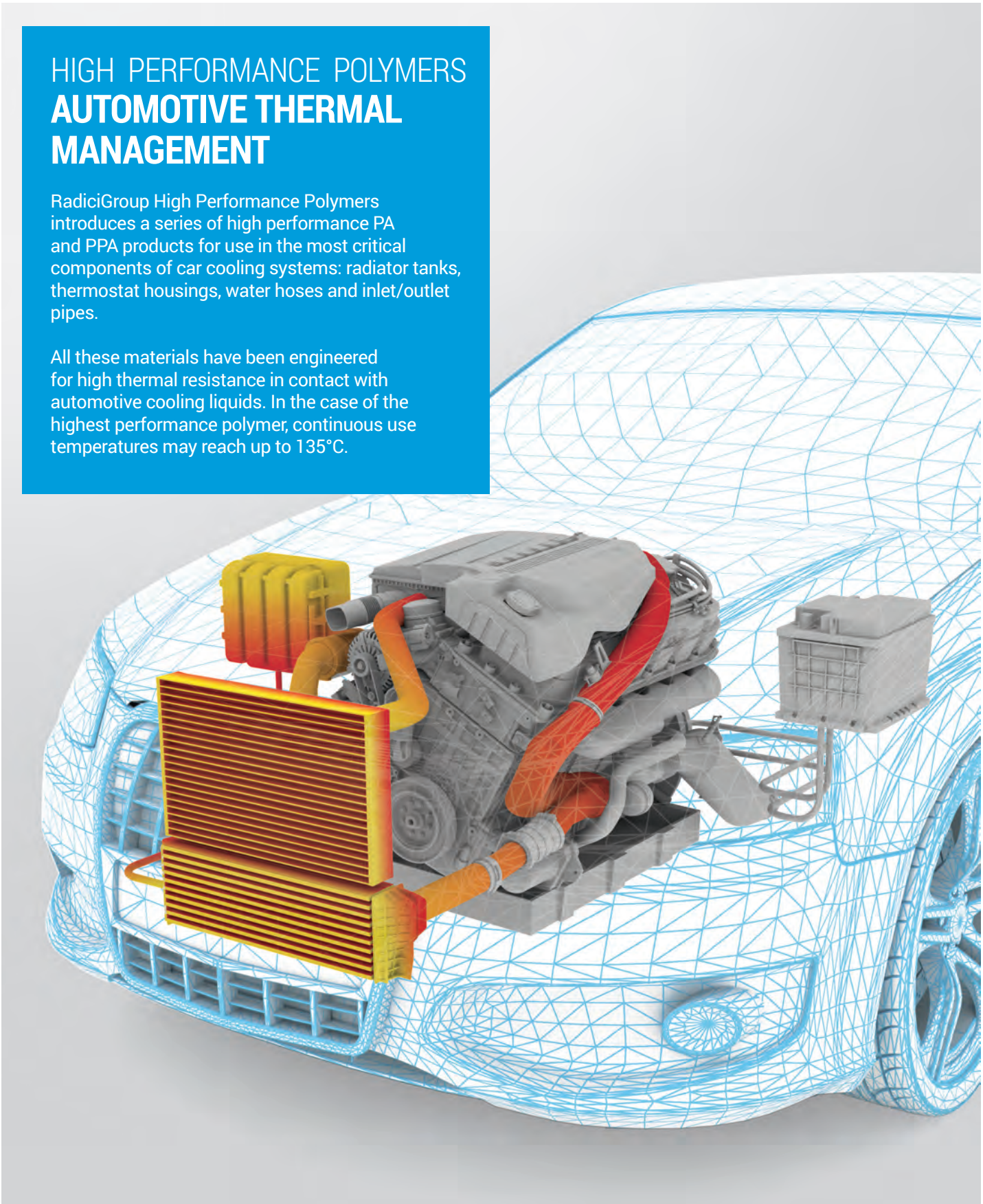
HIGH PERFORMANCE POLYMERS

AUTOMOTIVE THERMAL MANAGEMENT

RadiciGroup High Performance Polymers introduces a series of high performance PA and PPA products for use in the most critical components of car cooling systems: radiator tanks, thermostat housings, water hoses and inlet/outlet pipes.

All these materials have been engineered for high thermal resistance in contact with automotive cooling liquids. In the case of the highest performance polymer, continuous use temperatures may reach up to 135°C.



COOLING & HEATING SYSTEM MATERIALS

PROPERTIES		ISO STANDARD UNIT	TEST CONDITIONS	UNIT	RADILON® A RV300RG 3900 BK	RADILON® A RV300HRG 3900 BK
RHEOLOGICAL	Parallel shrinkage	294-4		%	0.3	0.3
	Transverse shrinkage	294-4		%	1	1
MECHANICAL	Tensile strength at break	527	23°C	MPa	180	180
	Elongation at break	527	23°C	%	3.5	3.8
	Tensile modulus	527	23°C	MPa	9900	10100
	Flexural modulus	178	23°C	MPa	8800	9600
	Charpy notched impact strength	179/1eA	23°C	kJ/m2	10	13
THERMAL	Heat deflection temperature	75	1.8 MPa	°C	240	240
	Melting temperature	3146	DSC	°C	260	260
	Flammability	UL 94	1 mm		HB	HB
PHYSICAL	Density	1183	23°C	g/cm3	1.35	1.35
	Water absorption	62	23°C	%	1.7	1.5

RADILON® A RV300RKC 339 BK 07056	RADILON® A NER GF300RKC	RADILON® D RV300RG 3900BK	RADILON® AESTUS T1 RV330RG 3900BK	PRODUCT	DESCRIPTION
0.3	0.3	0.4	0.3		
1	1	0.8	0.7		
180	150	150	225		
3.5	2.6	4.5	2.9		
9900	8900	8500	11900		
8800	8000	7300	10500		
10	7	15	11	**RADILON® A RV300RG 3900 BK**	Automotive cooling liquid resistant PA6.6-GF30 standard grade.
240	240	200	275	**RADILON® A RV300HRG 3900 BK**	Automotive cooling liquid resistant PA6.6-GF30 grade designed to operate even under the most severe operating conditions. Considered to be a top-of-the-class material.
260	260	220	312	**RADILON® A RV300RKC 339 BK 07056**	Automotive cooling liquid resistant PA6.6-GF30 standard grade.
HB	HB	HB	HB	**RADILON® A NER GF300RKC**	Automotive cooling liquid resistant PA6.6-GF30 grade containing a portion of postindustrial recycled polyamide.
1.35	1.36	1.3	1.45	**RADILON® D RV400RG 3900BK**	Automotive cooling liquid resistant. For use at temperatures of up to 125°C. Improved chemical resistance and dimensional stability.
1.7		1	0.2	**RADILON® Aestus T1 RV330RG 3900BK**	Automotive cooling liquid resistant. For use at temperatures of up to 135°C. Improved property retention after ageing.

For hoses, special materials have been developed that can be processed using gas injection technology (GIT) or water injection technology (WIT). With either of these technologies, the use of Radilon® products allows you to obtain hoses with high quality internal surfaces, which drastically reduce the pressure drop caused by surface roughness and satisfy the strictest automaker specifications, even for the lastest generation engines.

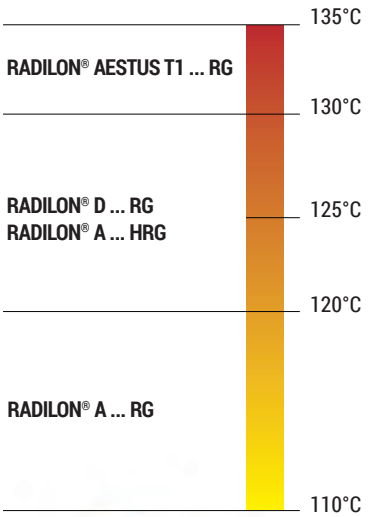
For all car cooling system applications, our glycol resistant filled polyamides (PA 6.6, PA 6.10 and PPA) ensure:

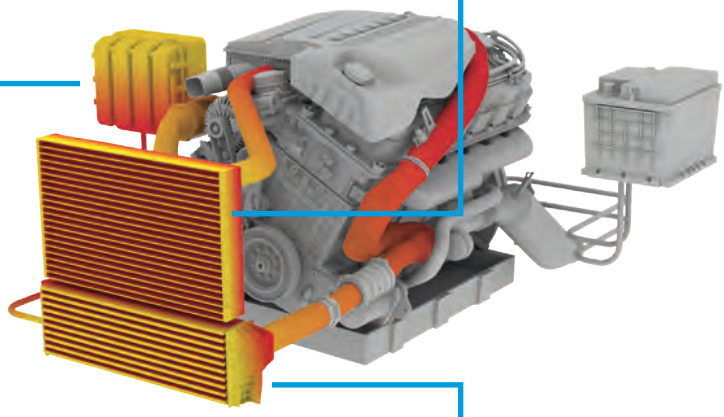
- High thermal resistance in contact with engine cooling fluids
- High creep resistance, even at high temperatures
- Vibration and fatigue resistance
- Excellent chemical resistance to engine compartment fluids

A RANGE OF SOLUTIONS FOR CAR COOLING SYSTEMS...

EXPANSION (OVERFLOW) TANKS
RADILON® A RV300RG 3900 BK
RADILON® A RV300HRG 3900 BK

RADIATOR TANKS
RADILON® A RV300RG 3900 BK RADILON® A RV300HRG 3900 BK
RADILON® A NER GF300RKC RADILON® A RV300RKC 339 BK 07056





COOLING HOSES
RADILON® A RCV3015RKC
RADILON® WIT 30/28

INLET, OUTLET PIPES, THERMOSTAT HOUSINGS
RADILON® A RV300RG 3900 BK
RADILON® A RV300HRG 3900 BK

...THE RADILON® HYDROLYSIS-RESISTANCE PRODUCT RANGE

Injection moulding products resistant to engine cooling liquids: extending PA6.6 applications to highly critical components

Radilon® PA6.6 materials for injection moulding are ideal for cooling circuit components, such as radiator tanks, thermostat housings and expansion (overflow) tanks. In addition to Radilon® A RV300RG, a standard hydrolysis-resistant 30% glass-fibre filled material, RadiciGroup High Performance Polymers offers Radilon® A RV300HRG, an innovative product for the most critical applications.

Radilon® A RV300HRG was designed using an original RadiciGroup technology and can be utilized in all kinds of applications where components must work under severe operating conditions, such as high temperatures and/or pressures. A typical example would be the thermostat housing right at the engine head. Our product, which has been approved by a number of important end users, opens up new possibilities, as it can be used as a replacement for metals and special polymer materials, such as PPS.

Chart 1| Test Conditions:
130°C, 50/50 GLYCOL/WATER

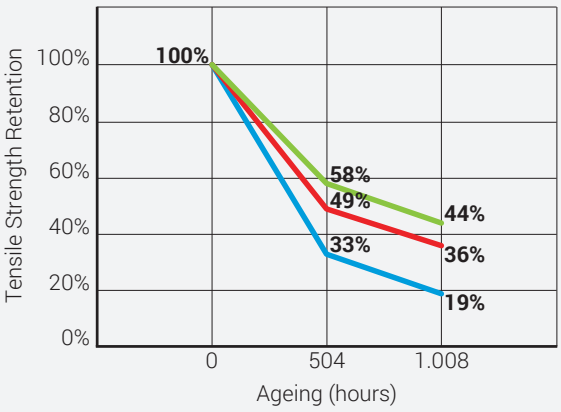


Chart 2 | Test Conditions:
130°C, 50/50 GLYCOL/WATER

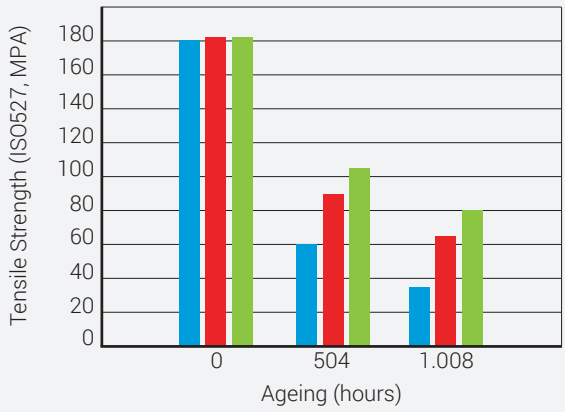


Chart 3 | Test Conditions:
130°C, 50/50 GLYCOL/WATER

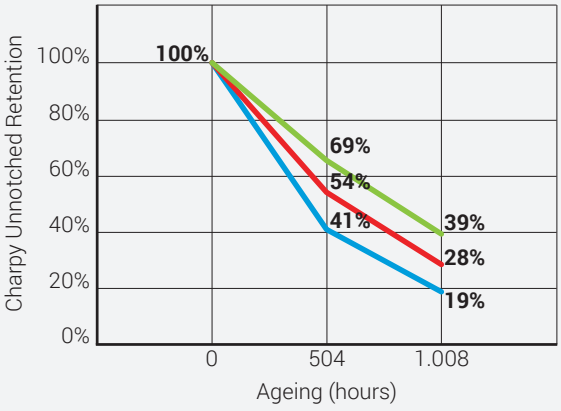


Chart 4 | Test Conditions:
130°C, 50/50 GLYCOL/WATER

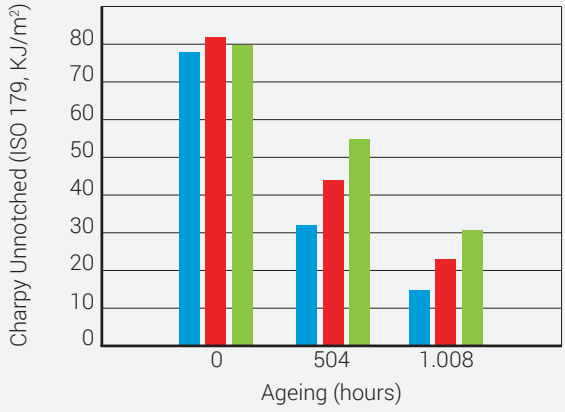


Chart 3 shows that, for Radilon® A RV300HRG, Charpy unnotched impact strength retention at aging half life in a glycol/water mix at 130°C is:

- About +30% compared to Radilon® A RV300RG, the standard material used in the manufacture of cooling
- system components
- About +90% compared to 30% glass-fibre filled PA6.6

A similar trend can also be seen in tensile strength (Chart 2). An increase in the ageing time needed to reach 50% of the initial property in glycol/water mixes translates into a proportional increase in the expected useful life of the component installed in a car, all operating conditions being equal.

Charts 5, 6, and 7 show how the product with high glycolysis resistance behaves in contact with an engine cooling media at a temperature of 120°C, with ageing extended up to 3000 hours!
These tests were performed at end-user sites during the material approval process.

Chart 5 | Radilon® A RV300HRG 3900 BK, Test Conditions: 120°C

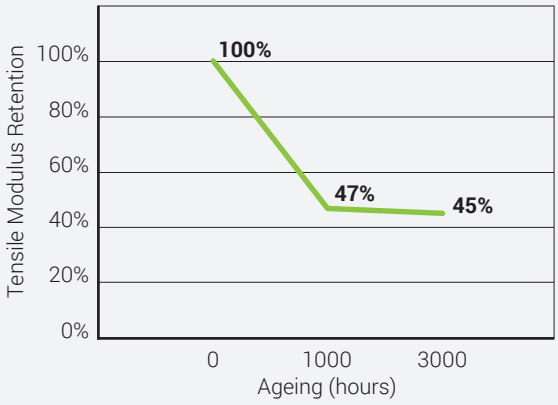


Chart 6 | Radilon® A RV300HRG 3900 BK, Test Conditions: 120°C

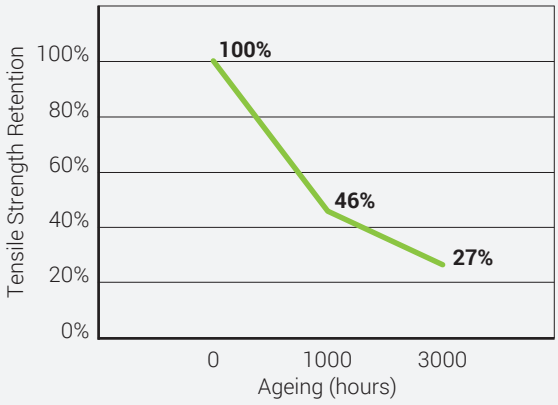
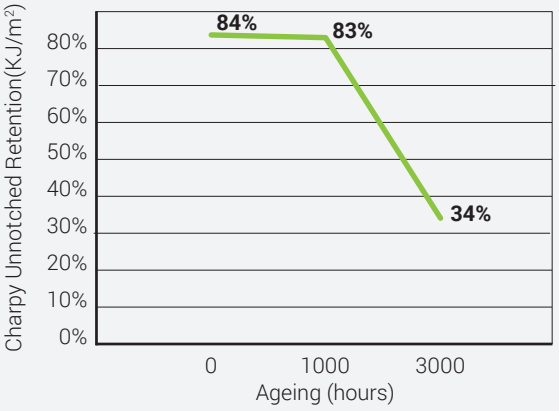


Chart 7 | Radilon® A RV300HRG 3900 BK, Glycol/Water 50/50, 120°C



Radilon® A RV300HRG 3900 BK exhibits excellent resistance to ageing up to 3000 hours at 120°C, thus substantiating the "Top of the Class" status awarded by important end users for use in car cooling systems.

New solutions for high performance demands: PA6.10 and PPA

Radilon® D shows less water and moisture absorption compared to PA6.6, due to the fact that the Radilon® D PA6.10 polymer has excellent hydrolysis resistance at higher temperatures than PA6.6 and can guarantee better dimensional stability. The PA6.10 product is a partially bio-based polymer as sebacic acid is used for the polymerization process.

Radilon® Aestus T1 is a product based on polyphthalamide, a partially aromatic PA. Thanks to its high heat resistance and melting temperature, it is also suitable for applications requiring superior hydrolysis resistance at high temperatures. The material can be used for the most critical applications where the requirements are:

- High temperature
- Excellent hydrolysis resistance
- High stiffness

Charts 8 and 9 compare the properties of Radilon® D RV300RG 3900 BK to a standard hydrolysis-resistant PA6.6-GF30, after ageing in a 50/50 glycol/water mix at 130°C.

As shown in Chart 8, the property retention of Radilon® D RV300RG 3900 BK is higher than the standard hydrolysis-resistant PA6.6-GF30. At the end of ageing, Radilon® D RV300RG 3900 BK shows tensile strength retention of 68%, which is 70% more than standard PA6.6-GF30.

Chart 8 | Test Conditions:
130°C, 50/50 Glycol/Water

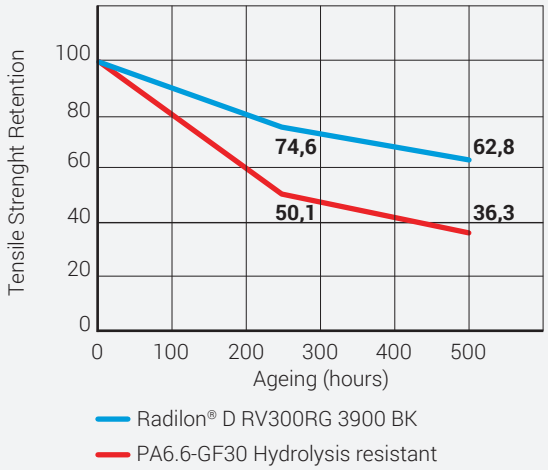
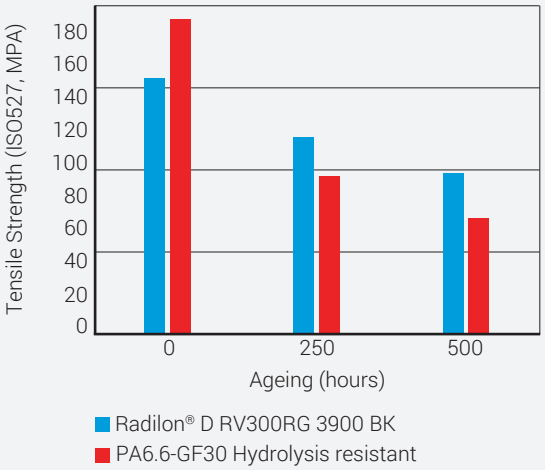


Chart 9 | Test Conditions:
130°C, 50/50 Glycol/Water



Charts 10 and 11 compare the mechanical properties of Radilon® Aestus T1 RV330RG 3900 BK and standard hydrolysis-resistant PA6.6-GF30. This characterization was done using a strict testing method requiring an autoclave to perform the ageing process in coolant. In Figure 10, after 1000 h at 135°C, Radilon® Aestus T1 RV330RG 3900 BK exhibits tensile strength retention 4 times higher than standard hydrolysis-resistant PA6.6-GF30.

Chart 10 | Test Conditions:
135°C, 1000h in autoclave

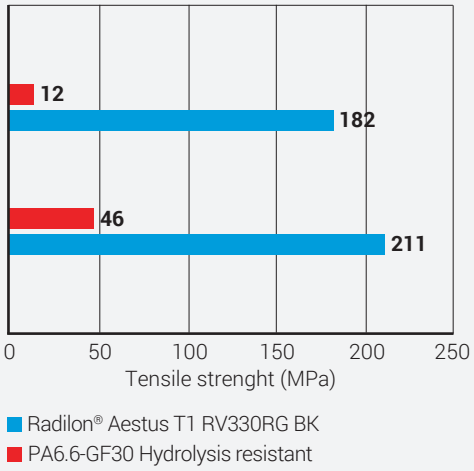


Chart 11 | Test Conditions:
135°C, 1000h in autoclave

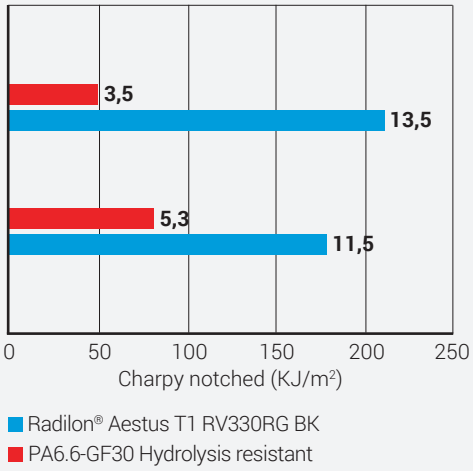


Chart 11 shows the impact behaviour after ageing. In this case Radilon® Aestus T1 RV330RG 3900 BK has 50% higher property retention than standard hydrolysis-resistant PA6.6-GF30. These results explain why the use of Radilon® Aestus T1 RV330RG 3900 BK is recommended for those applications where coolant temperatures are higher than 130°C.

Commitment to innovation in products for the automotive industry and more...

RadiciGroup High Performance Polymers can provide a complete range of materials ideal for car engine cooling systems. The range of products for this important market segment spans from standard to specialty materials and now, with the addition of new PA6.10 and PPA grades to its portfolio, RadiciGroup High Performance Polymers is able to cover all the OEM hydrolysis resistance requirements. The new grades extend the use of polymers to very critical applications, where standard hydrolysis-resistant PA6.6 grades cannot guarantee the required performance level.

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