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Vamac® Ultra HT

Ethylene Methylacrylate Elastomer

Vamac® Ultra HT has been developed to extend heat resistance and the dynamic performance of the standard Vamac® portfolio to a temperature range of 170 -180 °C, suitable for demanding applications such as turbo hoses and air ducts.

Vamac® G has been widely used for a number of years in turbo charger hose applications. Vamac® GXF was developed to improve heat resistance and dynamic properties and these properties have now been further enhanced with the development of Vamac® Ultra HT (high temperature).

Vamac® Ultra HT is a terpolymer of ethylene methyl acrylate (AEM) with an acidic cure site using a diamine-based vulcanization system delivering higher mechanical properties and better low temperature flexibility. Inherently, it has a halogen free structure like other Vamac® grades, all providing superior acid condensate resistance, characteristic of blow-by gas, and exhaust gas recirculation.

The Vamac® Ultra family which includes Vamac® Ultra HT offers a specific polymer design with a higher viscosity improving process & properties versus standard Vamac® grades.

Vamac® Ultra HT can be compounded as a DOTG-free compound similar to other Vamac® terpolymer products.

Vamac® Ultra HT provides better compound properties and higher heat resistance over Vamac® GXF as follows:
- Higher elongation at break before and after heat ageing
- Higher tear resistance
- Very low hardness and modulus change after heat ageing
- Better flex fatigue resistance after ageing.
- 170 – 180 °C continuous temperature resistance on hoses (with Nomex® textile reinforcement)

These properties make Vamac® Ultra HT the product of choice for turbo charger hoses in the 170 °C- 180 °C temperature range.

Bale size is nominally: 560 x 370 x 165 mm

Major Performance Properties and Applications

Engine downsizing and turbo charging are widely adopted by all OEMs for diesel and gasoline engines to reduce both fuel consumption and CO_2 emissions when compared to bigger, naturally aspirated engines. Industry leaders continue to develop cleaner vehicles to meet new, more demanding standards.

Vamac® Ultra HT has been developed to answer this automotive market trend and extend the Vamac® product range in terms of high temperature performance combined with flex fatigue resistance. This set of properties is further associated with oil resistance, tear resistance and sealing performance making it a material of choice especially for automotive turbo charger hoses.

Its continuous service temperature is 170 °C – 180 °C with peaks up to 190 °C – 200 °C are suitable especially for the latest diesel and gasoline turbo engines. A typical turbo hose construction recommendation follows: Vamac® Ultra HT / Nomex® aramid fibre / Vamac® Ultra HT.

At higher specified temperature, rubber multilayer structures are used such as FKM/VMQ construction or FKM/Vamac®/Nomex® aramid fibre/Vamac® construction

The main automotive applications targeted are:

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- Turbo charger hoses
- Other hoses / air ducts
- Torsional dampers

Although most applications are found in automotive, industrial applications can also benefit when a good extrusion process, heat resistance and improved flex fatigue resistance are required in addition to Vamac® typical properties.

Compound and Vulcanisate Properties

Compounds of Vamac® are formulated and processed by customers to meet their own specific performance requirements. Many of the highest-performing compounds are vulcanizates of Vamac® are proprietary, and cannot be published. We have independently formulated a wide variety of Vamac® compounds for its own short- and long-term properties testing programs.

A broad set of properties is required in automotive hose applications to insure the function of the final part. The key properties are heat and oil resistance induced by the engine environment itself. Vamac® Ultra HT delivers increased mechanical properties, tear strength and heat resistance compared to Vamac® GXF.

Vamac® Ultra HT displays a stable modulus after ageing and even measured at elevated temperature with an elongation above 120%. In addition, the hardness change is minimal after heat exposure. The ISO compression sets are all in line with specification but vary depending on the type of formulation. Effectively, the level of Diak™ No.1 is important to obtain the desired balance of properties between sealing and dynamic performance.

A typical compound of Vamac® Ultra HT is reviewed below. Vulcanizate performance test data are given to help endusers evaluate the potential fitness of similar compounds for their own applications.

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Sample Compound, Vamac® Ultra HT

Ingredients	Parts
Vamac® Ultra HT	100
Antioxidant: Naugard® 445	2
Release agent: Stearic acid	1
Release agent: Vanfre® VAM (alkylphosphate)	1
FEF black (N550)	45
Curative: Diak™ No. 1 (hexamethylene diamine carbamate)	1
Vulcofac® ACT 55	2
Alcanplast® PO 80	2

The recommended starting point formulation for Vamac® Ultra HT for turbo charger hoses is using 1 phr of Diak™ and 2 phr of Vulcofac® ACT55 or equivalent..

The above reference compound is a formulation with Vamac® Ultra HT polymer using a diamine curing agent and accelerators based on DBU. Cure accelerator Vulcofac® ACT55 is a cycloaliphatic amine (DBU). The DBU based accelerator has been used in recent years to replace DOTG due to the implementation of REACh legislation and provide similar vulcanizates properties. DPG can be used in combination with DBU to improve properties such as the elongation at break and the flex fatigue resistance.

The formulation does not contain any scorch retarder, like Armeen® 18D, commonly used in compounds with Vamac®. For a demanding manufacturing process with higher shear speeding up the reaction, 0.5phr of Armeen® 18D is recommended to minimize scorch.

A low level of plasticiser should be used in formulations for elevated service temperatures. At higher temperatures of 190 – 200 °C, most of the plasticiser can be lost from the elastomer. The recommended use is 1 to 3phr of a polymeric ether/ester plasticiser with low volatility at elevated temperature.

In certain applications where heat resistance is critical it is suggested that a maximum of 50 phr of N550 is used. Additionally, other types of carbon black with larger particle size can be used to further extend the upper temperature limit.

The curative level of Diak™ No.1 can be adjusted in the formulation related to the final requirements in terms of compression set and flex fatigue performance.

Rheological properties

A significant viscosity increase at equal formulation can be realized from Vamac® GXF to Vamac® Ultra HT. The higher viscosity improves processability and provides higher green strength. Vamac® Ultra HT cured with DBU provides a higher cross-link density compared to GXF or to Vamac® Ultra HT cured with a combination of DBU and DPG. Additionally, the cure speed is faster which can provide reduced cycle time.

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Dynamic properties

The DeMattia flex-fatigue and crack growth tests display the crack initiation to failure resistance at elevated temperature and the crack propagation resistance at room temperature.

The cross-linking density and the curing package have an important influence over this flex fatigue property. The DPG / DBU blend formulation with 1.25 phr of Diak™ No.1 will show, superior fatigue and crack resistance, when properly formulated, compared to formulations containing only DBU, but compromise will be made on compression set.

Heat ageing

Heat ageing performed at 200 °C which is the maximum peak service temperature advised for the material shows that the hardness change is very low with values below 5 points and the tensile properties maintain a high level with elongation still above 350% for the DBU cure package.

Fluid ageing

Vamac® Ultra HT provides an improvement in fluid ageing compared to GXF with higher absolute properties after fluid ageing and similar properties change.

Product information

Resin Identification	AEM		ISO 1043
Part Marking Code	>AEM<		ISO 11469
Colour	Clear[1]		
Viscosity, Mooney, ML 1'+4' at 100 °C	29		ISO 289-1-2
Volatiles	≤0.6	%	EN 1400 / EN 14350-2
Maximum Service Temperature	180	°C	

[1]: clear to light yellow translucent

Rheological properties

Viscosity, Mooney, compound, ML 1'+4' at 100 °C	66		ISO 289-1-2
Moving Die Rheometer at 180 °C, torque	80 - 1300	Nmm	ISO 6502
Moving Die Rheometer at 180 °C, t(50)	2	min	ISO 6502
Moving Die Rheometer at 180 °C, t(90)	6.1	min	ISO 6502

Cure conditions

Cure time	10	min
Cure temperature	180	°C
Post cure time	4	h
Post cure temperature	175	°C

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Typical mechanical properties

Tensile stress at 100% strain	3.3	MPa	ISO 527-1/-2
Tensile stress at break	20	MPa	ISO 527-1/-2
Tensile strain at break	>300	%	ISO 527-1/-2
Shore A hardness	67		ASTM D 2240
Compression set, 150°C, 70h	24	%	ISO 815

Thermal properties

Glass transition temperature, 10°C/min	-30	°C	ISO 11357-1/-3

Characteristics

Processing	Injection Moulding, Extrusion, Transfer Moulding, Compression moulding
Delivery form	Bale
Special characteristics	Heat stabilised or stable to heat

Additional information

Profile extrusion

Handling Precautions

Because Vamac® Ultra HT contains small amounts of residual methyl acrylate monomer, adequate ventilation should be provided during storage and processing to prevent worker exposure to methyl acrylate vapor. Additional information may be found in the Vamac® Ultra HT product Safety Data Sheet (SDS), and our bulletin, *Safe Handling and Processing of Vamac®*.

Mixing

Compounds made from Vamac® Ultra HT can be mixed either in an internal mixer or an open mill, with a relatively short cycle time. For internal mixers, single pass, upside-down mixing is preferred to control overheating. For more information, please refer to bulletin, *Vamac® Compound Mixing Guide*.

Chemical Media Resistance

Mineral oils

- ✔ SAE 10W40 multigrade motor oil, 23°C
- ✔ SAE 10W40 multigrade motor oil, 130°C
- ✔ SAE 80/90 hypoid-gear oil, 130°C
- ✔ Insulating Oil, 23°C
- ✔ Motor oil OS206 304 Ref.Eng.Oil, ISP, 135°C
- ✔ Automatic hypoid-gear oil Shell Donax TX, 135°C
- ✔ Hydraulic oil Pentosin CHF 202, 125°C

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Standard Fuels

- ✗ Diesel fuel (pref. ISO 1817 Liquid F), 23°C
- ✗ Diesel fuel (pref. ISO 1817 Liquid F), 90°C
- ✗ Diesel fuel (pref. ISO 1817 Liquid F), >90°C
- ✗ Diesel EN 590, 100°C

Symbols used:

- ✓ possibly resistant
  Defined as: Supplier has sufficient indication that contact with chemical can be potentially accepted under the intended use conditions and expected service life. Criteria for assessment have to be indicated (e.g. surface aspect, volume change, property change).
- ✗ not recommended - see explanation
  Defined as: Not recommended for general use. However, short-term exposure under certain restricted conditions could be acceptable (e.g. fast cleaning with thorough rinsing, spills, wiping, vapor exposure).

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