

**SIBUR**

**SIBUR Nitrile Rubbers**





## Krasnoyarsk Synthetic Rubber Plant

**Capacity – 42,5 kt/year**

**Integrated management system:**

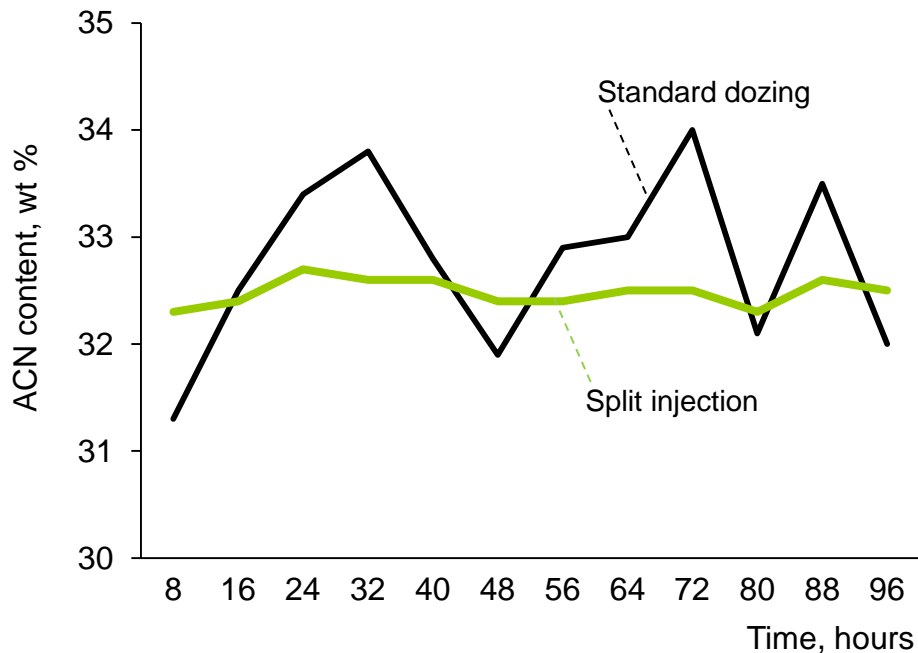
- ISO 9001 Quality Management
- ISO 14001 Environmental Management
- Reach Registration
- FDA registration





## Quality Improvements 2016-2018

### Modernization of the ACN feeding system



### Visual quality control system





## Standard Grades

	NBR 18XX	NBR 26XX	NBR 33XX	NBR 40XX
Definition	Low ACN	Medium ACN	Medium-high ACN	High ACN
ML <sub>-1+4</sub> 100°C	30-120			
ACN content, wt %	17-20	27-30	31-35	36-40
Temperature range, °C	-60 to +100	-30 to +120	-20 to +120	-10 to +120
Applications	Automotive applications, conveyor belts, hoses, O-rings, seals, cables, reinforced sleeves, gaskets, etc.			

### KEY BENEFITS:

OIL & FUEL  
RESISTANCE

ABRASION  
RESISTANCE

EXCELLENT  
PROCESS-  
ABILITY

EXCELLENT  
MECHANICAL  
PROPERTIES

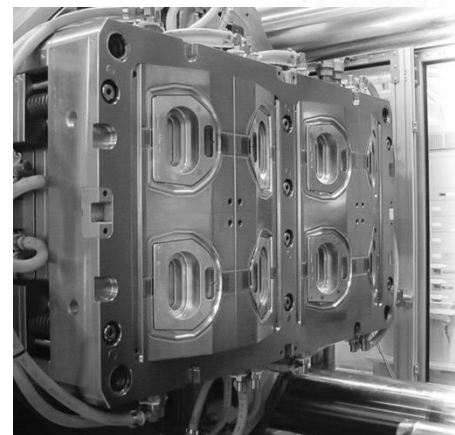




## Special Grades: NBR Fast Curing – Basic Properties

Grade*	ACN content, wt %	ML <sub>1+4</sub> 100 °C
NBR 2645 FC	27-30	45±3
NBR 2675 FC	27-30	75±3
NBR 3335 FC	31-35	35±3
NBR 3345 FC	31-35	45±3

Appearance: bales of light-yellow to pink or light-beige color  
Weight of a bale - 30 kg  
Shelf life: 1 year since the date of manufacture



The mold remains clear for up to 2500 cycles.

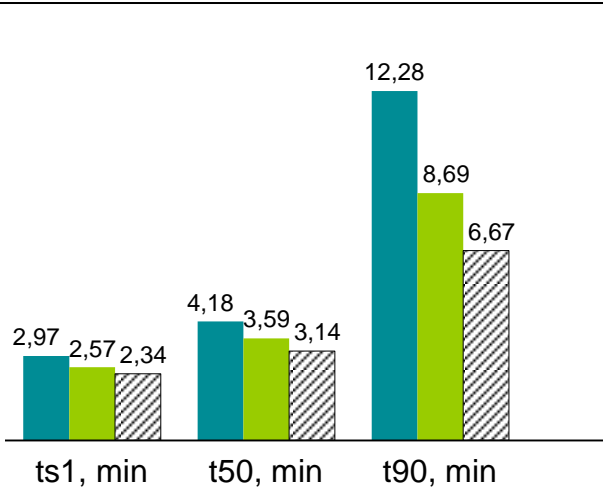
\* - Krasnoyarsk is able to produce other grades of NBR FC with wide range of Mooney viscosity and ACN content.

# Special grades: NBR Fast Curing – Applications & Benefits

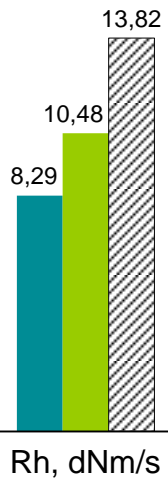
## \*Curing behavior: NBR 3345 FC vs. Standard NBR 3345

\* - MDR 2000: 160°C; 30 min; 0,5° arc

The lower the faster



The higher the faster



■ NBR 'Standard' ■ NBR 'Fast Curing' ▨ NBR 'Fast Curing' New

first industrial trial - IV Q of 2019

## NBR FC designed for injection molding applications

### Processing benefits:

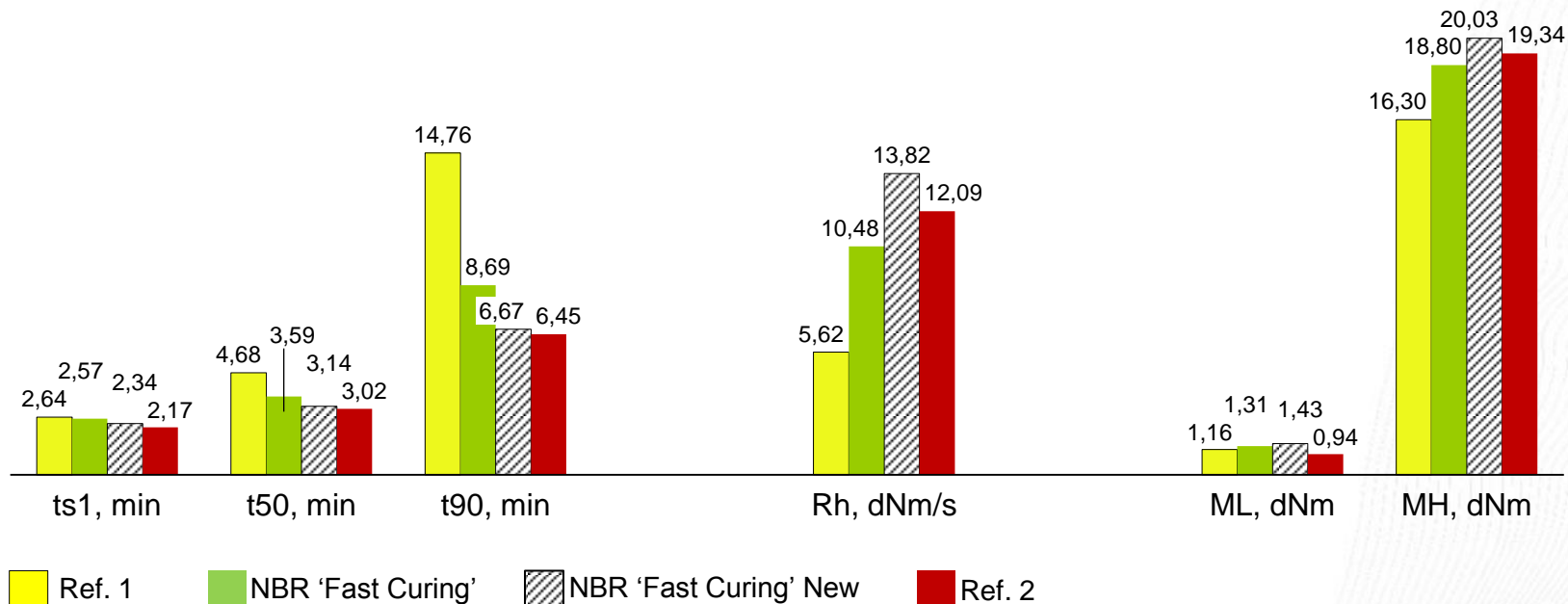
- ✓ Improve the performance of injection moulding equipment
- ✓ Reduce wear of injections moulds
- ✓ Excellent quality of manufactured rubber goods.





## NBR 3345 FC – Benchmark analysis 1/2

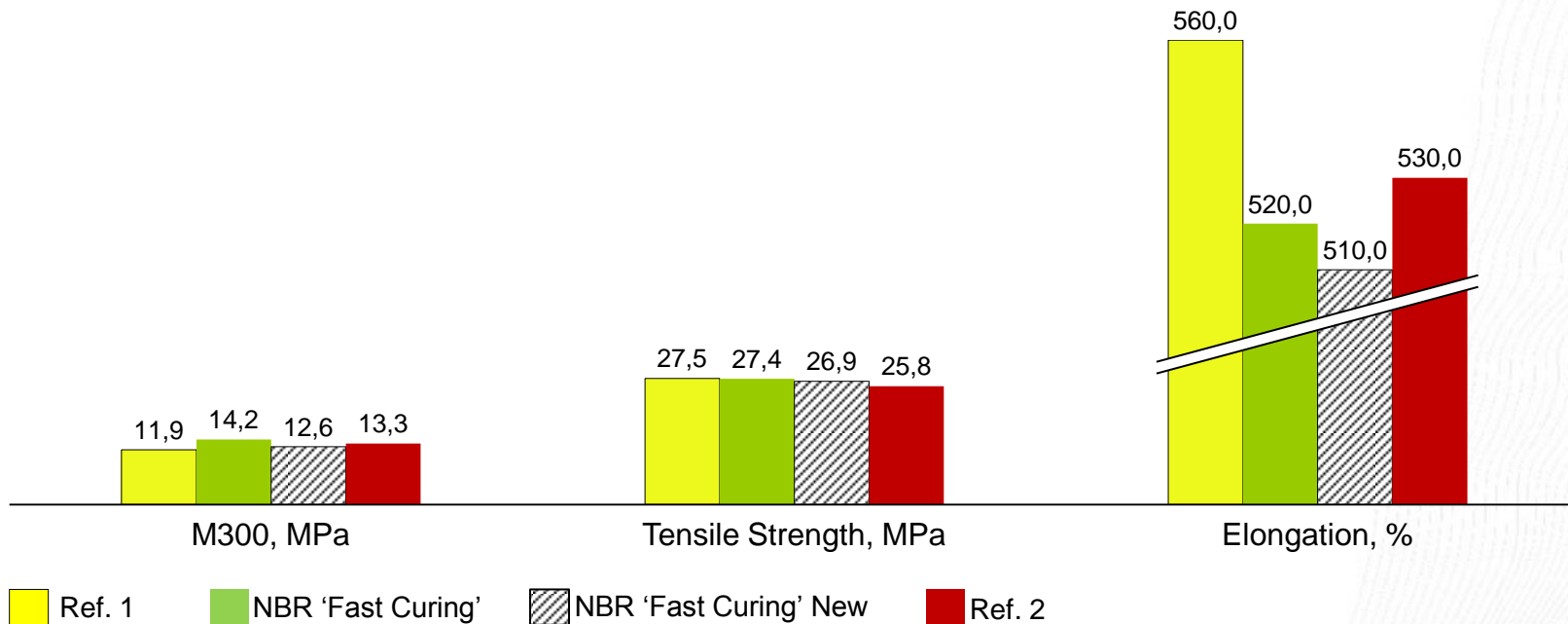
Curing Behavior [MDR 2000: 160°C; 30 min; 0,5° arc]





## NBR 3345 FC – Benchmark analysis 2/2

### Stress-Strain Behavior



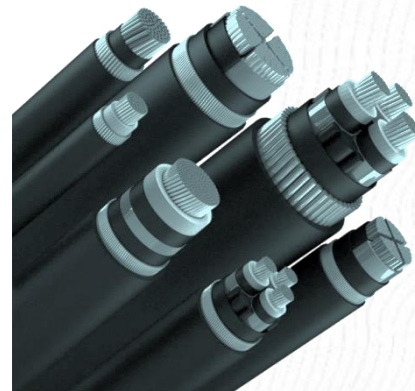




## Special grades: **NBR-26 PVC-30** – Basic properties

Grade	ACN content, wt %	ML <sub>1+4</sub> 100 °C
NBR-26 PVC-30 grade 1	27-30	50-65
NBR-26 PVC-30 grade 2	27-30	66-80

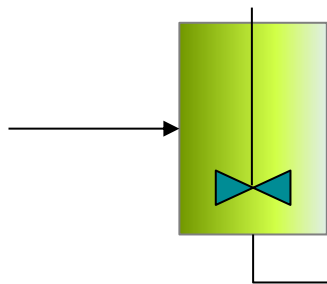
Appearance: bales of light-yellow to pink or light-beige color  
Weight of a bale - 30 kg  
Shelf life: 1 year since the date of manufacture



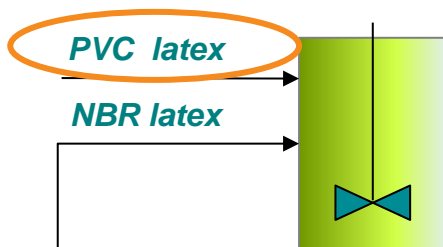
## Special grades: NBR-26 PVC-30 – Technology

Unique production technology

*Polymerization stage*



*Coagulation stage*



*Drying and pressing*



*NBR-26 PVC-30  
(bales)*

SKN-26 PVC-30 is manufactured by co-coagulation NBR latex with PVC latex



## Special grades: **NBR-26 PVC-30** – Applications & Benefits

Cable jackets



Hoses and hoses cover



Conveyer belts



Gaskets and seals



Rollers, shoes, etc.



### KEY BENEFITS:

- ✓ Increased resistance to ozone and adverse weather conditions;
- ✓ High resistance to gasoline, diesel fuel, engine and hydraulic oils, etc
- ✓ High flame resistance (in case of use of flame retardant fillers and plasticizers)
- ✓ Better resistance to wear than vulcanizates based on NBR 'Standard'



## Special grades: **NBR Pre-crosslinked** – Basic properties

Grade	ACN content, wt %	ML <sub>1+4</sub> 100 °C
*PNBR-33 CL (powder)	31-35	45-65
NBR-33 CL (bale)	31-35	35-85

\* PVC as anti-agglomerator, 6-12 wt %

Appearance: bales of light-yellow to pink or light-beige color for NBR-33 CL / white or pinky powder PNBR-33 CL

Weight of a bale - 30 kg; Weight of a cardboard box of powder – 25,4 kg

Shelf life: 1 year since the date of manufacture for NBR-33 CL / 0,5 year since the date of manufacture PNBR-33 CL



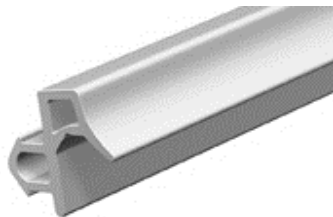


## Special grades: **NBR Pre-crosslinked** – Applications & Benefits 1/2

Stretch PVC film



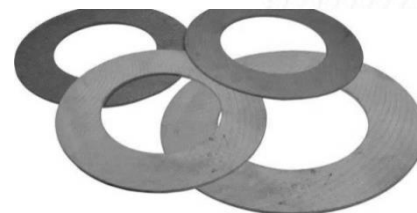
Window PVC seals



Rubber gaskets



Friction linings\*



PNBR 3355 PC and NBR 3355 PC can be used as additives for modification of Nitrile rubbers compounds and PVC to increase the stability of their dimensions during calendaring and extrusion.

\* PNBR 3355PC and NBR 3355 PC are used as a binder in the manufacture of organic friction linings for brake systems.



## Special grades: **NBR Pre-crosslinked** – Applications & Benefits 2/2

### KEY BENEFITS:

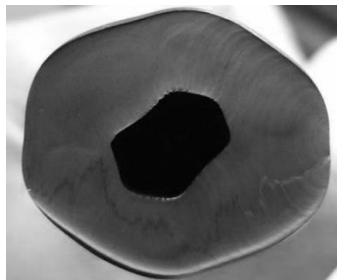
#### Processing

- ✓ Dimensional stability in extrusion and calendering
- ✓ Smooth compound's surface and high compound green strength
- ✓ Good calendering behavior and low shrinkage
- ✓ Reduced nerviness during milling

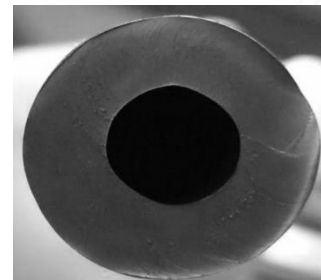
#### Performance

- ✓ Good oil resistance
- ✓ Excellent dynamical performance
- ✓ Improved compression set

Extruded parts of rubber hose compound

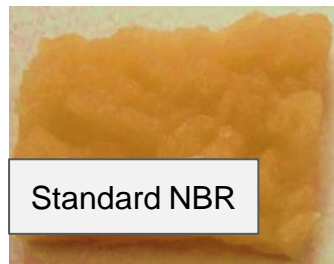


NBR 'Standard'



NBR 3355 PC

Comparative test of milled samples



Standard NBR



NBR 3355PC





## Special grades: **NBR Powder** – Basic Properties

Grade*	ACN content, wt %	ML <sub>1+4</sub> 100 °C
PNBR-3345	31-35	40-49
PNBR-3355	31-35	50-60
PNBR-3365	31-35	61-70

\* PVC as anti-agglomerator, 6-12 wt %

Application: stretch PVC film, hoses, profiles, gaskets, wires and cables, adhesives, etc.

Appearance: white or pinky powder  
Weight of a cardboard box of powder – 25,4 kg  
Shelf life: 0,5 year since the date of manufacture





## Special grades: NBR 'New Type' – Basic Properties

Grade*	ACN content, wt %	ML <sub>1+4</sub> 100 °C
NBR-2645 NT	27-30	42-48
NBR-3335 NT	31-35	32-38
NBR-3345 NT	31-35	42-48
NBR-3375 NT	31-35	72-78

Applications: colored compounds for injection molding, carbon black compounds, automotive molded parts, sealings, conveyor belts, industrial and hydraulic hoses, shoe soles, etc.

Appearance: bales of light-yellow to pink or light-beige color

Weight of a bale - 30 kg

Shelf life: 1 year since the date of manufacture





## NBR 'New Type' Benefits

- ✓ NBR NT has more linear polymer chains or low chain branching
- ✓ Linear polymer structure helps to process it easier due to easy fillers and plastisizers incorporation for better rubber compound quality
- ✓ The linearity provides less force to prepare rubber compound, finally it helps to achieve lower power consumption and save cost;
- ✓ It's also support better injection moulding and highly filled extrusions.





## Different Types of NBR Fingerprint

Parameter	NBR 3345 'Standard'	NBR 3345 'New Type'	Comment
Mooney (1+4) 100 °C, MU	47	47	Comparable
Area under Mooney stress relaxation curve, MU×sec	717	462	The lower value the better for processability. Lower value indicates low chain-branching
ACN, wt %	31,3	31,6	Comparable
Vinyl, wt %			
1.4-trans, wt %	47,4	51,8	Higher 1.4-trans provides easy processing
$M_w \times 10^{-3}$	309	294	Lower PDI indicates better homogeneity of macromolecules.
$M_n \times 10^{-3}$	80	97	
PDI ( $M_w/M_n$ )	3,86	3,03	
Lab. markers for processability prediction of raw rubber			
$1 / (\tan \delta_{0,05\text{Hz}} - \tan \delta_{33,5\text{Hz}})$ <small>[RPA-2000: frequency sweep mode]</small>	2,358	1,848	The lower value the better for processability. Lower value indicates low chain-branching.
Plasticity	0,36	0,42	Higher plasticity provides better quality of extruded articles
Elastic recovery, mm	2,16	1,59	Lower elastic recovery provides better quality of extruded articles



## Evaluation of ASTM Compounds Extrudability

Parameter	NBR 3345 'Standard'	NBR 3345 'New Type'	Comment
Green strength, kPa	606	665	Higher value indicates better carcass of uncured rubber compound
Garvey Die Rating			
Scale A	3-4-4-4	4-4-4-4	No shrinkage issues for 'New Type'
Scale B	6A	8A	Better shape edge for 'New Type'

**Poor shape** of Garvey type extruded article cross-section = **shrinkage issue**

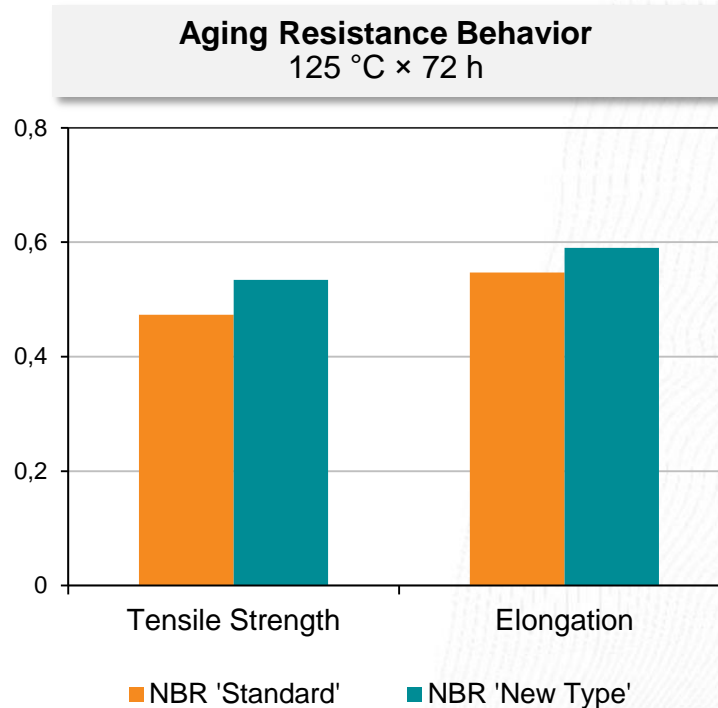


**Good shape** of Garvey type extruded article cross-section = **no shrinkage issue**



## Evaluation of ASTM Compounds Performance

Parameters	NBR 3345 'Standard'	NBR 3345 'New Type'	$\Delta$ , %
Ts2, min	1,266	1,116	-11,8
T90, min	2,183	1,850	-15,3
M <sub>100</sub> , MPa	1,5	1,8	+20,0
M <sub>300</sub> , MPa	4,5	5,2	+15,6
Tensile strength, MPa	15,2	18,5	+21,7
Tear resistance, N/mm	55,7	66,0	+18,5
Shore hardness A	55	57,2	+4,0
Compression set, %	27,0	24,6	-8,9



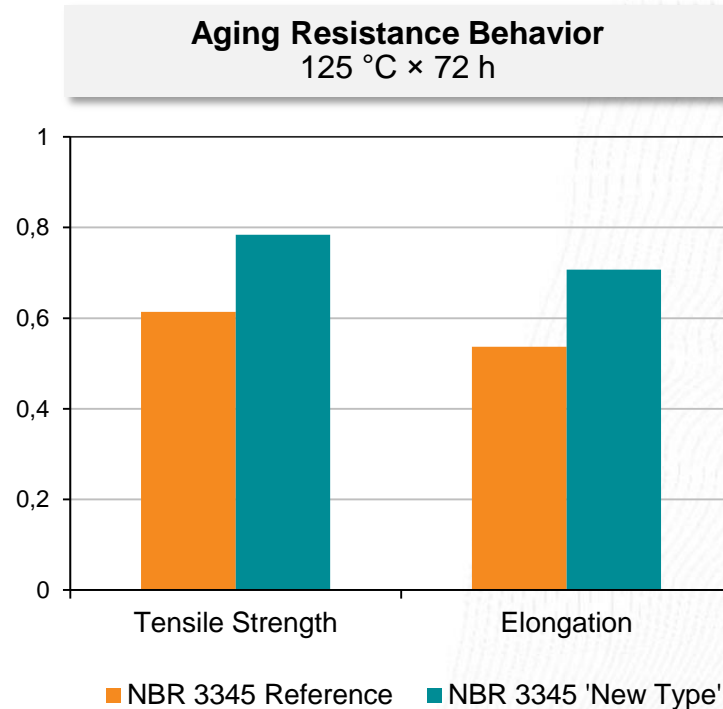




## SIBUR NBR NT vs Reference

Parameters	*NBR 3345 Reference	NBR 3345 'New Type'	Comment
M <sub>100</sub> , MPa	2,9	2,9	equal
Tensile strength, MPa	20,2	20,1	equal
Elongation, %	535	537	equal
Shore hardness A	61	60	equal

\*NBR 3345 Reference - grade of Top European NBR manufacturer





Thank you for your kind attention