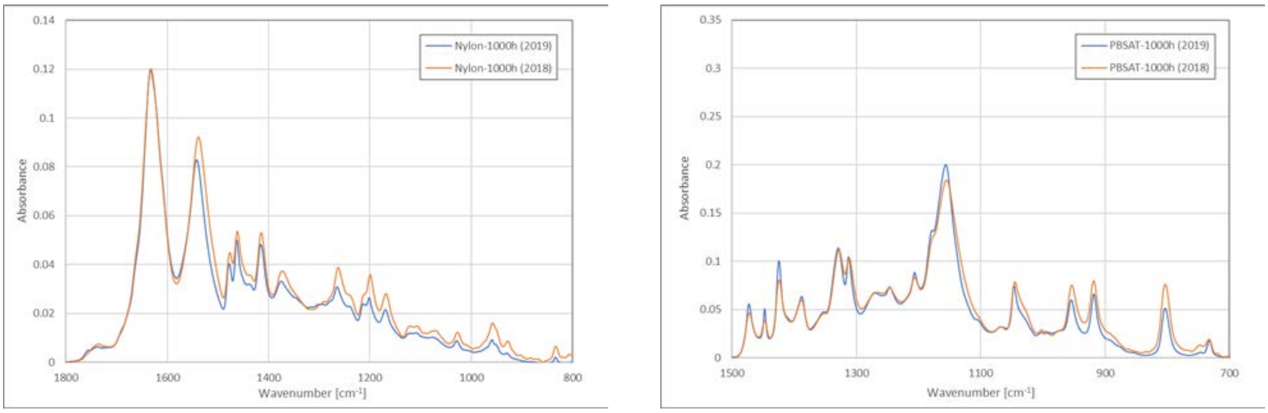

Figure 3: FTIR spectra of nylon (left) and PBSAT (right) in comparison to the results from the previous test in 2018.