

**THE WORLD'S
MOST VERSATILE
RUBBER ADDITIVE**

VESTENAMER®



 **EVONIK**
POWER TO CREATE

EVONIK, THE CREATIVE INDUSTRIAL GROUP FROM GERMANY, IS ONE OF THE WORLD LEADERS IN SPECIALTY CHEMICALS.

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The High Performance Polymers Business Line produces customized products, systems, and semi-finished products based on high performance polymers. Our plastics have proven their worth in various applications for more than 50 years.

VESTENAMER® was developed at the beginning of the 1970s as a processing aid for the tire industry. It is one of the first polymers to be commercially produced in a ring-opening metathesis polymerization.

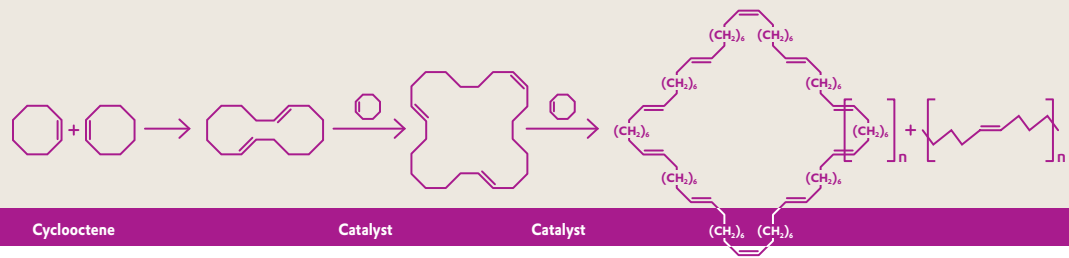
Evonik. Power to create.



Chemistry

VESTENAMER® is produced in a ring-opening metathesis polymerization (ROMP) from cyclooctene. The trans-polyoctenamer (TOR) consists of linear and cyclic macromolecules. The cis/trans ratio, which determines the degree of crystallinity of TOR, is controlled by the polymerization conditions. In general, if trans content is increased, a

higher crystallinity is produced and thus a higher melting point can be obtained. The crystallinity is thermally reversible, and the crystallization rate is exceptionally high. This effect can be used to reduce the cold flow of soft compounds, for example, to improve green strength and reduce shrinkage in calendering.



VESTENAMER® is a semicrystalline rubber that is also described as a trans-polyoctenamer rubber (TOR). It acts as a plasticizer of rubber compounds in mixing and manufacturing processes. In the vulcanization of rubber parts, it participates in crosslinking and, as an elastomer, it is fully incorporated into the network.



VESTENAMER®

Unique properties

- 1 Low melting point**
< 60 °C
- 2 Low viscosity in the melt**
Mooney < 10
- 3 High crystallinity**
~35%
- 4 High percentage of macrocycles**
~25%
- 5 A double bond every eight carbon atom**

Low viscosity above the melting point

VESTENAMER® semicrystalline rubber has a high macrocycle content and low molecular weight compared to basic rubber polymers. Unlike linear macromolecules, macrocycles can crosslink to a completely three-dimensional network, even at low molecular weight. Combined with a broad molecular weight distribution, its low molecular weight is also responsible for its unusually low viscosity at higher temperatures. Above its melting temperature at 100 °C ($T_m < 60^\circ\text{C}$), VESTENAMER® is a low-viscosity melt with Mooney values lower than 10.

The thermoplastic properties of unvulcanized TOR provide additional advantages, like being an easy to dose pellet at room temperature or showing a fast recrystallization. This helps to keep green compounds stable in shape, reducing tack, and improving the storage stability of rubber blends.

Double bond content

On metathesis polymerization, the double bond of the monomer cyclooctene is preserved so that the resulting trans-polyoctenamer contains a double bond at every eighth carbon atom. This is why the vulcanization speed is somewhat lower than for SBR. VESTENAMER® vulcanizes with all crosslinking agents commonly used in rubber curing, such as sulfur, sulfur donors, peroxides and curing resins.

Reactive additive

The trans-double-bond content of VESTENAMER® is nearly 80%, which results in high crystallinity of about 30%. The melting point is 54 °C, and the melt displays a honey-like consistency, the granules are light opaque. VESTENAMER® is stabilized with sterically hindered phenolic antioxidants.

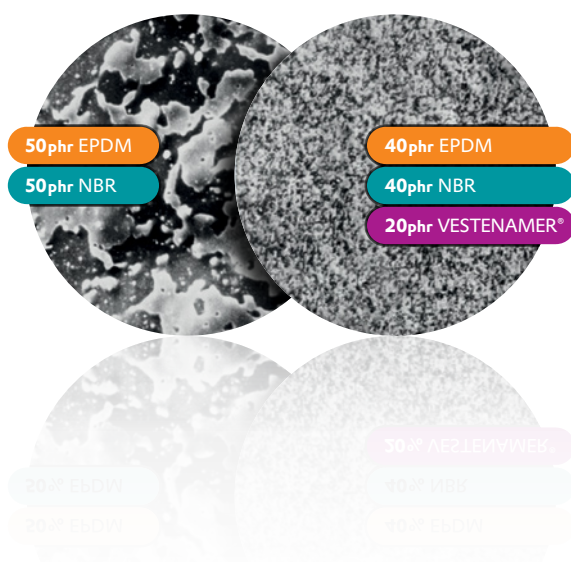


VESTENAMER® 8012 Characteristic values

Improving compatibility

VESTENAMER® enables the mixing of otherwise incompatible polymers. Some of these include emulsion and solution rubbers, polyolefin compounds or polar and nonpolar rubbers.

VESTENAMER® significantly increases, for example, the compatibility of NBR and EPDM rubber.



PROPERTY	METHOD	UNIT	VALUE
Molecular weight, Mw	GPC	g/mol	140.000
Glass transition temperature, Tg	ISO 11357-1/-2	°C	-67.1
Crystallinity at 23°C	DSC (2nd heating)	%	-35
Melting point	ISO 11357-1/-3	°C	55.6
Thermal decomposition	TGA	°C	> 400
Cis/trans ratio of double bonds	IR	%	20/80
Mooney viscosity 100°C	DIN 53 523	-	<10
Ash content	DIN 53 568, part 1	%	max 0.1
Volatile substances (1h/105°C)	DIN 53 526 ISO 248	%	max 0.5
Density	ISO 1183	kg/m ³	912
Melt viscosity MVR 190/2.16	ISO 1133	m ³ /10 min	19.6
Melt viscosity MVR 190/5	ISO 1133	m ³ /10 min	55
Melt viscosity MVR 230/2.16	ISO 1133	m ³ /10 min	28
Stress at yield	ISO 527	MPa	8.0
Strain at yield	ISO 527	%	21
Stress at break	ISO 527	MPa	7.3
Strain at break	ISO 527	%	265
CHARPY impact strength -20°C	ISO 179/1eU	kJ/m ²	N
Tensile strength 23°C	ISO 8256/1	kJ/m ²	108 C
Tensile strength 0°C	ISO 8256/1	kJ/m ²	114 C
Tensile strength -20°C	ISO 8256/1	kJ/m ²	12 C
IZOD notched impact strength 23°C	ISO 180/1A	kJ/m ²	29 P
IZOD notched impact strength 0°C	ISO 180/1A	kJ/m ²	28
IZOD notched impact strength -20°C	ISO 180/1A	kJ/m ²	13

N = no break

VESTENAMER® is more than a single additive!

It serves multiple needs in rubber manufacturing process and products.



25+ years of experience



Mixing

- Increases compatibility
- Improves and stabilizes dispersions
- Reduces viscosity, mixing time, and energy intake
- Is used as a replacement material for rubber



Shaping

- Improves dimensional stability
- Improves quality and increases throughput
- Improves storage stability
- Improves bonding to reinforcement material



Performance

- Does not migrate
- Reduces heat build-up
- Increases abrasion resistance
- Reduces compression set
- Gives surfaces a smoother finish and is colorless



Recycling

- Easier processing of ground tire rubbers
- Reduces stickiness
- Improves dispersion in matrices
- Crosslinking improves product properties
- Non-toxic

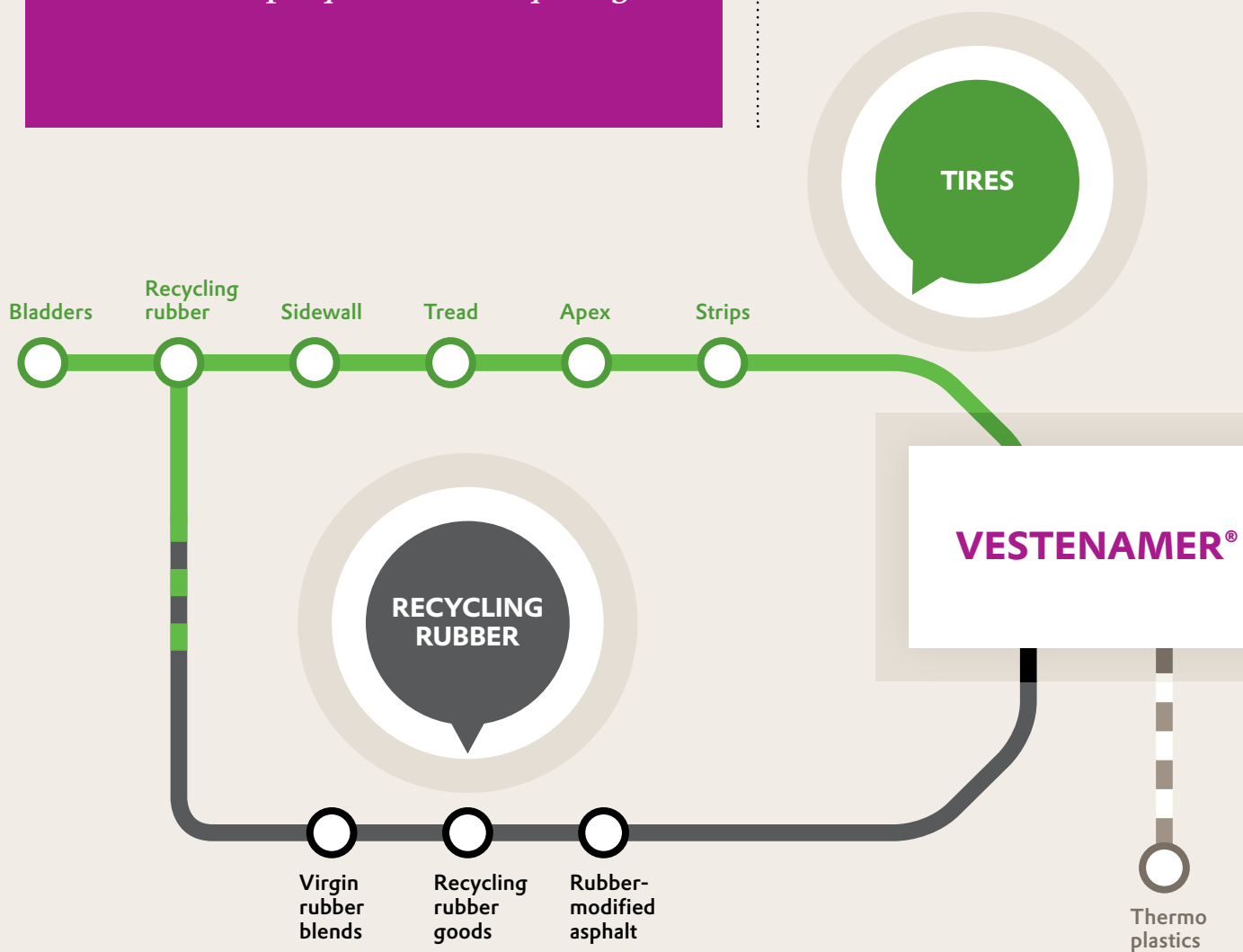
VESTENAMER®
has unique properties
that create value in
many applications

VESTENAMER® as process additive ...

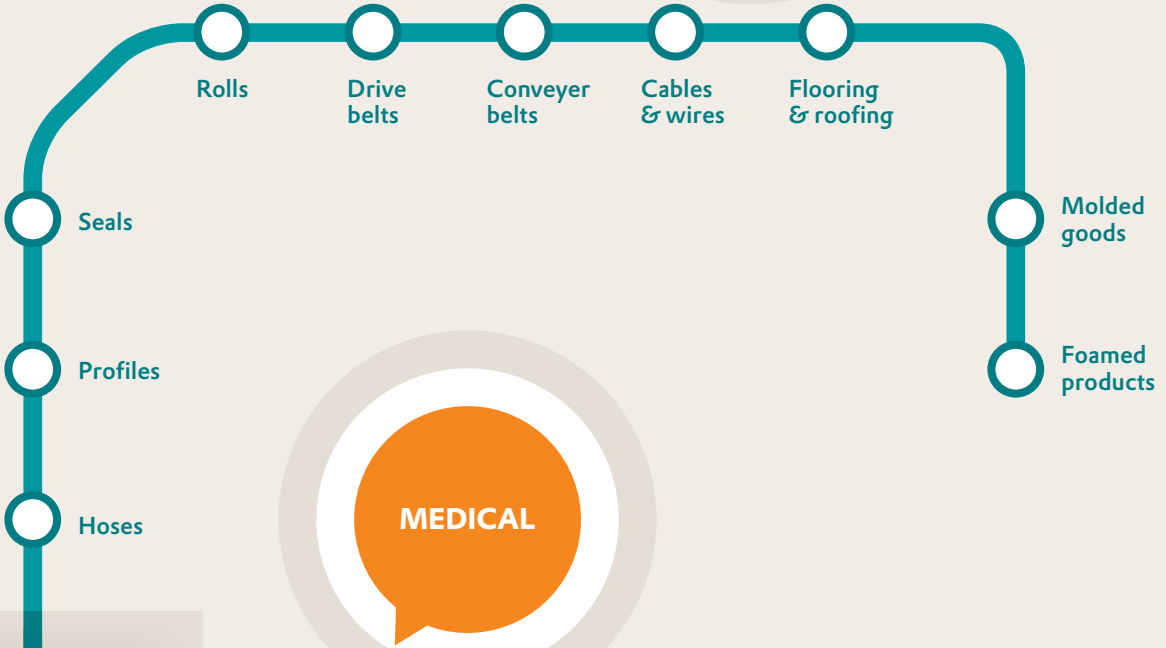
- 1 reduces the viscosity of rubber compounds**
→ facilitates processing and mixing, better incorporation of fillers!
- 2 gives higher green-strength and dimensional stability**
→ important feature when it comes to precise molding of rubber parts as well as extrusion!
- 3 acts as reactive compatibilizer**
→ Enhances compatibility of otherwise incompatible rubbers, e.g. polar and nonpolar rubbers (i.e. EPDM and NBR)!
- 4 improves the processability of natural rubbers**
→ significantly higher reversion stability especially at high vulcanization temperatures!
- 5 is a reactive additive**
→ participates in the vulcanization process and incorporates into the rubber matrix. No blooming or release over time!

VESTENAMER® is used as a processing aid for the rubber industry. In the production of masterbatches, to increase the compatibility of rubber blends, and to simplify rubber recycling.

Landscape of rubber applications



RUBBER GOODS



MEDICAL

Rubber stoppers

Thermoformable products

SPORTS

Shoe soles

Golf balls

APPLICATIONS

Sulfur

Carbon

Additives

MASTER BATCHES

VESTENAMER® helps close the materials cycle for rubber—sustainably. The unique process additive allows waste rubber to be efficiently processed into a tough material used again in a variety of applications such as molded goods, rubber flooring tiles, animal mattresses, virgin rubber blends, or road construction.



Efficient recycling

Every year, a waste volume of some 19.3 million metric tons of scrap tires is generated worldwide – including over 3.6 million metric tons in Europe alone. 20 years ago, over half of all scrap tires were incinerated to generate energy in Germany alone, while only every tenth scrap tire was processed into granulate. By now, the volume of the latter has caught up with energy-related processing.





As a process additive VESTENAMER® improves the flowability of the rubber compound, as a result of which the material can be processed much more efficiently. In addition to the economic aspect of providing a cost-efficient raw material, the material recycling of scrap tires is also becoming more important from the ecological viewpoint. For example, the use of scrap tire granulate in new products contributes significantly toward reducing the carbon footprint as compared with products that do not use a recycled material. And the closed circular economy of rubber also alleviates the global scrap-tire problem.

HANDLING AND QUALITY

As a rule, VESTENAMER® is supplied as cylindrical or lenticular pellets. It is delivered in polyethylene bags with a net weight of 25 kg each. One disposable pallet consists of 50 bags. Following production, the product is suitable for storage for a minimum of five years at temperatures of up to 30°C and protected against direct sunlight.

Our proven quality management system, from development, through production, to quality assurance, ensures a high level of quality for VESTENAMER®. We are continually optimizing our ISO 9001:2008 quality management system, which has been certified since 1992. The positive resonance among our customers is palpable. Nearly all rated our services and the management system in the highest category.

Physiological & toxicological evaluation

Environmental compatibility and safety

VESTENAMER® is a water insoluble solid polymer that is not expected to have any adverse effects on plants, animals or microorganisms under environmental conditions. It is non-toxic, not subject to a labelling requirement within the meaning of the German Hazardous Substances Ordinance, and not hazardous for water. In conformity with the regulations of the local authorities, this polymer may be disposed of through dumping or burning, similar to household waste. Our Customer Service Center will supply you with an EC safety data sheet containing further information on request.

If VESTENAMER® is properly processed, no hazardous by-products are generated, though adequate ventilation and extraction of polluted air from the working areas should be ensured nonetheless.

Combustibility

With melt temperatures of higher than 250°C to 300°C, flammable gases are emitted during processing. Combustion with an adequate air supply yields carbon monoxide, carbon dioxide, and water. As the spectrum of cracking and combustion products depends to a large extent on the actual fire conditions, no general statements can be made here.

Food contact

Following the harmonization of European laws and ordinances, new regulations have come into effect for food contact plastics. Commission Regulation (EU) No. 10/2011 has applied since May 1, 2011. VESTENAMER® 8012 is approved for use in food contact polymers for which the food simulant A (ethanol 10 vol%) is defined, because its base monomer and additives are on the positive list in Commission Regulation (EU) No. 10/2011. A migration limit of 0.05 mg/kg cyclo-octene, as well as migration limits for the additives, must be complied with on the finished article.

VESTENAMER® 8012 has not been approved by the FDA yet.

Toxicological properties

VESTENAMER® has an LD50 value of >12.500 mg/kg in rats (oral). The polyoctenamer causes no skin or eye irritation. In rats, oral intake of up to 4,000 mg/kg body weight over 90 days showed no toxic effects. Likewise, no mutagenic changes occurred with VESTENAMER® in the Ames test on *Salmonella typhimurium* (in vitro) and in the micronucleus test on mice.

For more detailed information and special inquiries, please contact us.

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