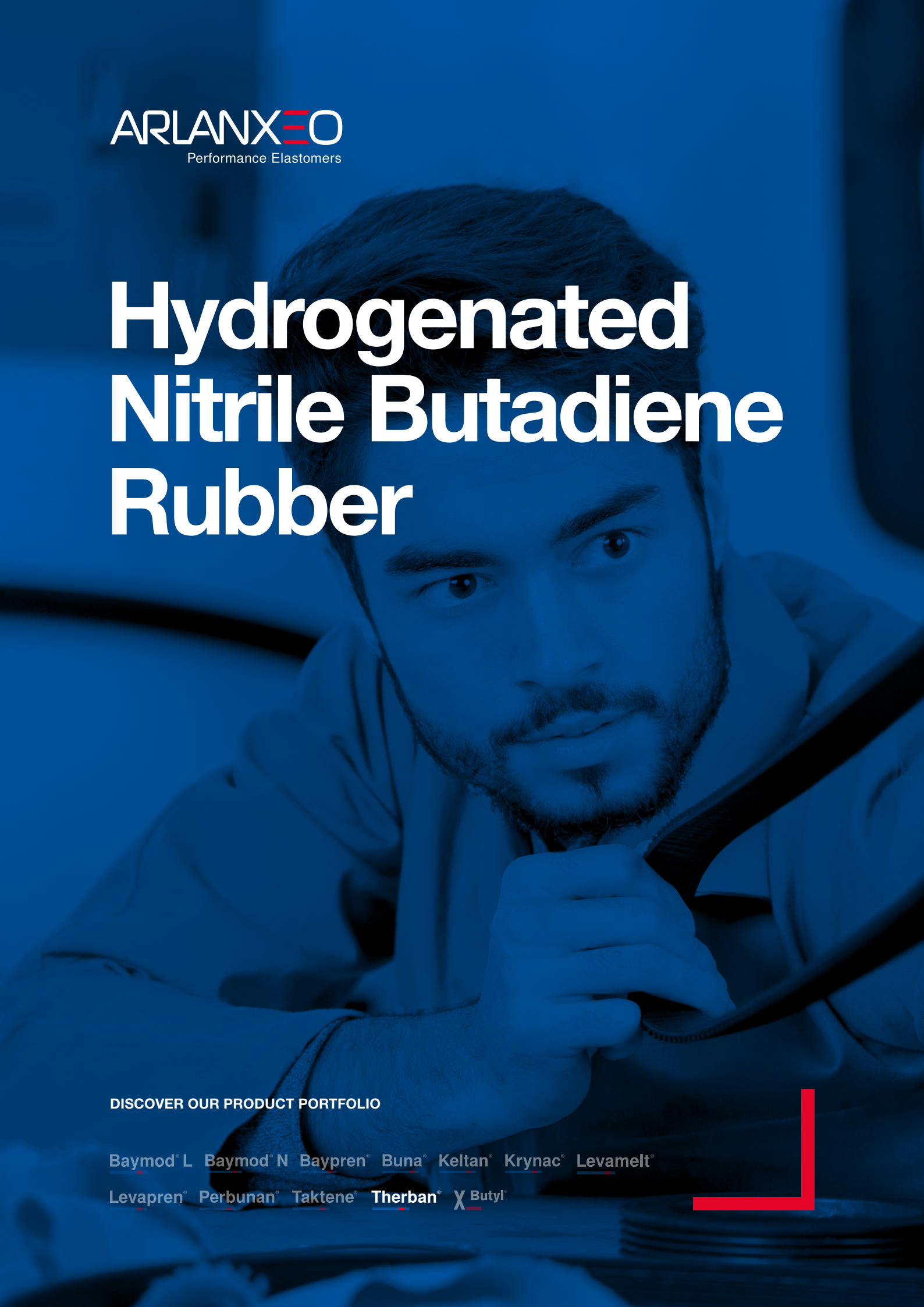
ARLANXEO
Performance Elastomers

Hydrogenated Nitrile Butadiene Rubber



DISCOVER OUR PRODUCT PORTFOLIO

Baymod® L Baymod® N Baypren® Buna® Keltan® Krynac® Levamelt®
Levapren® Perbunan® Taktene® Therban® X Butyl®

ABOUT ARLANXEO

ARLANXEO is a world-leading synthetic elastomer company with its headquarters in The Hague, the Netherlands. Since December 31st, 2018, the company is a wholly-owned subsidiary of Saudi Aramco, a leading producer of energy and chemicals, based in Dhahran, Saudi Arabia. ARLANXEO develops, produces and markets high-performance elastomers that are used for a wide range of applications in the automotive and tire industry, building and construction, oil and gas industries as well as for consumer goods and the pharmaceutical sector.

Our production sites, research and development facilities and business offices span the globe to be close to our customers, maintain short transportation routes and assure high delivery reliability. Our world-scale plants produce efficiently, flexibly and sustainably – in Europe, Asia and North and South America.

As a competent and reliable partner of our customers, we deliver tailor-made solutions that reflect our high standards of quality, innovation, safety and sustainability. ARLANXEO offers a broad product lineup for highest requirements. We aim to create significant value for our customers and shareholders by applying best practices, using best-in class technologies and constantly striving for new and better solutions – for first-class products and services.

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INTRODUCTION

Therban®

Therban® – the answer to your needs

Modern automotive engineering demands elastomers that can withstand high temperatures and aggressive substances and can meet the particular requirements of fuel-saving engine and car body designs. The demands in the oil exploration industry are just as stringent. Here, elastomers must weather aggressive environments and high mechanical stresses.

Standards were set in these fields over 40 years ago with the invention of **Therban®**, the world's first hydrogenated acrylonitrile-butadiene rubber. Since then, our research scientists have been constantly working on improvements. The result is a range of **Therban®** grades which will help you to find solutions for the most demanding applications. Our committed team of experts will give you the necessary detailed advice.

Therban® offers

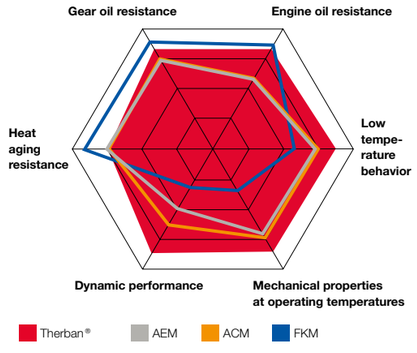
- High resistance to oil and grease
- Ability to function at temperatures from -40 °C to 165 °C
- Superior performance in aggressive fluids such as power steering fluids, automatic transmission fluids, engine oils, diesel and brake fluids
- A unique range of thermally stable grades with both partial and full saturation, ranging from 17 % ACN to 44 % ACN
- Excellent abrasion resistance
- Excellent ozone resistance for fully saturated grades.

The material which assures market success

Better performance gives the competitive edge. For grouped style **Therban®**, high performance is standard. And that means wherever and however it is used. The outstanding property profile ensures excellent vulcanizate properties. Our specialists from technical service will help you to find the **Therban®** grade that will best meet your needs.

Achievable Therban® vulcanizate properties	
Hardness (Shore A)	30 – 95
Tensile strength (MPa)	15 – 38
Elongation at break (%)	100 – 600
Modulus at 100 % elongation (MPa)	3 – 20
Modulus at 300 % elongation (MPa)	5 – 30
"Resilience" (%)	
Room Temperature	30 – 55
70 °C	55 – 65
Compression set (%) (examples)	
70 h / RT	15
70 h /150 °C	20
70 h / 200 °C	25
Abrasion	
RT (mm^3)	30 – 80
150 °C (mm^3)	50 – 80
Low-temperature properties	
Glass transition temperature (°C)	-19 to -40
Brittle point (°C)	-70

Comparison of Therban® with other elastomers



THERBAN® – SUPERIOR IN MANY DISCIPLINES

A direct comparison shows that **Therban®** is superior to many other elastomers and materials in several respects. This means that you can turn to **Therban®** HNBR in applications where you previously needed more complex solutions.

FKM

Therban® is superior to FKM (fluoroelastomer) in:

- Mechanical properties at operation temperature
- Chemical resistance to alkaline oil additives
- Low-temperature properties
- Adhesion

ECO/CO

Therban® is superior to ECO/CO (epichlorohydrin elastomers) in:

- Heat resistance
- Sensitivity to certain oil additives
- Corrosion & sour gas resistance

AEM

Therban® is superior to AEM (ethylene-acrylic elastomer) in:

- Oil and fuel resistance
- Processing properties
- Physical properties at high operating temperature
- Odor

CM/CSM

Therban® is superior to CM/CSM (chlorinated/chlorosulfonated polyethylene) in:

- Heat resistance
- Sensitivity to certain oil additives
- Corrosion resistance
- Sour gas resistance

ACM

Therban® is superior to ACM (acrylate elastomers) in:

- Processing behavior
- Diesel resistance
- Low-temperature properties
- Physical properties
- Adhesion

EVM

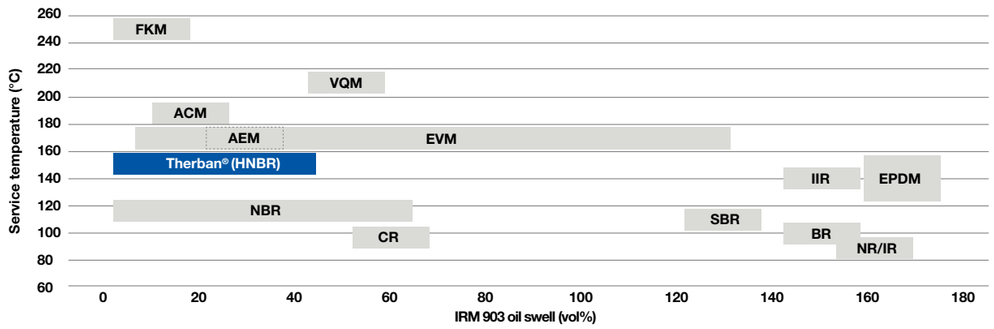
Therban® is superior to EVM (ethylene-vinylacetate copolymers):

- Physical properties
- Low-temperature behavior
- Oil swell

IN A CLASS OF ITS OWN

Therban® is an adaptable high-performance elastomer that can replace many other specialty materials because **Therban®** combines exceptional performance with cost-efficiency and versatility.

Temperature resistance and oil swell of EVM compared with other synthetic rubber families.



APPLICATIONS

A WINNING FORMULA IN PRACTICE

Therban® is already indispensable in automotive systems, oil exploration, mechanical engineering and aerospace. Our research team is focused on extending this advantage.

SEALS

Therban® superior line of fully saturated grades with high heat resistance is suited to seal applications in automotive systems and heavy equipment. Our fully saturated LT grade **Therban**® **LT 2007** provides an excellent combination of high and low-temperature performance, ozone and oil resistance and is ideal for long-term performance in off-the-road vehicle and automotive seals which come into contact with oil and grease.

Use Therban® for:

- Wheel bearing seals
- Shock absorber seals
- Camshaft seals
- Power steering assembly seals
- O-rings
- Water pump seals
- Gearbox shaft seals
- Air conditioning system seals
- Fuel system seals for diesel and RME coolant seals

OIL WELL SPECIALTIES

High ACN saturated grades are best for low swell and explosive decompression resistance. This also applies to fuel and refrigerant applications. No other supplier offers a line of fully saturated HNBR grades that equals **Therban**® for performance.

Use Therban® for:

- Blow-out preventers
- Packers
- Drill-pipe protectors
- Pump stators
- Drill bit seals

BELTS, HOSES, MOUNTINGS

Therban® **LT** grades are especially suitable for applications where cold flex cracking is a problem, as in snowmobile belts. **Therban**® partially hydrogenated grades are the right choice in these dynamic applications.

Use Therban® for:

- Timing belts
- Engine mountings
- Oil-cooler hoses
- Torsional vibration dampeners
- Boots and bellows
- Chain tensioning devices
- Fuel hoses
- Overflow caps
- Power steering hoses
- Ship couplings
- High-pressure hydraulic hoses
- Applications with a high dynamic load

WIRE AND CABLE

Medium-high ACN fully saturated grades are ideal for wire
and cable applications.

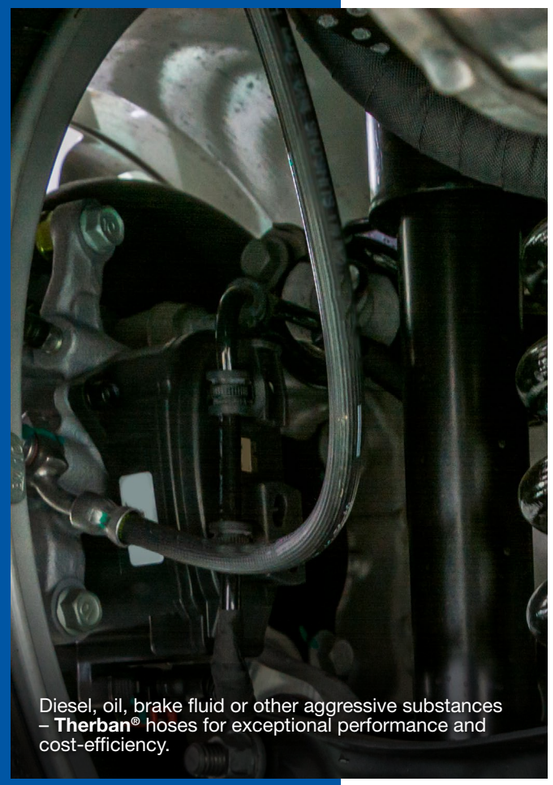
Use Therban® for:

- Protective components for electrical systems
- Protective jackets for electrical cables and wires
- Blends with EVM for FRNC cable jackets with excellent flame-retardant properties and excellent low temperature properties

Why not contact us to find out more?

We would be delighted to help you discover new applications and develop new projects.

Camshaft absorbers with **Therban**® HNBR: longer life-times for timing belts and perfect engine management.



Diesel, oil, brake fluid or other aggressive substances – **Therban**® hoses for exceptional performance and cost-efficiency.

ROLL COVERINGS

Therban® **AT** grades are especially suited to high hardness roll applications; they combine high modulus and good dynamic properties with low compound viscosity and high abrasion resistance. All partially saturated **Therban**® grades from ARLANXEO are ideal for these dynamic applications.

Use Therban® for:

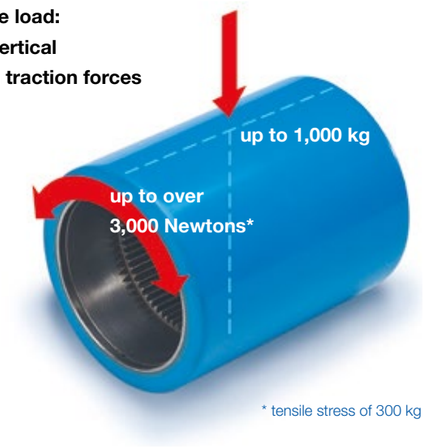
- Metal-working rolls
- Paper industry rolls
- Printing rolls
- Elastomer components for looms
- Textile rolls
- Rolls for transport of containers in aircraft

EXAMPLES

Extremely high demands –
extremely customized solutions

Therban® for covering the rollers of power drive units in the cargo-loading system of one of the world's largest transport planes: top performance in all key criteria including dynamic strength, dimensional and thermal stability, abrasion resistance, resistance to technical fluids and chemicals. The basis for the success is the precisely adjustability of this high-performance elastomer from ARLANXEO to meet specific requirements.

Double load:
high vertical
+ high traction forces



* tensile stress of 300 kg

Big in performance, small in size: outer diameter 74 mm, length 91 mm.

ACCELERATE PROCESSING

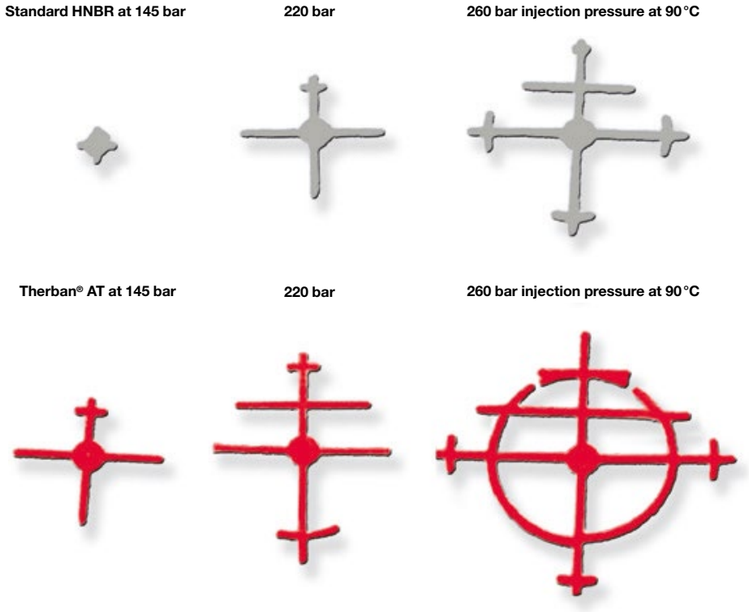
Therban® AT for improved processability
With the **Therban®** AT grades, research scientists at ARLANXEO have achieved a breakthrough in process technology resulting in outstanding benefits for both processing and product properties.

Through a unique process, a series of linear low-Mooney **Therban®** grades has been developed that avoids problems typically encountered during the mixing and compound processing.

Better flow, faster mold filling and shorter cycle times with Therban® AT
In comparison to regular HNBR grades, the low Mooney viscosity of **Therban® AT** leads to better mixing at lower temperatures and therefore to overall cost reduction. Rheovulcameter testing shows the beneficial effect of the significantly improved flow for injection molding. The use of **Therban® AT** may reduce mold filling cycle times by up to 50 %. Alternatively, lower injection pressure or lower temperature can be applied. Extrusion rates can be increased by up to 40 %. Benefits can also be observed for compression molding and transfer molding.

Improved sealing force retention with Therban® AT
Due to the low Mooney viscosity of **Therban® AT**, the use of plasticizers can be reduced or – particularly for crucial compounds – even completely omitted. Thus significantly improved sealing force retention upon aging can be achieved.

Discover the advantages of Therban® AT as the raw material of choice, either applied alone or in a blend with another standard or specialty Therban® grade!

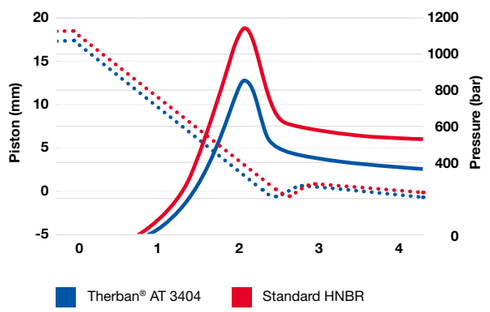


Faster production, smoother surfaces and sharper edges with Therban® AT
The charts on the right show the significant benefits of **Therban® AT** for injection molding and extrusion. Besides time and energy savings in processing, **Therban® AT** improves the quality of the finished article. Improved flow results in smoother surfaces and sharper edges.

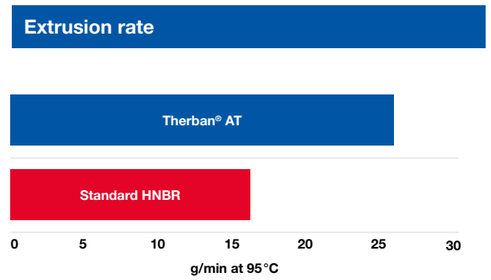
Adjustments of recipe and crosslinking agent to enhance vulcanizate properties for Therban® AT applications
The comparison of various vulcanizate properties shows only minor differences, which can be handled simply and safely. A possible slightly lower crosslink density can be compensated by a minor adjustment of the crosslinking agent.

	Therban® AT 3404 40 phr / 50 phr N330	Standard HNBR 40 phr N330
Modulus (100%) (MPa)	5.6 / 7.5	6.5
Ultimate tensile strength (MPa)	26.6 / 27.8	27.4
Ultimate elongation (%)	273 / 256	237
Shore A hardness (pts)	64/ / 69	66
Compound Mooney	57 / 69	101

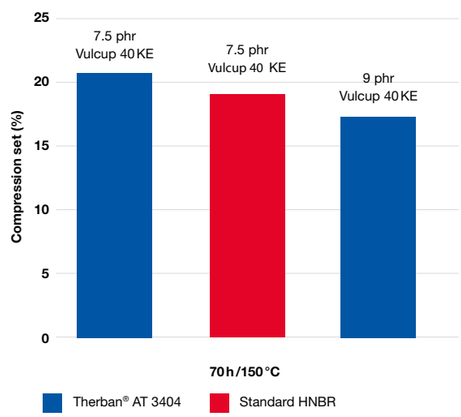
Injection molding



Extrusion rate



Compression set



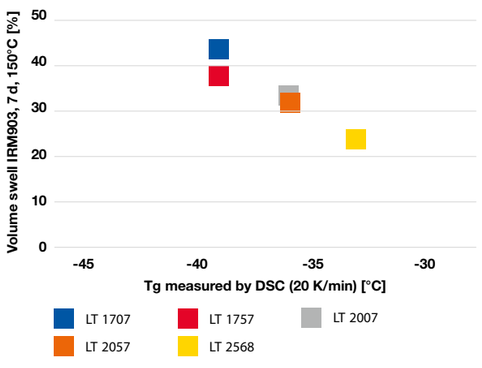
THERBAN® LT GRADES TO COVER ALL LOW TEMPERATURE REQUIREMENTS

The acrylonitrile (ACN) content is a crucial factor determining the properties of **Therban®** compounds. High levels of ACN result amongst others in excellent oil and media resistance. However, at the same time low temperature flexibility is reduced due to the increase of the glass transition temperature caused by the higher ACN content.

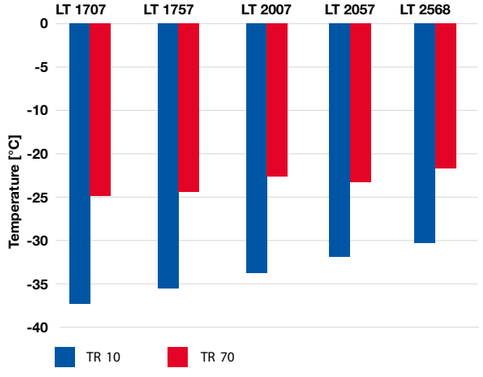
For several low temperature applications the flexibility and excellent compression set at temperatures below -30 °C are more important than volume swell in oil. The **Therban® LT** grade range has been developed for these applications.

The **Therban® LT** portfolio has been expanded from 25 % ACN over 20 % ACN down to 17 % ACN to meet stringent low temperature requirements. The optimal product for volume swell and low temperature properties can be chosen from this broad range.

Tg versus swell, influence of ACN content



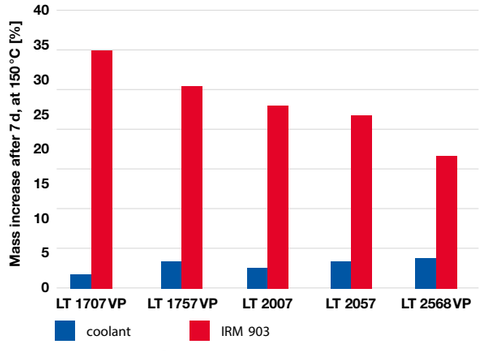
Low temperature properties – improvement TR-10



The answer to your needs when low temperature flexibility is key for the product performance

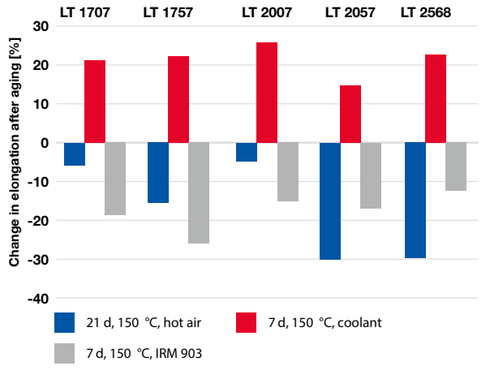
- A broad range of **Therban®** grades for usage at temperatures below -30 °C
- Balanced properties between oil resistance and low temperature flexibility
- Full or partial hydrogenation
- Mooney viscosity ML(1+4)100 °C from 39 to 80 MU
- Optimal material available for every requirement

Oil and media resistance



Higher swell of Therban® LT 1707 VP and LT 1757 VP in IRM 903 reflects lower ACN content

Aging in different Media



THERBAN® PRODUCT RANGE

FULLY AND PARTIALLY SATURATED GRADES

	ACN CONT. (%)	MOONEY VISCOSITY[1] ML (1+4) 100 °C	RESIDUAL DOUBLE BONDS (%)	DENSITY (g/cm³)	STANDARD PACKAGING	REMARKS
Fulvly saturated (suitable for peroxide crosslinking)						
Therban® 3406	34	63	max. 0.9	0.95	Bulk box with 20 bales of 25 kg each wrapped in polyethylene film	similar to Therban® 3407, but with improved flow behavior[2]
Therban® 3407	34	70	max. 0.9	0.95		for lifetime belts, O-rings, gaskets and seals requiring maximum heat resistance and dynamic performance
Therban® 3607	36	66	max. 0.9	0.96		lower swelling compared to Therban® 3407
Therban® 3907	39	70	max. 0.9	0.96		further improved oil swelling resistance compared to Therban® 3607, excellent for fuel-resistant hoses, belts, seals, O-rings and gaskets
Therban® 4307	43	63	max. 0.9	0.96		very high temperature resistance combined with minimal swelling in oils and fuels; ideal for severe application conditions in hoses, diaphragms, O-rings and seals for automotive and oil field applications
Therban® 4309	43	100	max. 0.9	0.96		similar to Therban® 4307 for special compounds with high filler and plasticizer loads
Partially saturated grades (suitable for peroxide and sulfur crosslinking)						
Therban® 3446	34	61	4.0	0.95	Bulk-Box with 20 bales of 25 kg each wrapped in polyethylene film	optimal combination of heat resistance, dynamic properties and processing
Therban® 3467	34	68	5.5	0.95		recommended standard grade for sulfur cure; excellent dynamic properties
Therban® 3496	34	55	18.0	0.96		optimal compromise between low-temperature compression set and oil swell resistance; especially suited for rolls and dynamic oil field components
Therban® 3627	36	66	2.0	0.96		special low RDB type, comparable to Therban® 3607 (peroxide cure recommended) to increase crosslink density for high modulus and/or low compression set applications
Therban® 3629	36	87	2.0	0.96		special low RDB type, similar to Therban® 3627 for higher filler load capacity (peroxide cure recommended)
Therban® 3668	36	80	6.0	0.95		high RDB, high Mooney grade similar to Therban® 3627 for higher filler and plasticizer load capacity
Therban® 4367	43	61	5.5	0.98		excellent resistance to oils; should be used instead of Therban® 4307 in case improved dynamic and bonding properties are required
Therban® 4369	43	97	5.5	0.98		similar to Therban® 4307 with capacity for higher filler loads
Therban® 4498	44	78	9.0	0.98		High ACN and high RDB grade, primarily designed for dynamic application requiring excellent resistance to heat and nonpolar hydrocarbon fluids

[1] unmassed (ISO 289; ASTM D 1646)
[2] see Therban® AT for maximum flow

NOMENCLATURE

Therban® 3406

Brand

wt% ACN
(34, 36, 39, 43)

% RDB
0 ≙ <0,9
2 ≙ 2,0
6 ≙ 5,5
9 ≙ 18

Mooney Viscosity
(x10) approx. MU

ACN Content
Amount of acrylonitrile monomer incorporated in weight%

RDB (Residual double bonds)
Degree of unsaturation, percentage of double bonds remaining after hydrogenation (NBR is defined as 100% RDB)

Mooney
viscosity correlates to molar mass of HNBR, measure for processability

SPECIALTY GRADES

	ACN cont. (%)	MOONEY VISCOSITY[1] ML (1+4) 100 °C	RESIDUAL DOUBLE BONDS (%)	DENSITY (g/cm³)	STANDARD PACKAGING	REMARKS
Low Temperature Technology – LT						
Therban® LT 1707	17	74	max. 0.9	0.96	Bulk box with 20 bales of 25 kg each wrapped in polyethylene film	Low ACN grade for optimal flexibility and excellent compression set at very low temperature, designed for extreme service conditions (peroxide curable)
Therban® LT 1757	17	70	5.5	0.96		designed for excellent compression set at low temperatures (sulfur and peroxide curable)
Therban® LT 2157	21	70	5.5	0.96		optimal low-temperature flexibility balanced with good oil resistance for use in low-temperature belts, seals, O-rings and gaskets
Therban® LT 2007	21	74	max. 0.9	0.96		similar to Therban® LT 2157 with optimal combination of heat and low-temperature resistance, designed for extreme service conditions (peroxide curable), outstanding low mold fouling
Therban® LT 2057	21	67	5.5	0.96		similar to Therban® LT 2157 with outstanding low mold fouling properties (sulfur and peroxide curable)
Therban® LT 2568	25	80	5.0	0.97		similar to Therban® LT 2157 low mold fouling grade with improved oil resistance
Low Mooney – Advanced Technology – AT						
Therban® AT 3404	34	39	max. 0.9	0.95	Bulk box with 20 bales of 25 kg each wrapped in polyethylene film	optimal combination of heat resistance, dynamic properties and processing
Therban® AT 3443	34	39	4.0	0.95		recommended standard grade for sulfur cure; excellent dynamic properties
Therban® AT 3904	39	39	0.9	0.96		optimal compromise between low-temperature compression set and oil swell resistance; especially suited for rolls and dynamic oil field components
Therban® AT 4364	43	39	5.5	0.98		for dynamic applications requiring excellent media resistance. Sulfur cure for improved dynamic properties and adhesion to steel and textile reinforcing materials.
Therban® AT LT 2004*	21	39	max. 0.9	0.95		special low RDB type for low temperature applications and with low mold fouling. Similar to Therban® 3627 for higher filler load capacity (peroxide cure recommended)
Carboxylated Technology – XT						
Therban® XT VP*	33	77	3.5	0.97		excellent resistance to oils; should be used instead of Therban® 4307 in case improved dynamic and bonding properties are required
Acrylate Reinforced Technology – ART						
Therban® ART 3462	34[2]	22[3]	5.5[2]	1.14	20 kg boxes on pallets contents: 640 kg	enhanced stiffness, abrasion and load bearing properties, excellent adhesion to metal; use where extreme dynamic performance is warranted e. g. lifetime belts, paper and steel rolls (peroxide curable)

[1] unmassed (ISO 289; ASTM D 1646)
[2] of base polymer
[3] compound Mooney
* Trial product (VP=Versuchsprodukt)

ARLANXEO
Performance Elastomers

Portfolio/Edition 2023

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Trial Product:
(VP = Versuchsprodukt = trial product). The information contained herein is merely preliminary. Testing as to properties and applications is not final. Further information, including data which could change or add hazards with use, may be developed by the manufacturer, the user or a third-party institute. Such information may be needed to properly evaluate or use this product. Use is undertaken at the sole risk of the user.

Quality & Environmental Management:
All ARLANXEO products are produced under strict control regarding safety, environmental protection and quality. The whole supply chain, from production to customer service, is covered by ISO 9001 and ISO 14001 certification.

Product Safety:
Relevant safety data and references as well as the possibly necessary warning labels are to be found in the corresponding safety data sheets.

Health and Safety Information:
Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the ARLANXEO products mentioned in this publication. For materials mentioned which are not ARLANXEO products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of these products, you must read and become familiar with the available information on their hazards, proper use and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets and product labels. Consult us through your ARLANXEO representative.

Regulatory Compliance Information:
Some of the end uses of the products described in this publication must comply with applicable regulations, such as the FDA, BfR, NSF, USDA and CPSC. If you have any questions on the regulatory status of these products, contact your ARLANXEO representative.
The manner in which you use and the purpose to which you put and utilize our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations, is beyond our control.
Therefore, it is imperative that you test our products, technical assistance and information to determine to your own satisfaction whether they are suitable for your intended uses and applications. This application-specific analysis must at least include testing to determine suitability from a technical as well as health, safety, and environmental standpoint. Such testing has not necessarily been done by us. Unless we otherwise agree in writing, all products are sold strictly pursuant to the terms of our standard conditions of sale. All information and technical assistance is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed that you assume and hereby expressly release us from all liability, in tort, contract or otherwise, incurred in connection with the use of our products, technical assistance and information.

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