Heat resistance properties

Heat resistance

ARPRO is a very versatile material with a broad range of applications (automotive, building, HVAC, furnishing, toys…), and the heat resistance is an important property for some of the applications.

Below is the set of technical information that covers "heat performance":

- The lifetime of ARPRO related to the service temperature
- The changes in the mechanical properties (according to simulated ageing process)
- The dimensional stability of moulded parts due to ageing process

Note: Do not hesitate to contact your JSP representative about the data presented, or any aspect of ARPRO performance if you have any questions.

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1. Expected ARPRO lifetime – aesthetic degradation

'Expected lifetime' for ARPRO is linked to the absolute temperature, duration of continuously applied temperature and the moulded density of the application. This datasheet will provide an indication of how ARPRO will perform under continuously applied temperatures. The points on the graphs illustrate where the first signs of degradation appear (various temperatures, without any stress on the part).

Test method: ARPRO moulded parts are exposed in a dry oven to varying temperatures between 85°C and 120°C. Data gathering is stopped at the first sign of any degradation (e.g. powdering or breaking of the polymeric chains). Tested densities are ARPRO Black between 20g/l and 100g/l.

Criteria: The first signs of degradation (powdering) provide a data point for lifetime calculation at the given temperature. Generally, the first signs of degradation appear on the corners and edges of the moulded part (see picture). When signs of degradation appear, the ARPRO parts are removed from the dry oven. As long as this powdering does not occur, there is no drop in physical properties.

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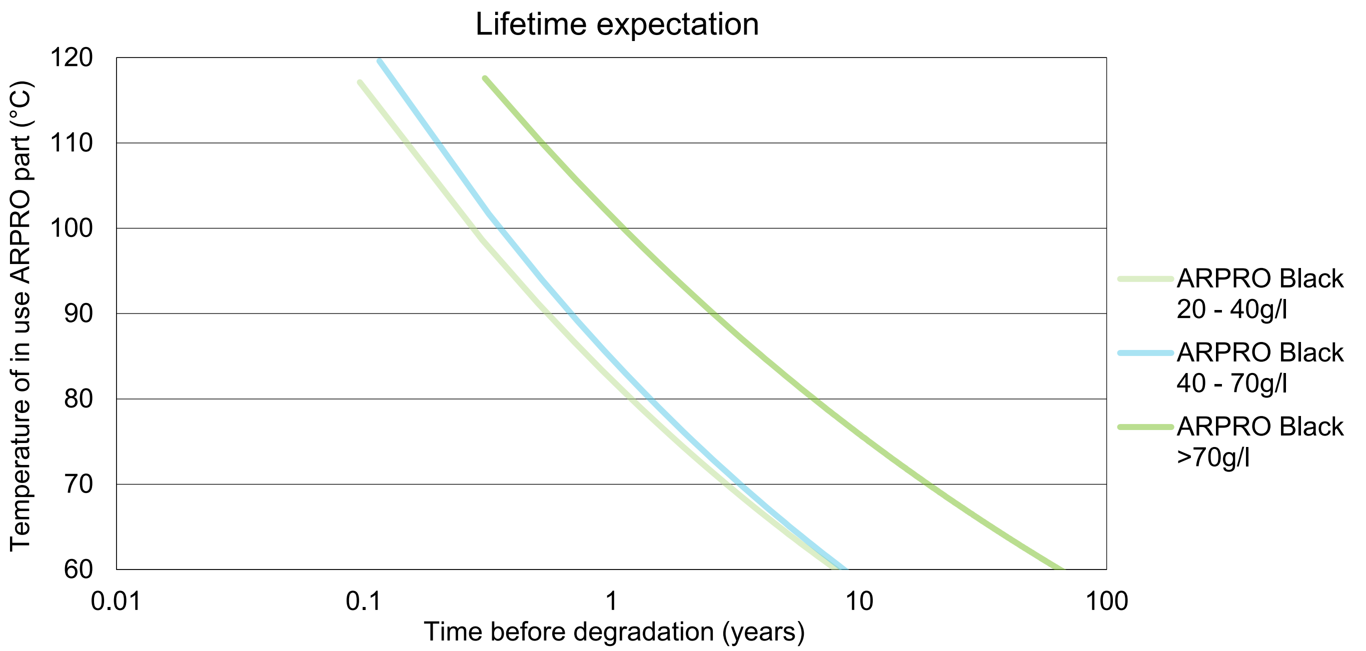
Heat resistance properties

The graph below indicates the expected duration before the first signs of degradation appear at various temperatures, without any stress on the part.



In order to use the curves, the minimum lifetime expected or the average working temperature has to be known. For instance, if the application requests a 10 years lifetime, then ARPRO can be used when the continuous working temperature is 60°C or below. If the application has to sustain a temperature profile (with various temperature cycles or differences between winter and summer), then the average temperature should be used as the reference to obtain the expected lifetime.

Notes:

There are some accelerating factors that could lead to shorter lifetime.

- Exposure to UV (see coating method for further details to protect ARPRO).
- Direct contact to copper parts, depending on the temperature of use. The effect of copper on ARPRO degradation is 3 to 6 times faster at temperatures above 100°C but almost insignificant at temperatures below 80°C. In order to avoid contact between ARPRO and copper, the following solutions can be applied:
    - Layer of air.
    - Another material used as a protective layer (e.g. aluminium foil).
    - Paint copper with epoxy paint.

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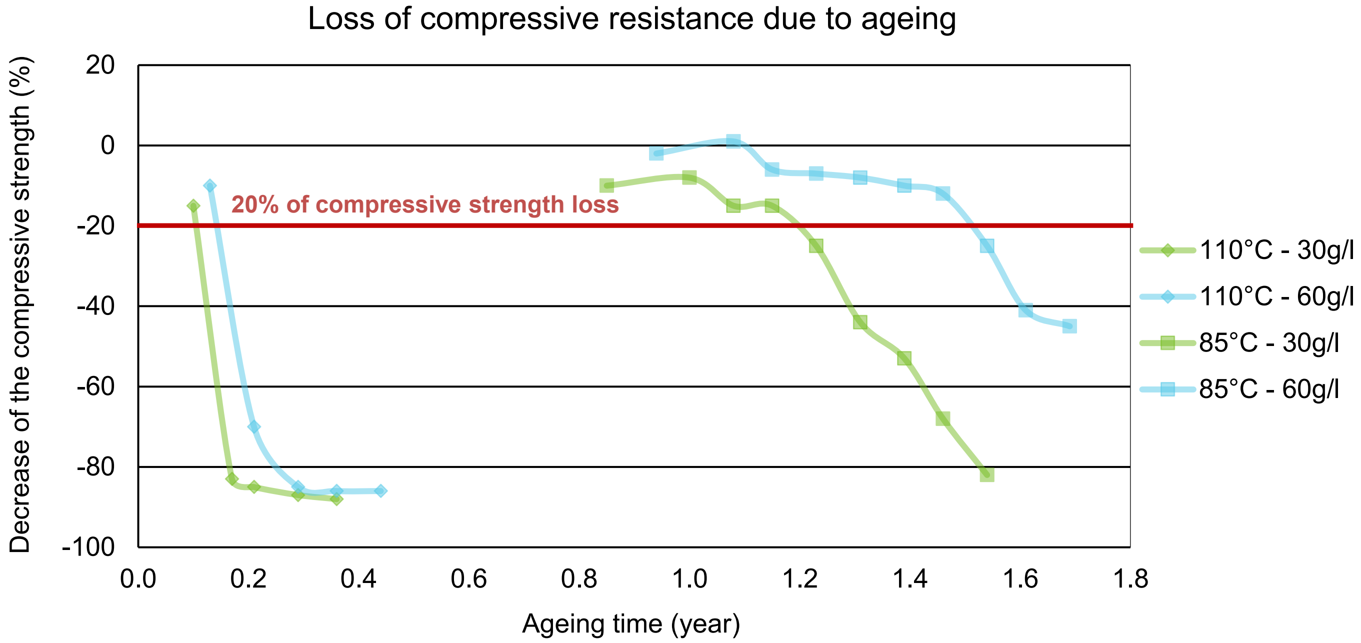
2. Expected ARPRO lifetime – performance degradation

Powdering is not always the right "fail criteria" depending on the application (visible or not) as the mechanical properties are still unaffected at first occurrence.
The loss of compressive strength is dependent on time and temperature (the initial point of each curve comes from the 'Lifetime Expectation' graphic).
At lower temperatures, the degradation is much lower than at higher temperatures.

Tested densities: ARPRO Black at 30 and 60g/l

Test method: ARPRO moulded parts are exposed in a dry oven to temperatures of 85°C and 110°C. Once the first sign of aesthetic degradation appears (see section 1), the compressive resistance of the ARPRO moulded parts is monitored regularly. The performance of ARPRO moulded parts is usually considered as compromised when the loss of compressive strength is higher than 20%. Tested densities were ARPRO Black 30g/l and 60g/l.



Test results explanation: At a constant temperature of 110°C, ARPRO at 30g/l and 60g/l will start degrading and losing performance after two months. At a constant temperature of 85°C, ARPRO at 30g/l will lose 20% of its initial compressive strength after 15 months. For ARPRO at 60g/l, this will occur after 18 months.

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3. Change in mechanical properties due to ageing

Exposure to heat softens ARPRO during usage and can modify the mechanical properties because of the ageing process. The data below gives an overview of ARPRO properties after ageing.

Test method: The mechanical properties (compression strength and tensile strength) are measured before and after ageing. The specimens are cut from 400*300*80mm blocks and aged at 110°C for 10 days or at 130°C for 5 days according to ISO 2440.

Tested density: ARPRO Black at 60g/l

Test	Method	Unit	Result	Result
Heat ageing	ISO 2440		110°C – 10 days	130°C – 5 days
Tensile strength				
Initial ambient temperature	ISO 1798	kPa	730	730
Change after heat ageing		%	up to 14*	up to 14*
Tensile elongation				
Initial ambient temperature	ISO 1798	%	13	13
Change after heat ageing		%	up to 30*	up to 30*
Compressive strength at 25% strain				
Initial ambient temperature	ISO 844	kPa	380	380
Change after heat ageing		%	up to 8*	up to 8*

* *Part of the property variation is due to test variation. Tensile test results, especially elongation, are much more variable than compression results. Another source of variation is the densification of specimens, due to slight shrinkage during ageing.*

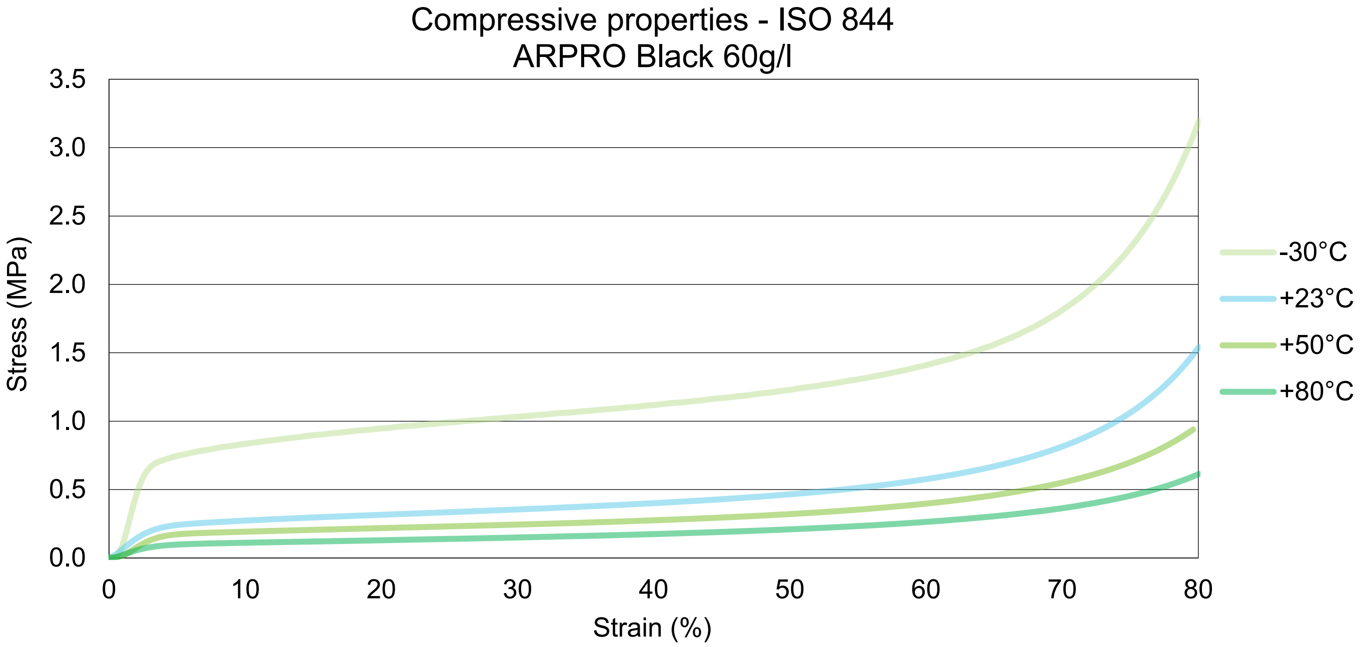
Note: Once the temperature goes back to the ambient temperature the mechanism of ageing is stopped.

4. Change in mechanical properties due to usage

The data below gives an overview of ARPRO performance at various temperatures.

Test method: Compression according to ISO 844 (with a speed of compression of 5mm/min).

Tested density: ARPRO Black at 60g/l



Test result explanation: When ARPRO is submitted to heat, the material will soften; some residual resistance will remain, even at high temperature. The general thermoplastic behaviour will remain steady whatever the temperature tested, even below the glass transition (around -10°C).

Note: Once the temperature returns to ambient, the mechanical properties of ARPRO will revert to those at ambient level.

5. Change in moulded part dimensions due to ageing

A moulded parts dimensions can be affected by heat. The data below illustrates this effect.

Cold temperatures have less effect on the dimensions; the largest variations come from high temperature. The effect is a slight shrinkage of the part, depending on the temperature applied, the ageing duration and the tested density. A slight densification, by 1g/l to 5g/l is observed for the temperatures and densities presented below.

Test method: Moulded blocks of ARPRO are heated in an oven with dry air and aged at 110°C for 10 days or at 130°C for 5 days according to ISO 2440. The temperature is regulated within ± 2°C. The dimensions are measured before and after the ageing process, at three or more different points in every direction according to EN 1604.

The test result describes the maximum dimensional variation expressed in %.

Tested densities: ARPRO Black at 30, 60, 80 and 105g/l

ARPRO moulded density (g/l)	Linear dimensional change (%)	
	Ageing at 110°C for 10 days	Ageing at 130°C for 5 days
30	- 1.0	- 5.8
60	- 0.6	- 3.0
80	- 0.6	- 1.7
150	- 0.6	- 1.1

Note: This effect can be partially increased or decreased by varying the process parameters during the moulding (especially the autoclave pressure and post-treatment). If you need further details, please contact your JSP representative.

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