ARKEMA

ORGALLOY®

High Performance Polyamide Alloys

Chemical Resistance

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INTRODUCTION

The chemical resistance of a material can be defined as it's ability to maintain it's properties after contact with an aggressive chemical reagent for a given temperature and time period.

Many factors can influence chemical resistance, two of the principal ones being:
- The nature and concentration of the reagent
- Temperature

Testing the chemical resistance of a material consists of measuring it's change in properties following exposure to a hostile chemical environment. These properties can be either mechanical (eg, impact resistance, tensile elongation, modulus...), geometric (dimensional stability, swelling), visual (yellowing, surface fracturing) or electrical (resistivity...).

This brochure contains a compilation of the chemical resistance data for ARKEMA's range of polyamide-polyolefine alloys, available under the tradename of ORGALLOY®.

A number of the tests also compare the chemical resistance of ORGALLOY® alloys with standard polyamide 6 and 6.6.

In total, these results enable the typical performance characteristics of ORGALLOY® alloys to be established against the most common chemical reagents to which it could be exposed.

It is however, recommended that the contents of this brochure be used as a general guideline only. Potential users are still advised to confirm the chemical resistance of ORGALLOY® alloys in the particular environment for which an application is envisaged.

2 – CHEMICAL RESISTANCE OF ORGALLOY – GENERAL BEHAVIOR

Medium	Temperature	RS range	LE range	LT range	PA6 or PA 66	PBT
Acetone	23 °C	G	G	G	L	P
Toluene	23 °C	G	G	L	G	-
Trichloroethylene	23 °C	G	G	L	G	P
MEK	23 °C	G	G	-	G	-
Ethanol	60 °C	G	G	-	L	G
Methanol	60 °C	G	G	-	L	G
Methanol/Water 50/50	70 °C	G	G	G	L	-
Fuel/Methanol	40 °C	G	G	-	L	L
Ethylene-glycol/Water 50/50	115 °C	G	-	G	L	-
Ethylene-glycol/Water 50/50	135 °C	L	-	-	P	-
Sulfonitric acid *	95 °C	L	L	-	P	-
H_2SO_4 3%	23 °C	G	G	L	P	G
HCl 10 %	23 °C	G	G	L	L	P
NaOH 5 %	60 °C	G	G	L	L	G
ASTM OIL n°3	80 °C	P	L	P	P	-
Brake Fluid	80 °C	G	G	-	G	G
$CaCl_2$ 5 %	60 °C	G	G	G	L	G
$ZnCl_2$ 50 %	40 °C	G	G	G	L	-

* Composition : H_2SO_4 400mg/l , HNO_3 50 mg/l , HCl 50 mg/l

G Good, **L** Limited, **P** Poor, **-** No data

Remarks : These data are based on tensile test and swelling measurement, after immersion in mediums.
A lot of other factors may influence the properties and mechanical resistance of polymers.

3 – RESISTANCE TO ACIDS, BASES AND SALTS: CHEMICAL AGING VS PA 6

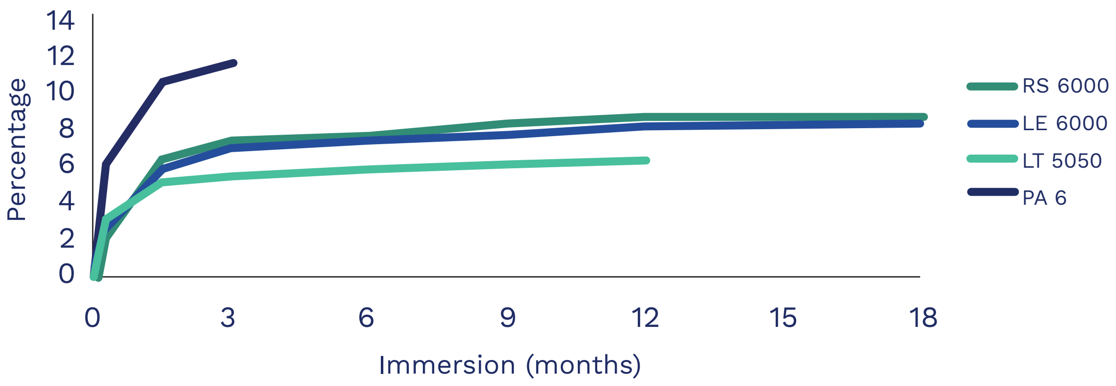
3.1 – Test procedure:

Tensile test:
Equipment: ZWICK 1455 Dynamometer
Test: Tensile
Temperature: 23 °C
Standard: ARKEMA (ISO R 527 procedure with specific dumbells)
Dumbells: IFC (5 Dumbells/product)
Conditioning: n days heat aging immersed in different solvents

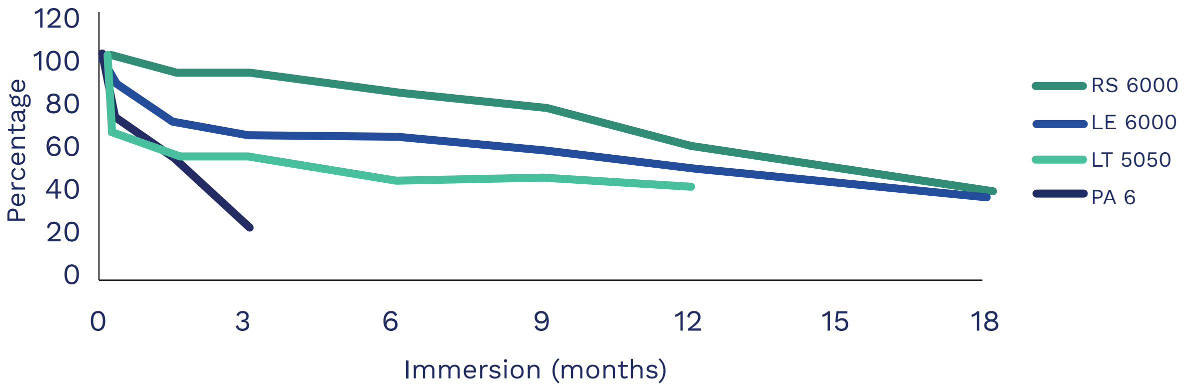
Weight variation:
Equipment: SARTORIUS hydrostatic balance
Test: Weight variation
Temperature: 23 °C
Standard: ARKEMA
Dumbells: IFC (3 Dumbells/product)
Conditioning: n days aging immersed in in different solvents

3.2 – SULFURIC ACID (H_2SO_4) 3% AT 23 °C:

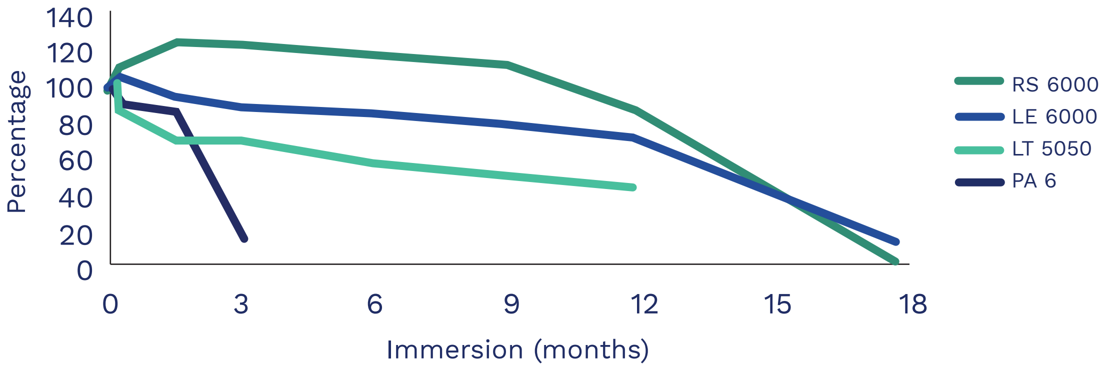
WEIGHT VARIATION



STRENGTH VARIATION

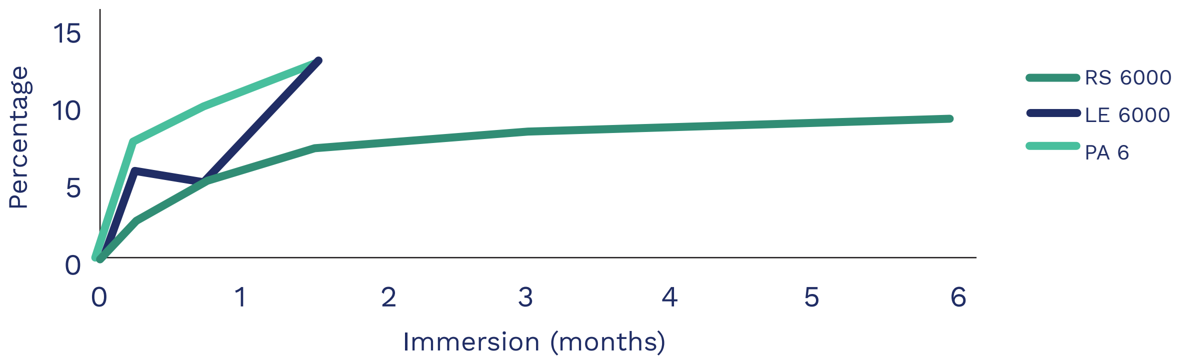


STRAIN OF BREAK VARIATION



3.3 – HYDROCHLORIC ACID (HCl) 10% AT 23 °C:

WEIGHT VARIATION



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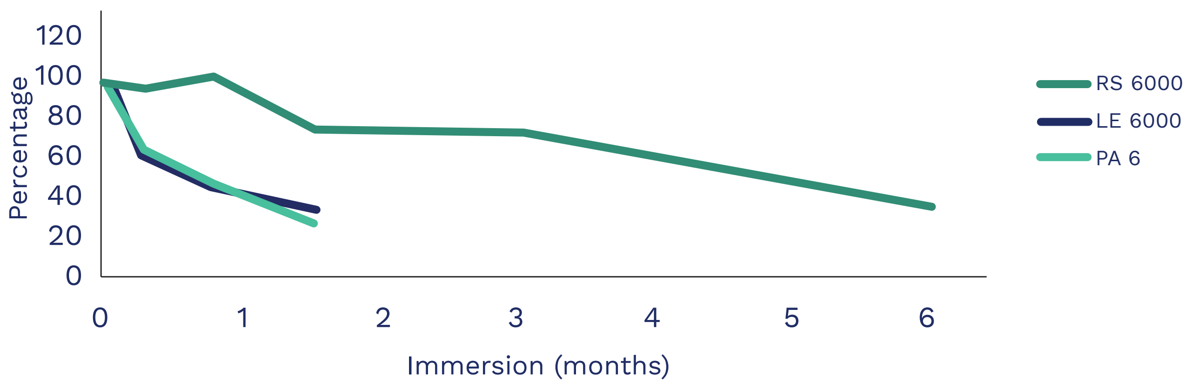
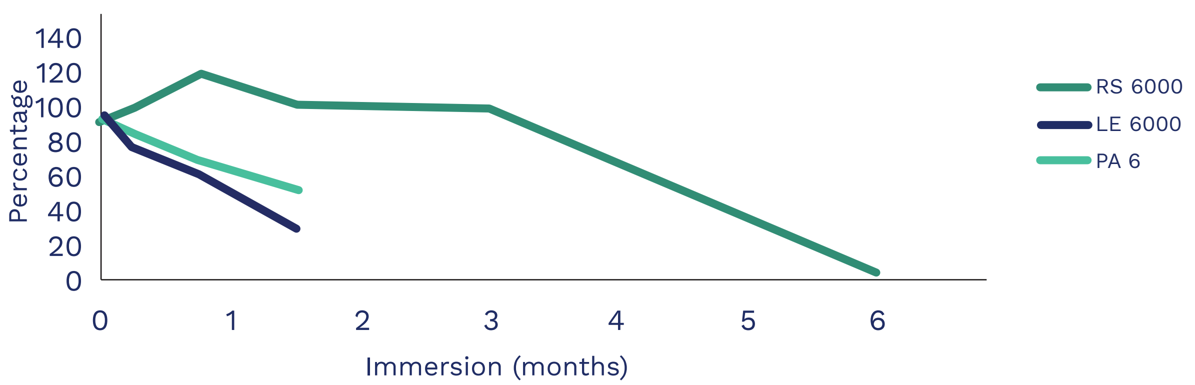
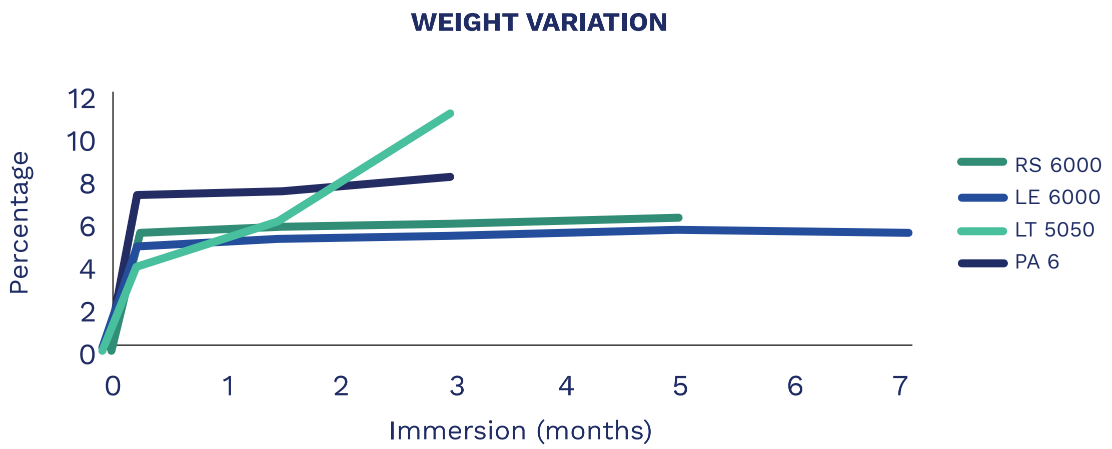
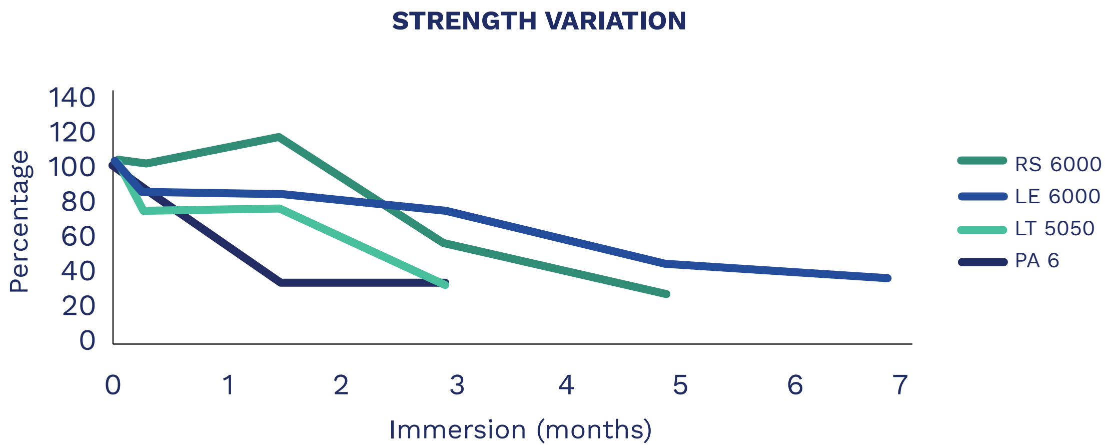


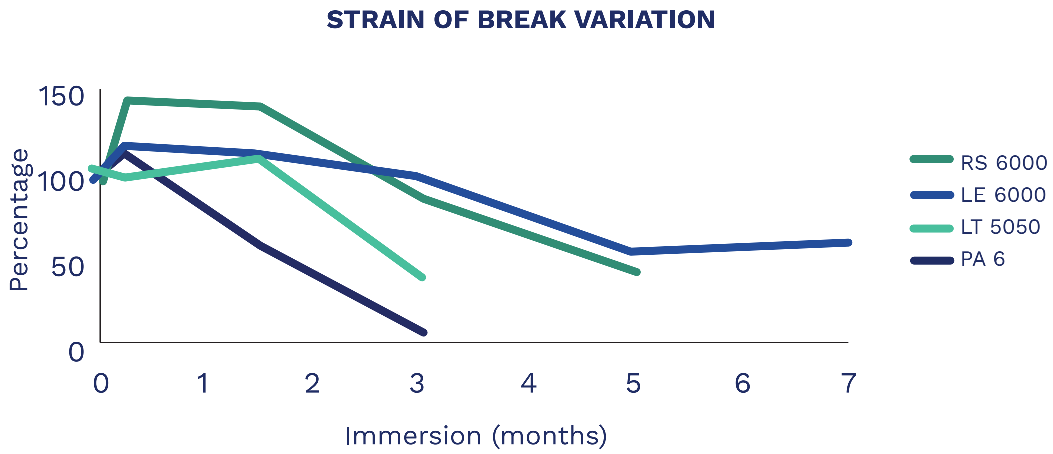
STRAIN OF BREAK VARIATION



3.4 – CAUSTIC SODA (NaOH) 5% AT 60 °C:

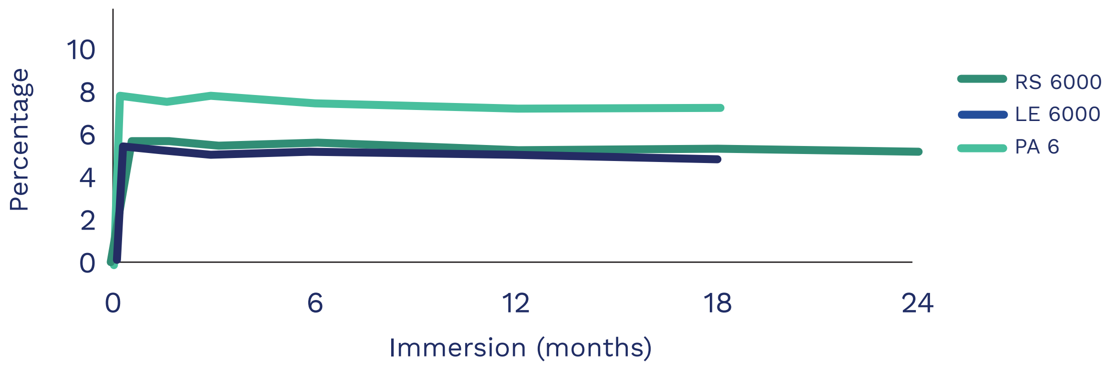






3.5 – CALCIUM CHLORIDE ($CaCL_2$) 5% AT 60 °C:

WEIGHT VARIATION



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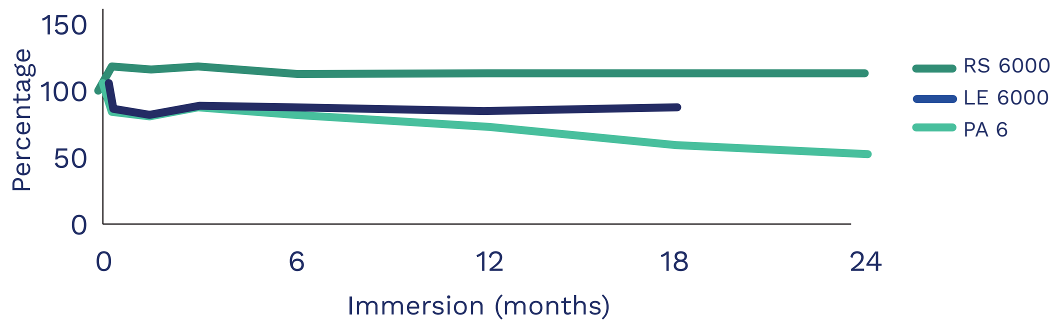
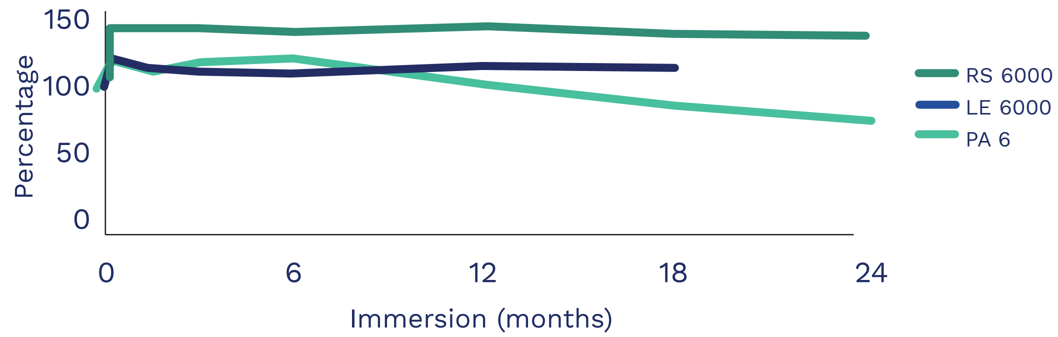
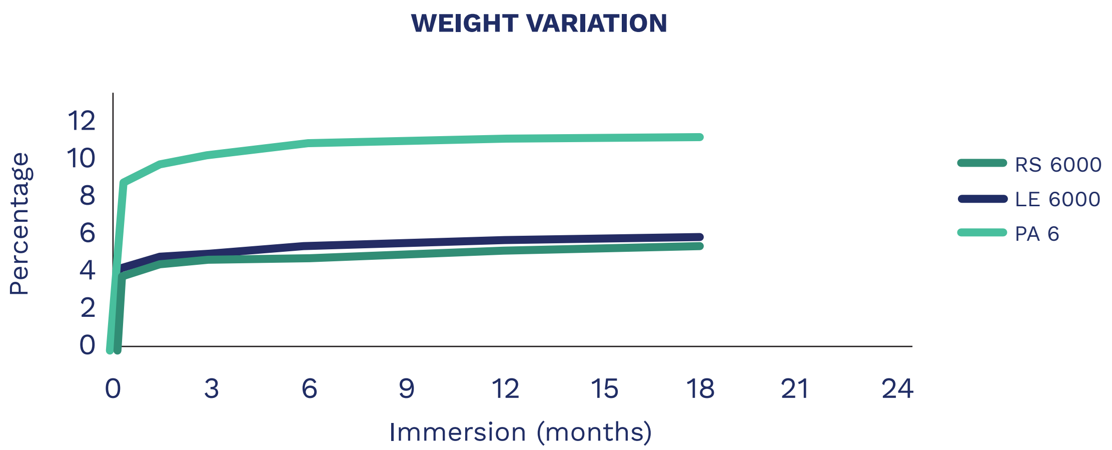


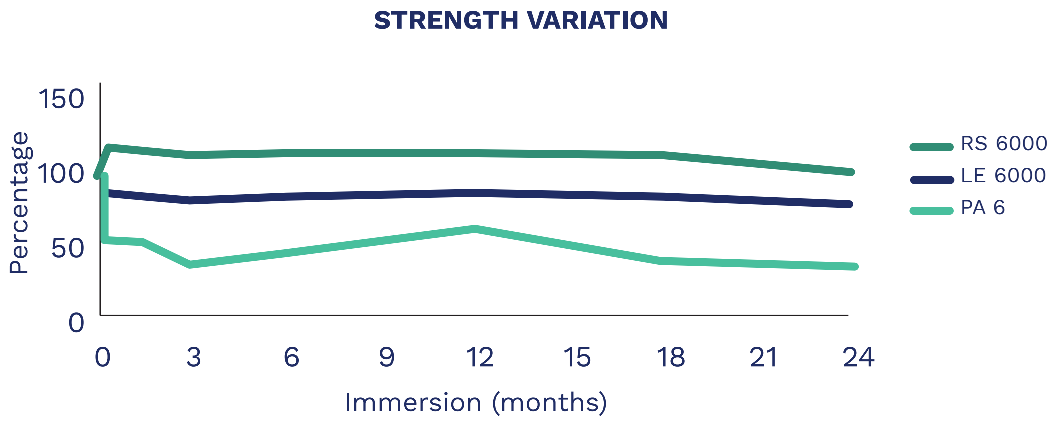
STRAIN OF BREAK VARIATION

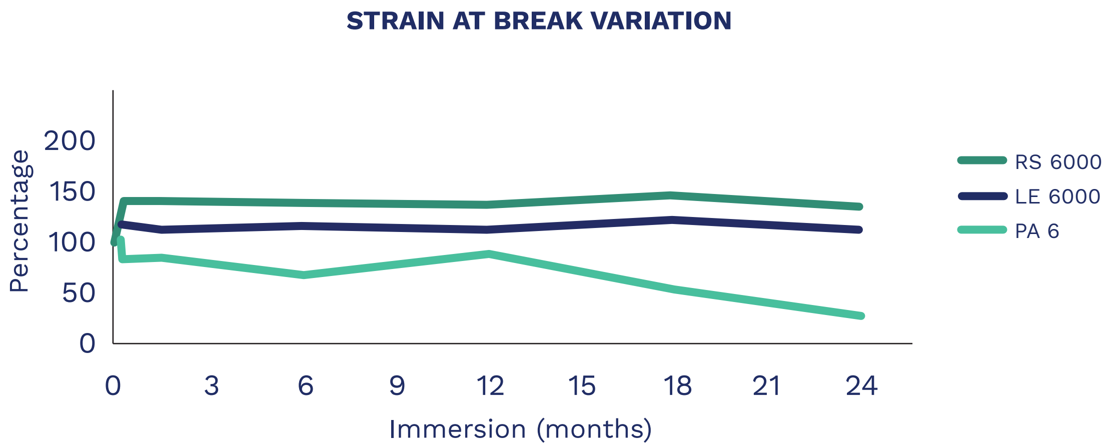


3.6 – ZINC CHLORIDE ($ZnCl_2$) 50% AT 45 °C:

Note : The IFC dumbells were immersed in $ZnCl_2$ solution without any stress. The same test under stress gave totally different results.







4 – RESISTANCE TO ORGANIC SOLVENTS: CHEMICAL AGING VS PA 6

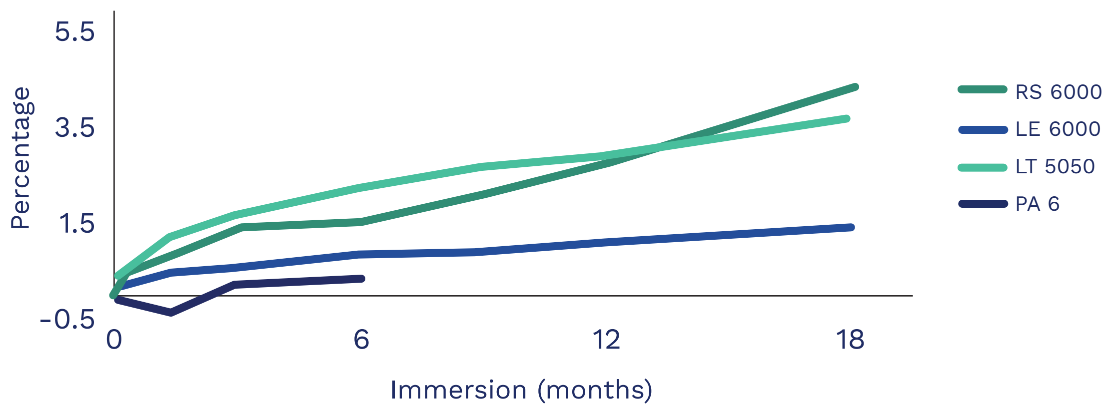
4.1 – Test procedure:

Tensile test:
Equipment: ZWICK 1455 Dynamometer
Test: Tensile
Temperature: 23 °C
Standard: ARKEMA (ISO R 527 procedure with specific dumbells)
Dumbells: IFC (5 Dumbells/product)
Conditioning: n days heat aging immersed in different solvents

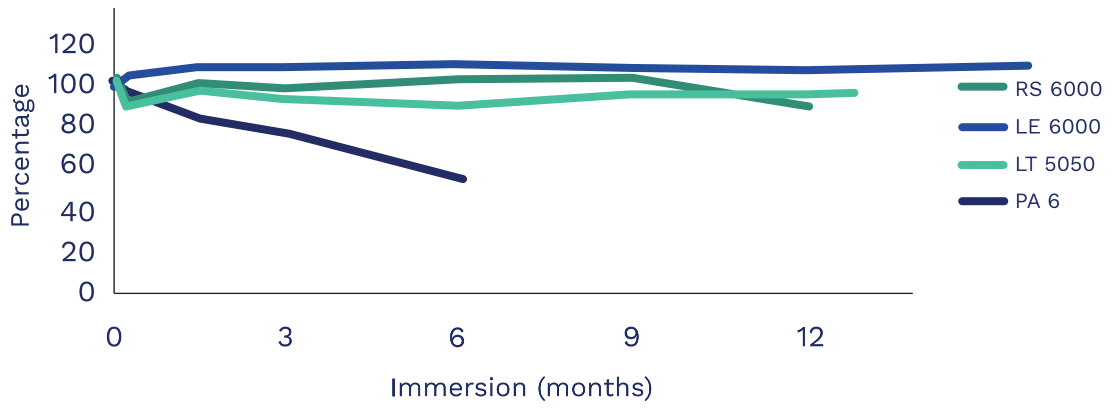
Weight variation:
Equipment: SARTORIUS hydrostatic balance
Test: Weight variation
Temperature: 23 °C
Standard: ARKEMA
Dumbells: IFC (3 Dumbells/product)
Conditioning: n days aging immersed in in different solvents

4.2 – ACETONE AT 23 °C:

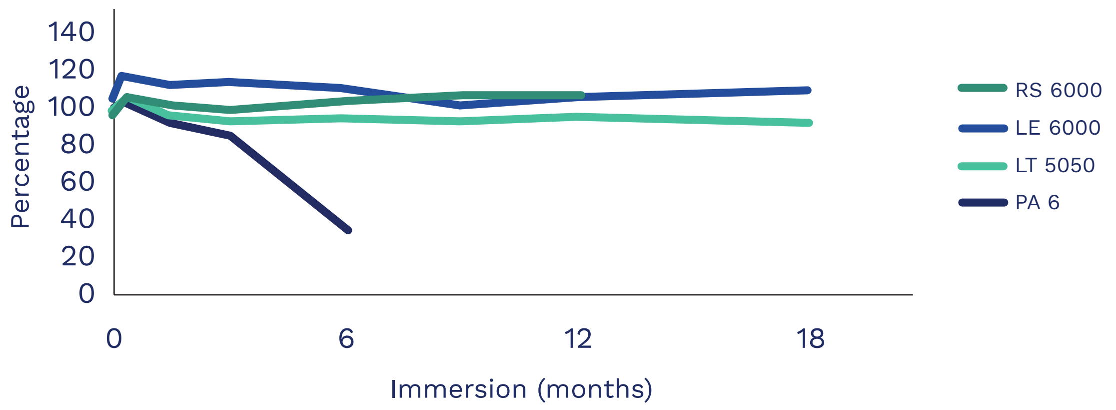
WEIGHT VARIATION



STRENGTH VARIATION

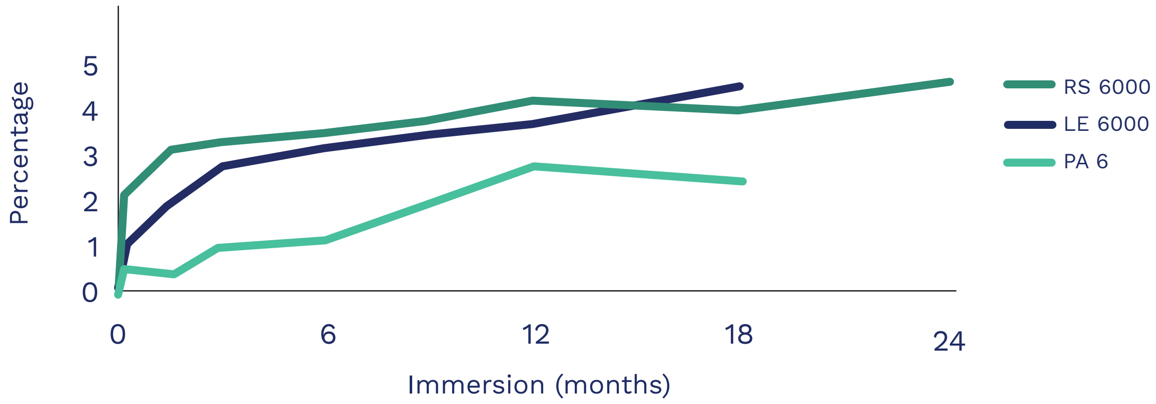


STRAIN AT BREAK VARIATION



4.3 – TOLUENE AT 23 °C:

WEIGHT VARIATION



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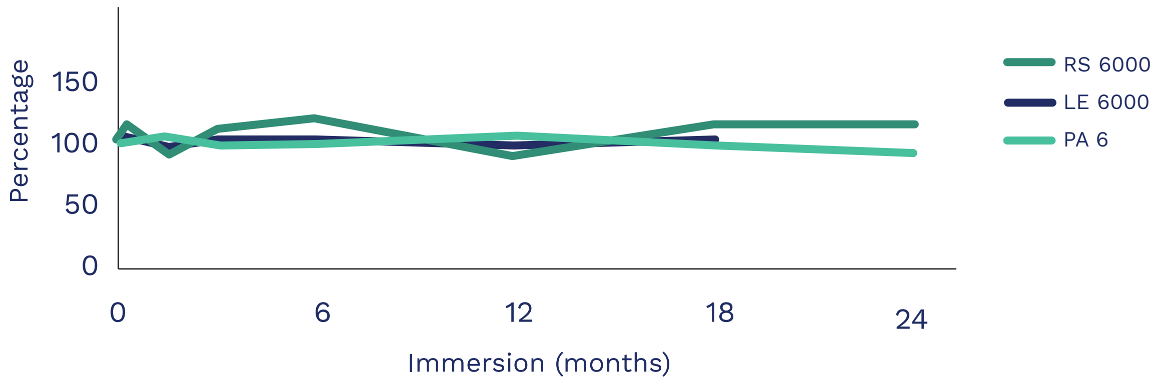
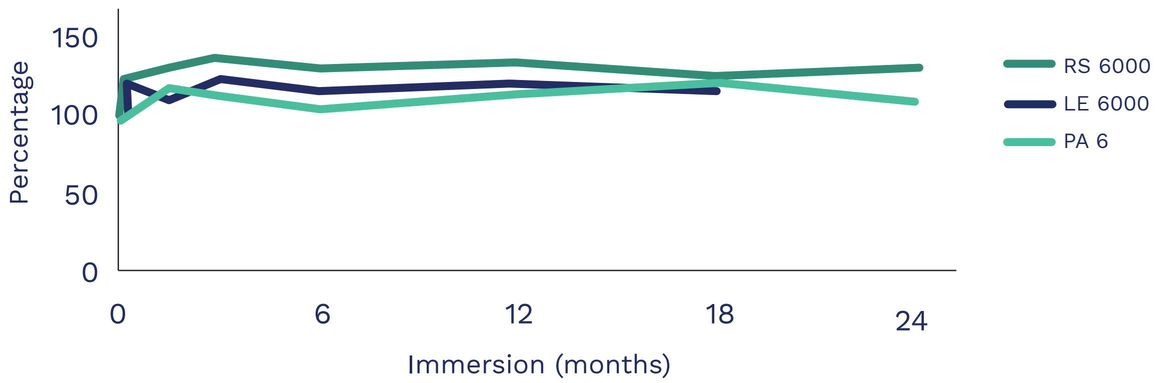
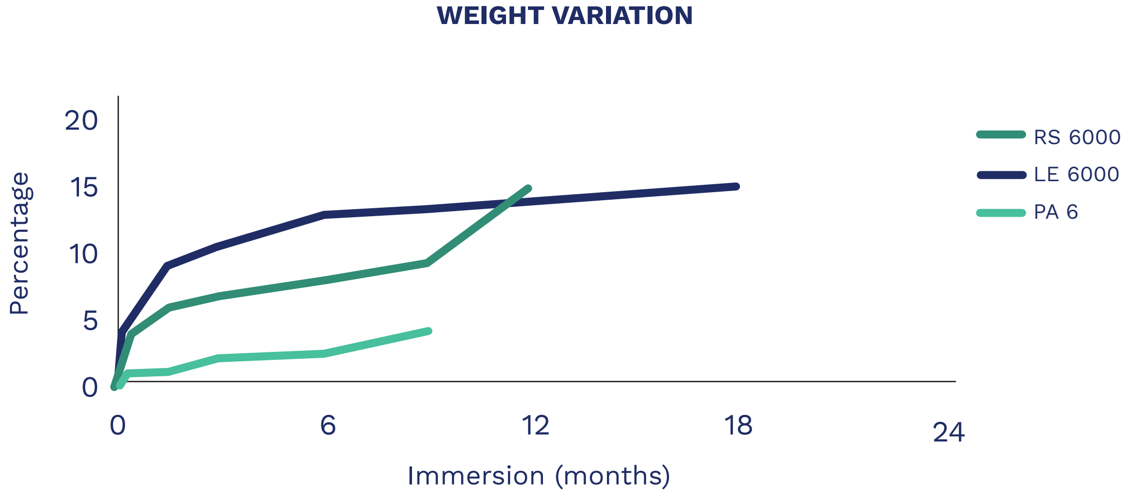
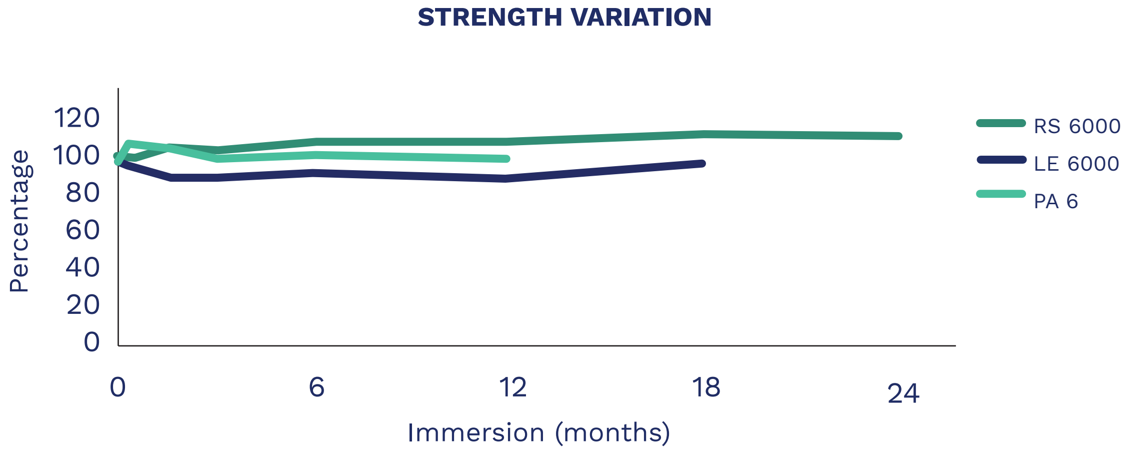


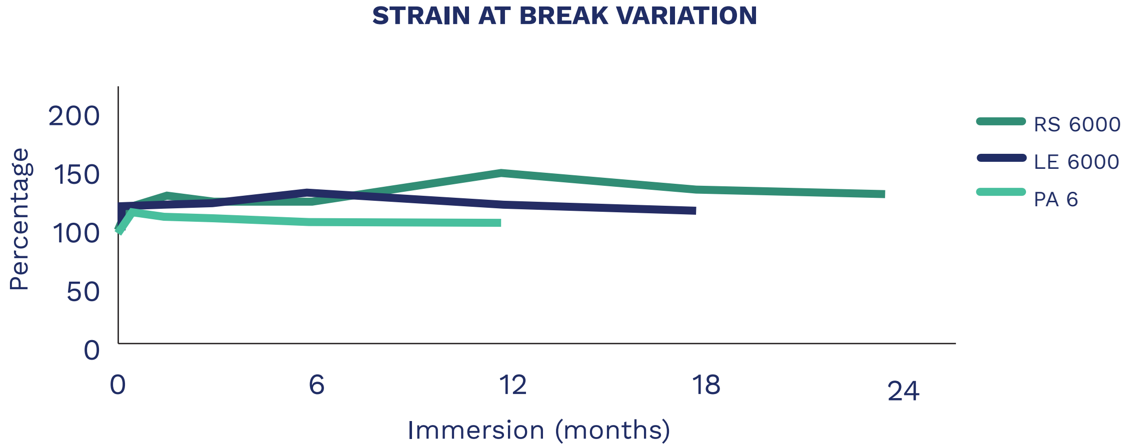
STRAIN AT BREAK VARIATION



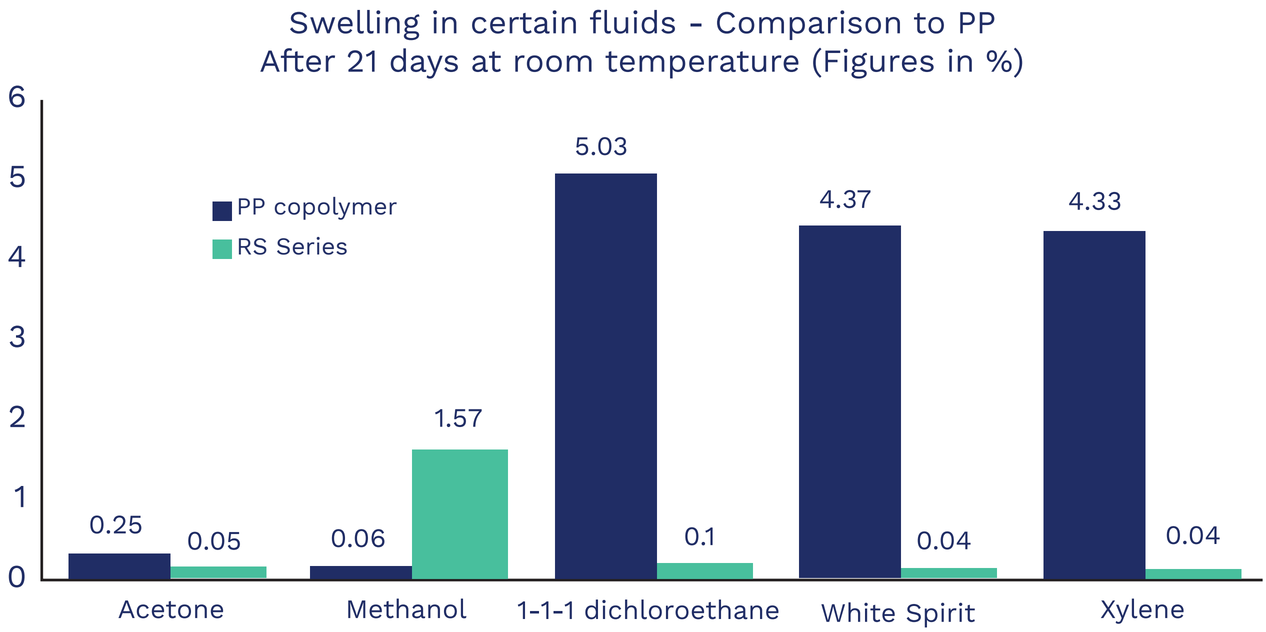
4.4– TRICHLOROETHYLENE AT 23 °C:







4.5 – SWELLING IN VARIOUS SOLVENTS AT 23 °C: COMPARISON



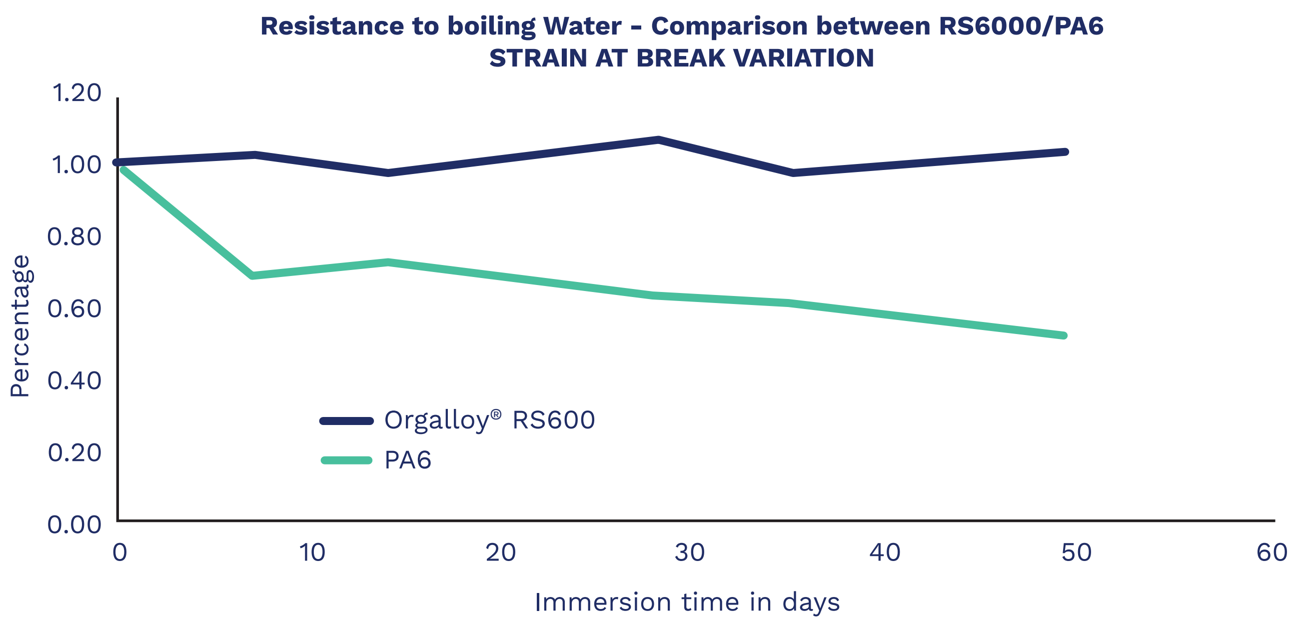
5 – RESISTANCE TO WATER AND COOLING LIQUID: CHEMICAL AGING VS PA 6

5.1 – Test procedure:

Tensile test:
Equipment: ZWICK 1455 Dynamometer
Test: Tensile
Temperature: 23 °C
Standard: ARKEMA (ISO R 527 procedure with specific dumbells)
Dumbells: IFC (5 Dumbells/product)
Conditioning: n days heat aging immersed in different solvents

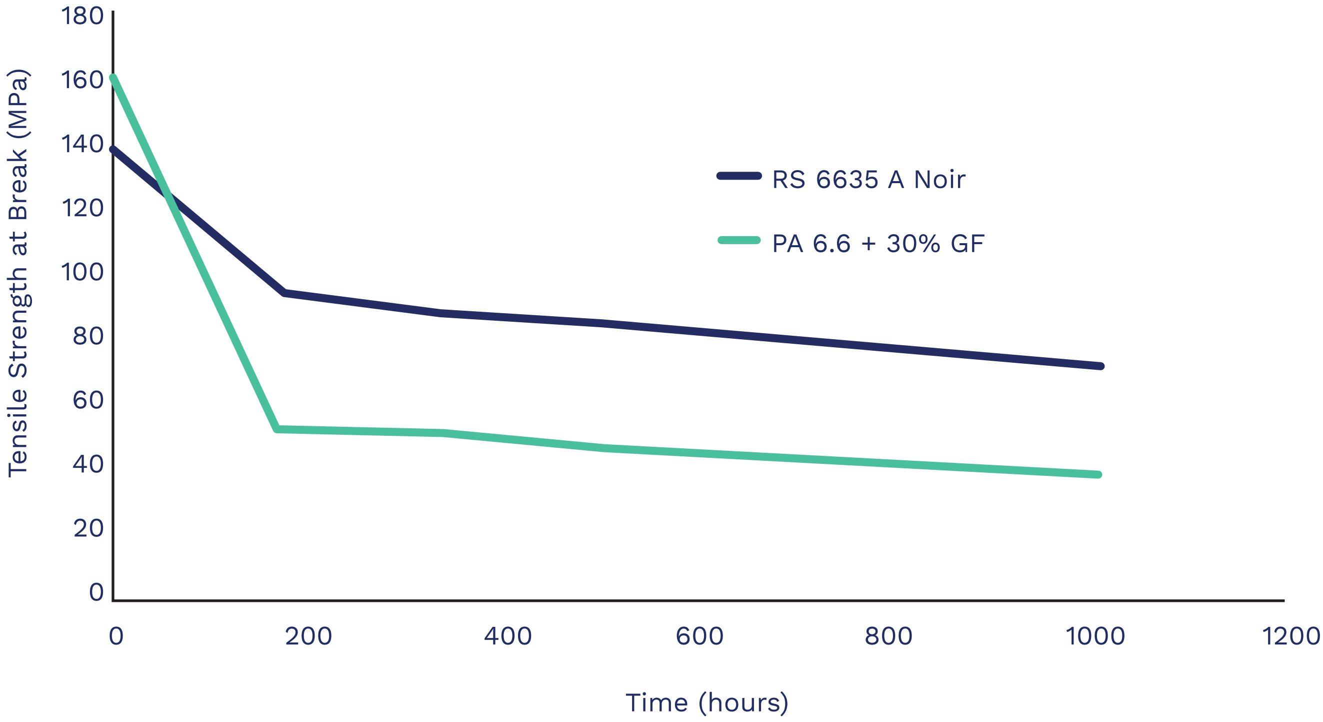
Weight variation:
Equipment: SARTORIUS hydrostatic balance
Test: Weight variation
Temperature: 23 °C
Standard: ARKEMA
Dumbells: IFC (3 Dumbells / product)
Conditioning: n days aging immersed in in different solvents

5.2 – BOILING WATER:

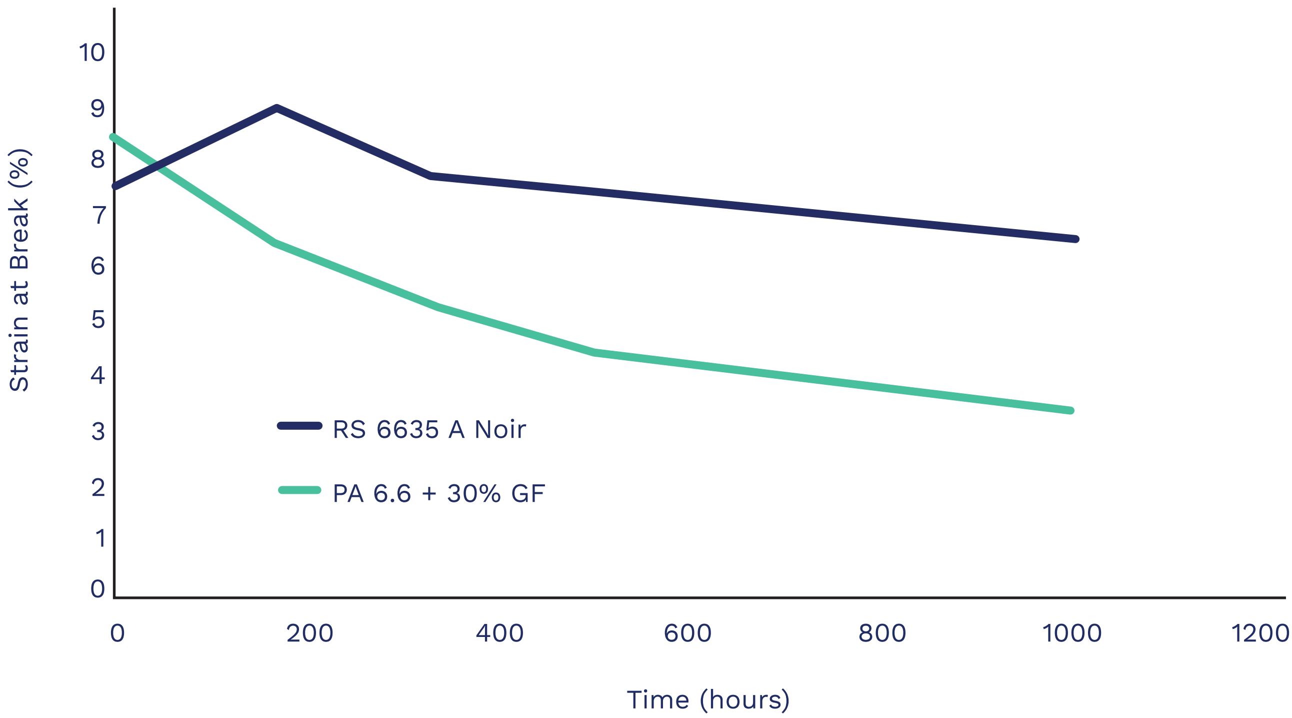


5.3 – COOLING LIQUID AT 135 °C:

STRENGTH VARIATION



STRAIN AT BREAK VARIATION



6 – CHEMICAL RESISTANCE TO FORANE® 134A REFRIGERANT

6.1 – TEST PROCEDURE:

Method: ARKEMA method MO/FTS4/028 – 09/98: Evaluation method for the rubber and plastics resistance to FORANE® 134a refrigerant.

Measurement: Dimensions – Weight – Hardness – Tensile strength at break - after aging in FORANE® 134a refrigerant.

Test specimen: IFC Dumbells

6.2 DIMENSION AND WEIGHT VARIATIONS AFTER 7 DAYS AT 60 °C:

PRODUCT	Length (%)	Width (%)	Thickness (%)	Weight (%)
PA 6.6 modified	-0.3	-0.4	0.3	-0.1
CoPA 6.6/6 plasticized	-1.2	-0.8	-0.8	-2.6
ORGALLOY® LT 5050 T6L	-0.2	0.5	0.1	0.5

6.3 DIMENSION AND WEIGHT VARIATIONS AFTER 7 DAYS AT 100 °C:

PRODUCT	Length (%)	Width (%)	Thickness (%)	Weight (%)
PA 6.6 modified	-0.6	-0.5	-0.2	-0.7
CoPA 6.6/6 plasticized	-4.2	-3.1	-3.7	-9.9
ORGALLOY® LT 5050 T6L	0.9	0.3	1.1	4.5

6.4 HARDNESS AND TENSILE STRENGTH AT BREAK VARIATIONS AFTER 7 DAYS AT 60 °C:

PRODUCT	Hardness (%)	Tensile strength at break (%)	Elongation at break (%)
PA 6.6 modified	-0.1	-0.4	-5.5
CoPA 6.6/6 plasticized	-2.0	1.5	-11.3
ORGALLOY® LT 5050 T6L	0.4	5.3	-8.1

6.5 HARDNESS AND TENSILE STRENGTH AT BREAK VARIATIONS AFTER 7 DAYS AT 100 °C:

PRODUCT	Hardness (%)	Tensile strength at break (%)	Elongation at break (%)
PA 6.6 modified	-0.7	-5.4	-13.4
CoPA 6.6/6 plasticized	-1.3	-1.0	-23.2
ORGALLOY® LT 5050 T6L	-0.4	-6.9	-10.0

For Chemical resistance to other Forane® grades, see ORGALLOY® ALLOYS FOR AIR CONDITIONING HOSE
technical brochure.

7 – RESISTANCE TO OILS: CHEMICAL AGING VS PA 6

7.1 – Test procedure:

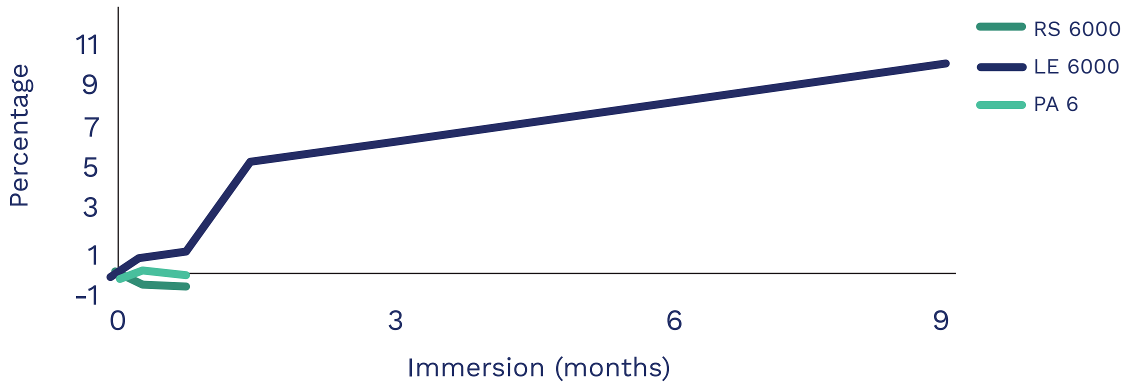
Aging Test Conditions:
Equipment: 12 Autoclaves filled with oil
Temperature: 150 °C (Ventilated oven)
Dumbells: IFC (33 Dumbells/product) immersed in oil
- Elongation at break (5 IFC x 6)
- Weight variation (3 IFC)
- Oils: Industrial A/C oils
- MOBIL GARGOYLE™ Arctic 155 Mineral oil
- MOBIL EAL Arctic 22 Synthetic oil – POE

Tensile test:
Equipment: ZWICK 1455 Dynamometer
Test: Tensile
Temperature: 23 °C
Standard: ARKEMA (ISO R 527 procedure with specific dumbells)
Dumbells: IFC (5 Dumbells / product)
Conditioning: n days heat aging immersed in oil

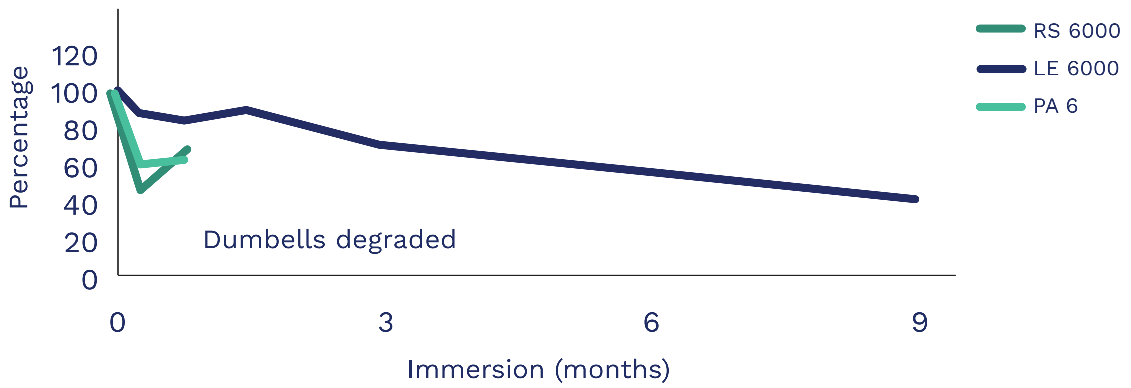
Weight variation:
Equipment: SARTORIUS hydrostatic balance
Test: Weight variation
Temperature: 23 °C
Standard: ARKEMA
Dumbells: IFC (3 Dumbells / product)
Conditioning: n days aging immersed in oil

7.2 – ASTM OIL N°3 AT 80 °C:

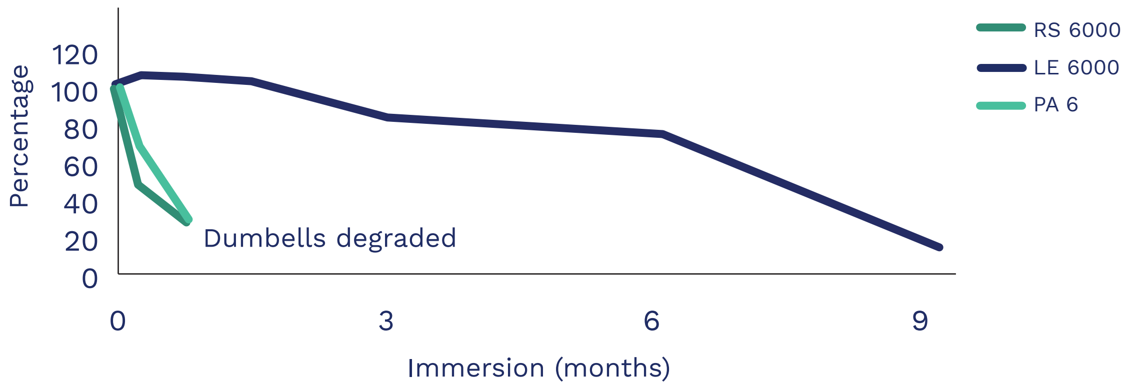
WEIGHT VARIATION



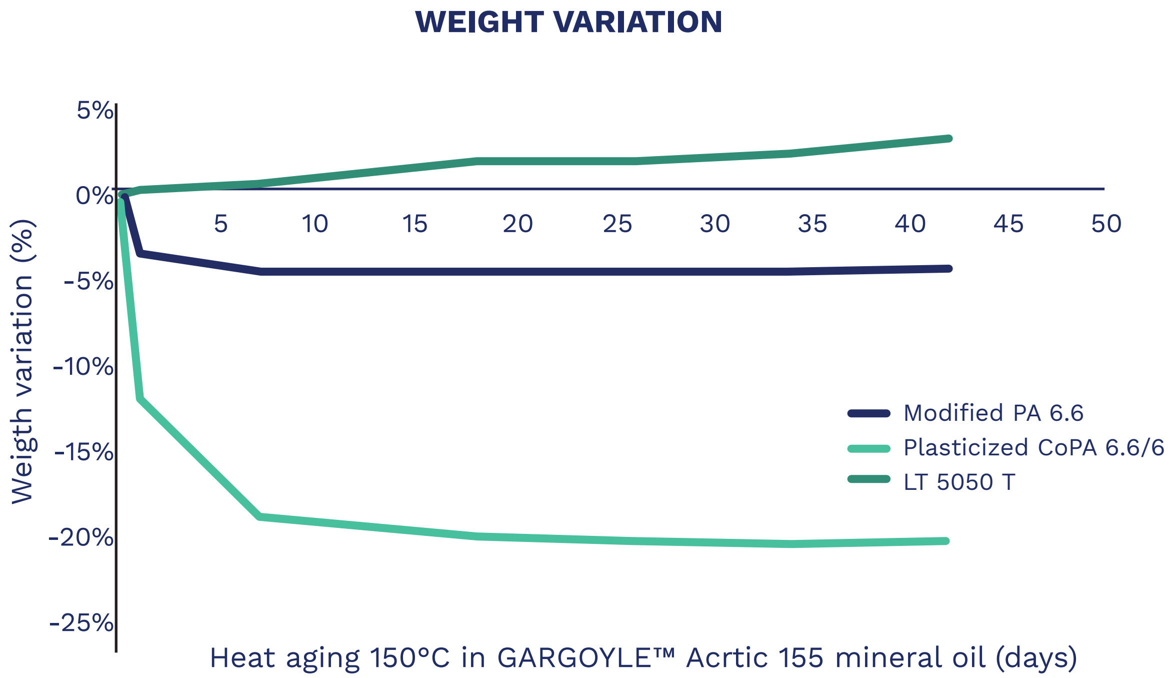
STRENGTH VARIATION

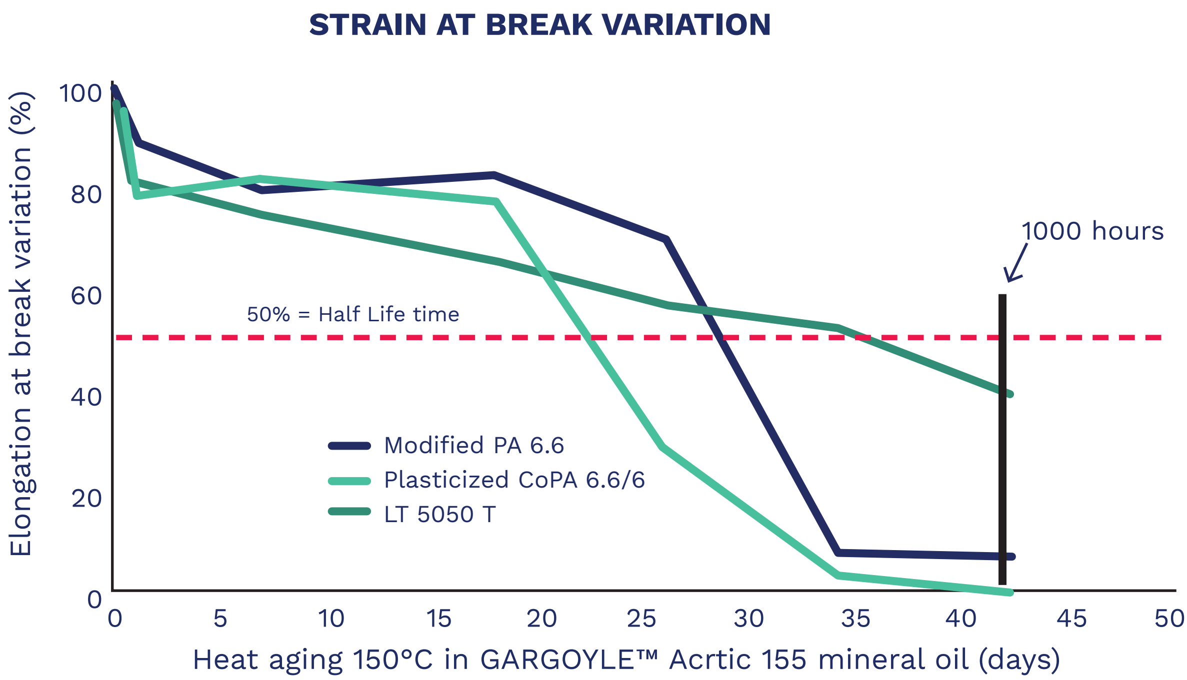


STRAIN AT BREAK VARIATION



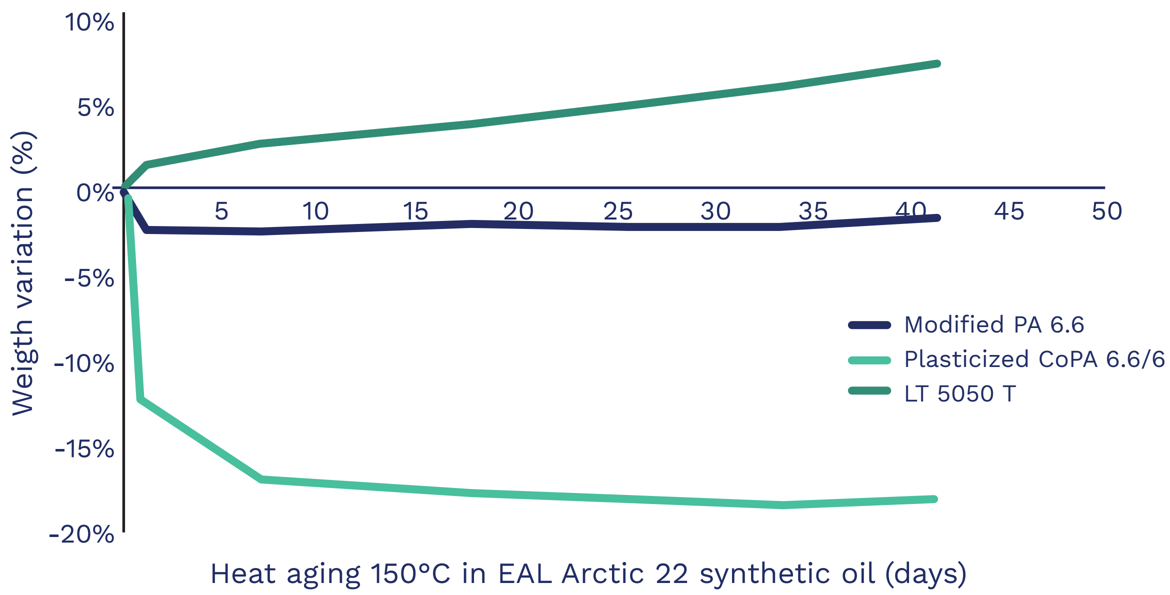
7.3 – AIR CONDITIONING MINERAL OIL AT 150 °C:



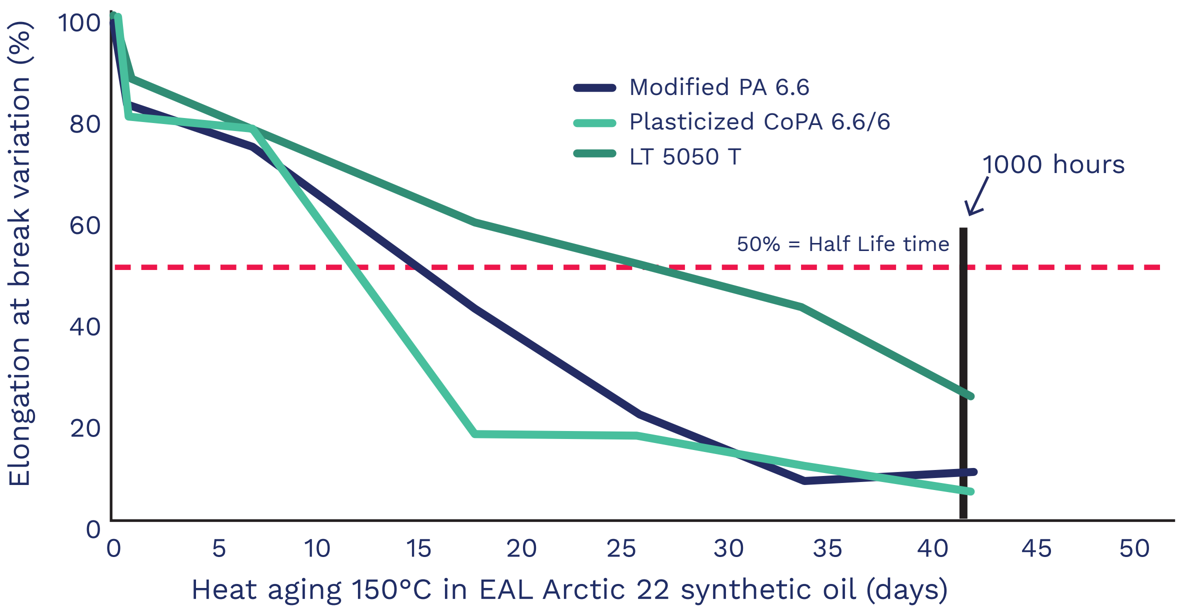


7.4 – AIR CONDITIONING SYNTHETIC OIL (POE) AT 150 °C:

WEIGHT VARIATION



STRAIN AT BREAK VARIATION



8 - Conclusion :

This data within this brochure demonstrates the significantly better chemical resistance of ORGALLOY® alloys compared to standard polyamide 6 and 6.6.

Polyamides are generally known for their good resistance to hydrocarbons, grease, oil and aromatic solvents. On the other hand, they can be affected by polar liquids such as water, alcohols and acids (at higher temperatures). This is shown in the form of hydrolysis, along with changes in dimensional stability and electrical properties.

Polyolefins meanwhile tend to be inert with respect to polar liquids but prone to aging when in contact with hydrocarbons.

ORGALLOY® alloys, through the technology of alloying polyamides with polyolefins, benefits from many of the strengths of the two individual components. In particular, it has excellent dimensional stability and electrical properties in polar solvents as well as improved hydrolysis resistance compared to polyamides.

The chemical resistance of ORGALLOY® alloys along with it’s other outstanding properties make it the material of choice for many market sectors : Automotive (clips, fans, connectors, fuel contact, fluid transfer), Electrical (connectors, cables, circuit breakers, casings, cable ties), Packaging (containers, stoppers, technical films) and Industrial (refrigeration, speciality piping, pump bodies).

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