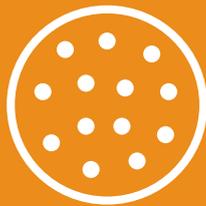


WARADUR® WAX ADDITIVES



**Higher tensile
strength /
impact strength**



**Proper
dispersion**



**Flow
improvement**



**Reduced
ejection force**

IMPROVE YOUR PLASTIC PRODUCTION

WARADUR® S | WARADUR® GE | WARADUR® GSM | WARADUR® E |
WARADUR® ESM | WARADUR® OP | WARADUR® OPplus | WARADUR® GSA

OVERVIEW

With almost 120 years of experience in the production of montan and specialty waxes, VOELPKER is one of the most experienced wax producers in Europe. VOELPKER develops and produces tailor-made wax derivatives whose chemical functionalities and application properties are precisely adapted to the specific use.

VOELPKER Plastic Series: At the heart of the WARADUR® (the subject of this brochure) and CEVO® special wax additives from VOELPKER is their unique multifunctionality. This enables the simultaneous resolution of different processing problems. It leads to improved surface quality and filler or pigment dispersion, improved flow properties and the reduction of friction peaks. WARADUR® montan wax derivatives also enable the production of particularly high-quality compounds containing recycle.



WARADUR® WAX ADDITIVES - PERFORMANCE AND MULTIFUNCTIONALITY

INTRODUCTION

WARADUR® montan waxes are used as high performance additives in the plastics industry, due to their unique properties and versatility. Montan wax derivatives serve for example as combined external and internal lubricants, dispersing agents and surface improvers in many types of plastics and processing methods (Table 1). They are therefore particularly valued for technically

challenging tasks in the engineering plastics field where high demands are placed on functionality, optical appearance and cycle time reduction. WARADUR® montan waxes in addition also provide excellent lubricating and mould release properties for thermosets.

Applications and effects of lubricant classes in different thermoplastics

Polymer	Flow improvement	Release effect	Dispersion
Styrenics	montan wax oxidised PE wax wax esters polyol wax	amide wax montan wax PE wax polyol esters wax esters	amide wax montan wax polyol esters
PP (reinforced)	montan wax copolymer wax polyol esters	montan wax amide wax wax esters metal soaps	montan wax polyol esters
PET/PBT	montan wax polyol esters wax esters	montan wax PE wax wax ester	montan wax polyol esters
POM	montan wax amide wax complex esters polyol esters wax esters	montan wax amide wax oxidised PE wax polyol esters fatty acids	amide wax polyol esters
PC	montan wax wax esters	montan wax PE wax oxidised PE wax polyol esters wax esters	montan wax polyol esters
PA	montan wax amide wax copolymer wax wax esters polyol esters	montan wax copolymer wax metal soaps polyol esters wax esters	montan wax polyol esters wax esters
TPU	montan wax complex esters polyol esters	montan wax amide wax complex esters polyol esters	montan wax

Table 1: Application and effects of various lubricants in different polymers: Montan wax additives are the most multifunctional additives for engineering plastics¹.

¹ H. Zweifel et. al, Plastics Handbook, Carl Hanser Verlag, Munich 2009 (mod.)

TYPICAL STRUCTURAL ELEMENTS OF MONTAN WAX DERIVATIVES

Name	Chemical nature	Structural characteristics
WARADUR® S	Montanic acids (linear, saturated), mainly C28 – 32	
WARADUR® GE	Glycerol esters of montanic acids	
WARADUR® GSM	Glycerol hybrid esters of montanic and oleo acids	
WARADUR® E	Ethylene glycol esters of montanic acids	
WARADUR® ESM	Ethylene glycol hybrid esters of montanic and oleo acids	
WARADUR® OP	Butylene glycol esters of montanic acids; calcium montanate	
WARADUR® OPplus	Butylene glycol esters of montanic acids; high content of calcium montanate	
WARADUR® GSA	Complex esters of montanic acids	

Table 2: Structural characteristics and typical analytical values of VOELPKER montan wax additives



WARADUR® S

is a mixture of straight-chained monocarboxylic acids with a chain length in the range of mainly C28 – C32 (montanic acids).

WARADUR® E

is an ester wax consisting of esters of montanic acids with ethylene glycol.

WARADUR® GE

is a glycerol ester wax of montanic acids and exhibits a slightly higher molecular weight than WARADUR® E. Both esters exhibit chain length in the range of mainly C58 – C66 and provide low volatility, good thermostability and low migration rates.

WARADUR® GSM and WARADUR® ESM

are innovative hybrid ester waxes consisting of a mixture of long chain (mainly C28 – 32) wax acids montan esters and fatty acids esterified with multihydroxyl alcohols. They combine, on a mo-

lecular level, the chemical properties of montan esters and oleo esters. Both esters combine in an ideal manner the properties of montan esters (high thermal stability, low volatility, no blooming out, excellent release/anti sticking) and fatty esters (e.g. improved mould release in TPU).

WARADUR® OP

is an ester wax consisting of esters of montanic acids with multihydroxyl alcohols and contains calcium montanate.

WARADUR® OPplus

is also a montan wax based special wax consisting of esters of montanic acids with multihydroxyl alcohols. In addition, WARADUR® OPplus contains an increased amount of calcium montanate and fatty acid salts and esters.

WARADUR® GSA

is a high-molecular complex ester of montanic acids.

Case study: WARADUR® OP

Suppression of heavy foaming

A compounder of flame retardant PA66 GF 25 was unable to efficiently mould their compound without strong foaming. The flame retardant additive was partially degraded due to the high shear forces that occurred during processing and the acid that was produced initiated degradation also of the polyamide.

The use of WARADUR® OP (0.3 %) instead of calcium stearate reduced the shear stress of the melt to such an extent that foaming did not occur. The compound could be produced without problems while maintaining the required fire classification V0 (UL94).



PHYSICAL PROPERTIES

Montan wax additive	Analytical data: typical values				Typical applications	Registration numbers of montan waxes	
	Drop point [°C]	Melting range - main peaks [°C]	Acid value [mg KOH/g]	Viscosity @ 120° C [mPas]		REACH registration number	CAS number
WARADUR® S	86	80	140	15	External release agent for thermosets and engineering plastics	01-2119480151-48-0001	68476-03-9
WARADUR® GE	81	77	21	35	Internal and external lubricant for PC, PBT (filled)	01-2119969450-34-0001	68476-38-0
WARADUR® GSM	79	53, 78	14	16	External lubricant for rigid PVC processing	01-2119969452-30-0001	2215088-68-7
WARADUR® E	85	80	18	15	Internal and external lubricant for PA, TPU, PBT, PC, PS, PVC, epoxy resins, phenolic resins	01-2119480145-41-0001	73138-45-1
WARADUR® ESM	82	75, 81	32	12	Internal and external lubricant for PA, PBT, PC, PS, PVC, epoxy resins, phenolic resins	01-2120763810-55-0000	2279155-46-1
WARADUR® OP	101	67, 82, 100	12	250	Internal and external lubricant for PA, TPU, PBT, PC, PS, PVC, epoxy resins, phenolic resins	01-2119480144-43-0001	73138-44-0
WARADUR® OPplus	n.a.	104	4	n.a.	Multi-purpose additive suitable for PA and other engineering plastics, PVC, thermosets, etc.	01-2119480144-43-0001	73138-44-0
WARADUR® GSA	78	63, 66	19	55	Lubricant, e.g. for Ca/Zn stabilised rigid PVC extrusion grades and PMMA; shows a very high compability and extreme low volatility	01-2119969451-32-0001	73246-99-8

Table 3: Overview of physical data and typical applications

As a result of the long, linear carbon chain as their key structural element, the montan waxes exhibit good thermal stability and low volatility (Figure 2b).

Other lubricants like amide wax, calcium stearate, underivatised vegetable ester waxes or polyester waxes from polymer

degradation do not provide the equivalent processing and performance characteristics of montan esters. They also show differing performance in colour stability (Figure 1) and volatility (Figure 2a). VOELPKER offers a particularly bright quality of WARADUR® E.

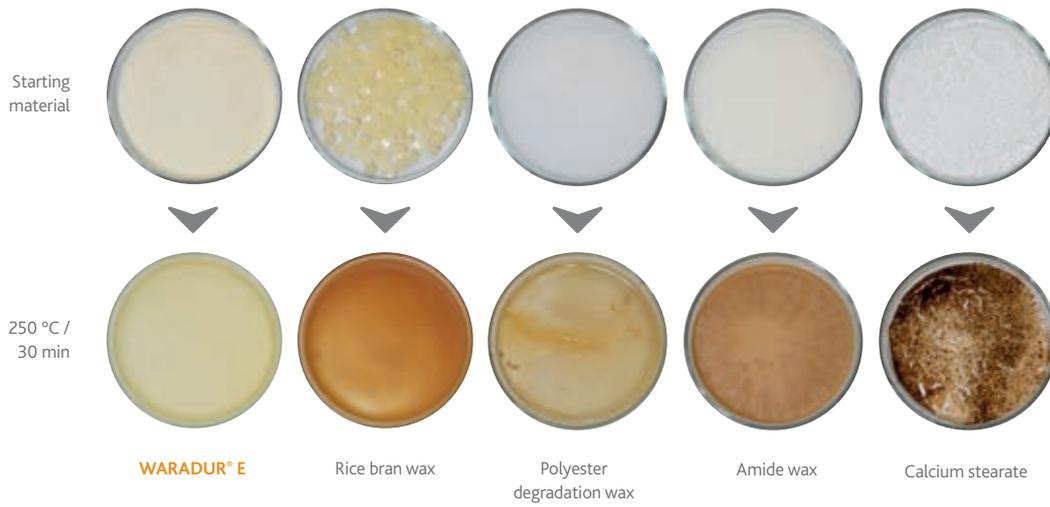


Figure 1: Colour stability under thermal stress (Laboratory Air Circulation Oven Heraeus UT 6120; 250 °C/30 min)

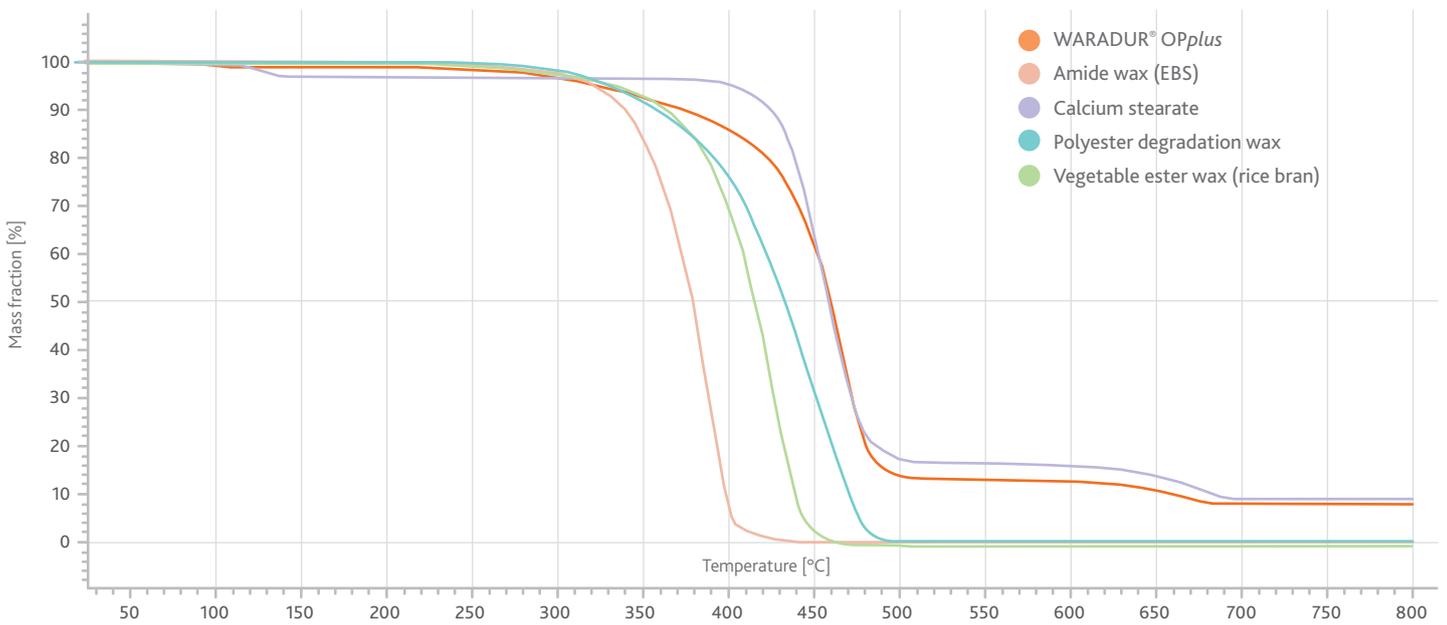


Figure 2a: Volatility of various conventional lubricants compared to WARADUR® OPplus

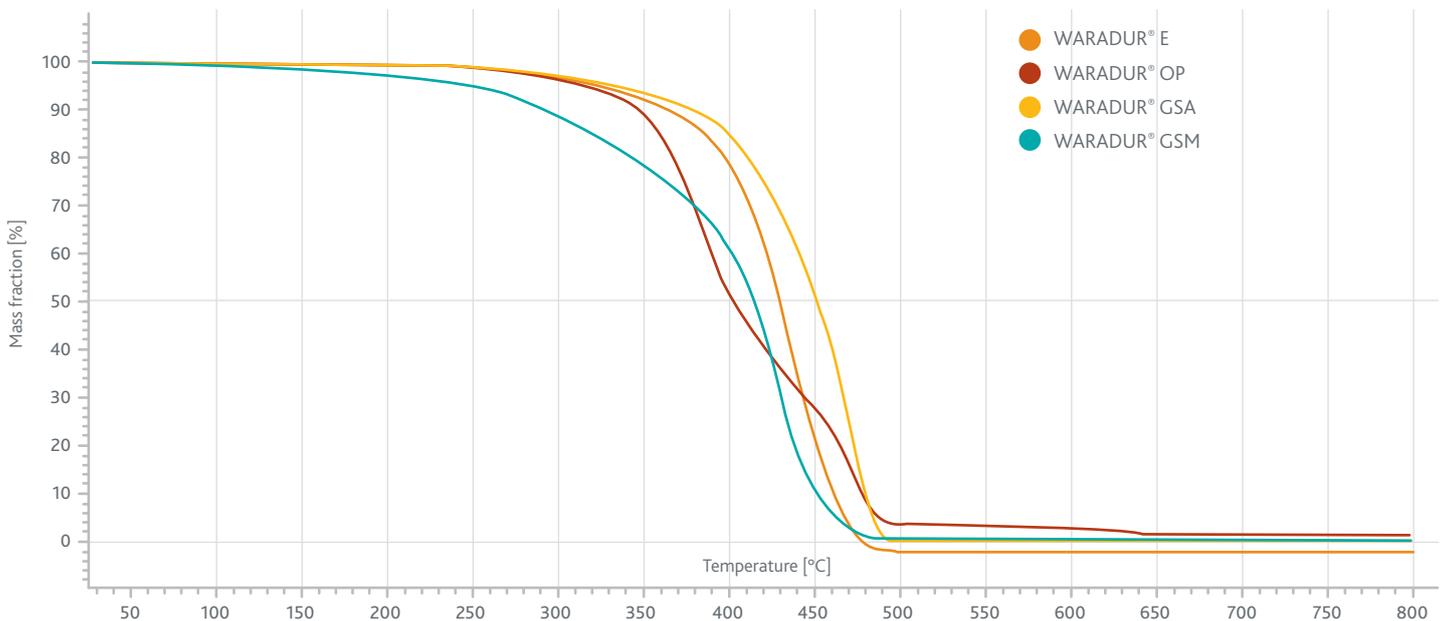


Figure 2b: Volatility of various montan wax additives

APPLICATION EXAMPLES

Polyamide (PA)

Polyamides are processed in many different modifications leading sometimes to critical processing properties. Due to the polymer's strong tendency to adhere to hot machine parts, additives are required to improve their mould release properties and so reduce the production cycle time. Especially highly filled compounds normally do not flow easily in the injection moulding tool. This is mainly due to the distribution but also the orientation of the fillers and may lead subsequently to reduced mechanical and optical quality of the final product. WARADUR® E and especially the partially saponified WARADUR® OP improve the flowability of polyamides through internal lubrication. As a result, both the filler distribution and orientation of fillers are improved and the shear stress of the melt is reduced during compounding and injection moulding. The waxes also reduce the required demoulding force and provide a better external release effect than for example amide wax. A concentration of around 0.5 % WARADUR® E or OP in unfilled polyamide is typically used.

Standardised spiral flow experiments clearly demonstrate that WARADUR® E, and especially WARADUR® OP, improve the flow of the polymer, resulting in an extension of the flow path in the flow spiral mould².

Glass fibre reinforced polyamides intended for processing by injection moulding often contain more than 20 – 30 % of glass fibre. To improve the dispersion of the glass fiber particles, the flow properties and mould release, the addition of up to 1.0 % WARADUR® E or OP has been proven to be advantageous³. Furthermore, the use of WARADUR® E or OP markedly improves the optical properties (surface gloss, no deposits) of polyamide mouldings due to a finer and more even distribution of pigments and of fillers and/or uniform orientation of glass fibers.

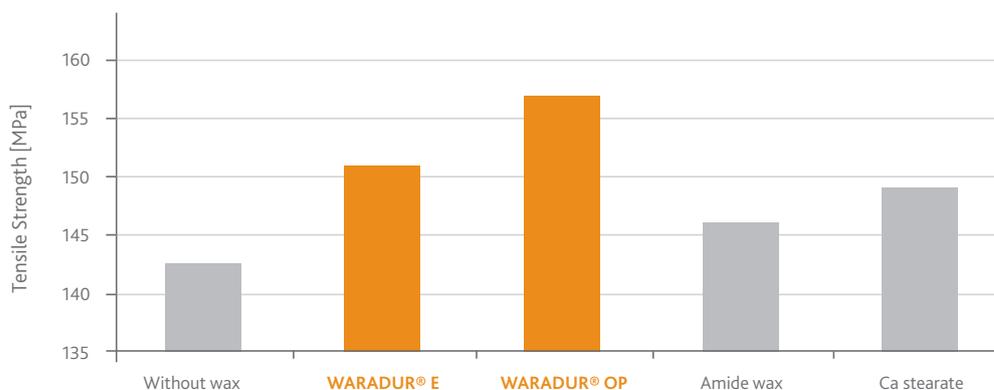


Figure 3: Improvement of tensile strength of PA GF 30

²VOELPKER TechPaper 01/2017: Flow improvement of unreinforced PA6 enabled by montan wax; 1st edition 02.03.2017; reprint

³Technical study (VOELPKER): Positive effects of montan waxes and the mechanical properties of PA 6 GF 30, 2nd edition 07.02.2017

Case study: WARADUR® E

Generation of uniform conductivity

A manufacturer of a 25 % conductive carbon black-filled PP copolymer was unable to produce his compound without large variations in conductivity properties. WARADUR® E ensured uniform distribution even when using twin-screw extruders for the production. The use of WARADUR® E allowed in this case the reduction of the property variation by one order of magnitude.



Our previous study "POSITIVE EFFECTS OF MONTAN WAXES ON THE MECHANICAL PROPERTIES OF PA 6 GF 30" analysed the mechanical properties of PA compounds with 0.5 phr of different lubricants. The study demonstrated that use of calcium stearate caused a deterioration of mechanical properties. In

contrast, with WARADUR® E and WARADUR® OP a significant improvement of both the tensile modulus (Figure 3) and Charpy notch impact strength (Figure 4) was identified. These results suggest that the WARADUR® wax additives promote a better dispersion of the used glass fibers.



Figure 4: Improvement of Charpy notch impact strength of PA GF 30

Ca salts of montanic acid in WARAMONT CA – also contained in WARADUR® OP and WARADUR® OPplus – act as strong flow

promoters. Significantly reduced cycle times can be achieved in injection moulding of PA 6.6.

Case study: WARADUR® E

Cost reduction / Improved performance

A compounder of carbon fiber reinforced polypropylene compounds for the EE industries was able to reduce the cost of raw materials. When using 0.5 % WARADUR® E in PP with 8 % CF, a 2 orders of magnitude reduction of the values for resistance [Ω] and specific electrical resistance [Ω mm²/m] was measured. WARADUR® E causes a very good distribution and alignment of the individual fibers, so that the conductivity is significantly improved, which manifests itself in a drop in resistance values.

This significantly improved carbon fiber distribution ultimately lead to a reduction in the cost of raw materials, e.g. up to 50 % less carbon fiber usage with about the same conductivity.





Polyolefins

Excellent wetting and dispersion of inorganic and organic fillers

WARADUR® OP powder can be used as a processing aid in injection moulding of polyolefins. It serves as an excellent wetting and dispersion agent for inorganic fillers (e.g. talc and mineral blends). It improves the flow of the melt and the gloss and surface texture of the mouldings.

Carbon fiber filled polymers are used in many industries, including aerospace, automotive, and electrical & electronics, due to their low weight, strength, stiffness and conductivity.

In carbon fiber reinforced polypropylene compounds, the dispersing effect of montan waxes such as WARADUR® E and WARADUR® OP*plus* could be demonstrated: When using 0.5 % in PP with 8 % CF, a 2 orders of magnitude reduction of the values for resistance [Ω] and specific electrical resistance [$\Omega \text{ mm}^2/\text{m}$] was measured.

Montan waxes cause a very good distribution and alignment of the individual fibers, so that the conductivity is significantly improved, which manifests itself in a drop in resistance values.

This significantly improved distribution of the filler/reinforcer ultimately leads to a significant reduction in the cost of raw materials, e.g. max. 50 % less carbon fiber usage with about the same conductivity.

	PP + 8.0 % CF	PP + 8.0 % CF + 0.5 % WARADUR® E	PP + 8.0 % CF + 0.5 % WARADUR® OP
Electrical resistance [Ω]	2.5×10^4	4.5×10^2	4.2×10^2
Specific electrical resistance [$\Omega \text{ mm}^2/\text{m}$]	1.2×10^7	2.0×10^5	2.0×10^5

Table 4: Significant reduction of electrical resistance in PP 8 % CF, induced by the dispersing effect of montan waxes

Polyester (PET, PBT, PC)

Glass fibre reinforced polyesters contain 20 – 30 % of glass fibre or even more and are normally processed by injection moulding. To improve the dispersion of the glass fibre particles, the flow

properties and mould release, the addition of up to 1.0 % & WARADUR® E or WARADUR® GE has been proven to be advantageous.

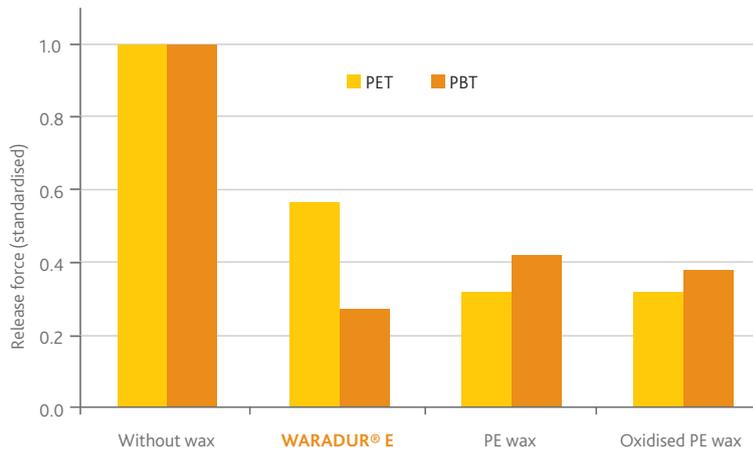


Figure 5: Release force of PBT as a function of different lubricants (0.2 %)

TPE

TPEs (thermoplastic elastomers) have achieved widespread usage and popularity in thousands of products, owing to their durability, softness and colourability, as well as other benefits. TPUs (thermoplastic polyurethanes, sometimes described as TPE-U) for example are extensively used in the automotive, footwear, transportation and sports industries. The combination of rubber-like properties and good processing features makes TPUs an important class of materials. The family of TPUs comprises a wide range of very soft to hard types. Due to their flexible, rubbery nature, TPUs tend to adhere to hot machine parts and to cake during processing. For this reason lubrication and release agents must meet special requirements.

The montanic ester waxes WARADUR® E and WARADUR® OP are preferably used in TPU, because they reduce the tack power and exhibit good lubricant properties at low volatility. One disadvantage of amide waxes, when used in TPU is their tendency to migrate. This results in the formation of surface deposits on the final product. In contrast to amide waxes, the tendency of montan waxes to migrate is negligible.

WARADUR® E or WARADUR® have an excellent mould release effect in TPU. As a result of their high compatibility they show no tendency to migration and they have a low volatility, even at higher temperatures. The usual concentration is 0.5 – 1.0 %. WARADUR® E and OP also improve the flow properties of TPU. Also in other thermoplastic elastomers like TPE-O and TPE-V montan waxes or special blends of montan waxes with other lubricants have been exhibiting positive application results.

PVC

The advantages of montan waxes come to light in PVC especially when there are high demands made on the quality of the end product.

Superior surfaces, excellent release effects and reduced melt viscosity

Among other properties, montan waxes function in PVC as release agents ("external lubrication"). They improve the surface quality and smoothness and provide the final product with a superior gloss. Montanic esters are used in materials processed by injection moulding and other processes that require a good melt flow, as they also reduce the melt viscosity ("internal lubrication"; Fig. 1). For example, they show their advantageous lubricating properties in high-speed cable extrusion, especially at the screw tips.

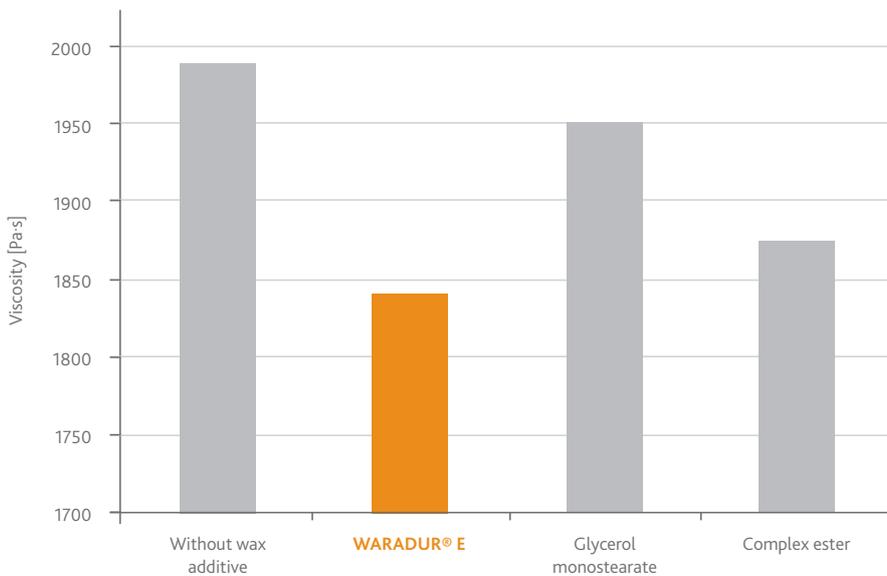


Figure 6: Effect of various waxes on the viscosity of PVC melts

No plate out, better transparency, low volatility

Montan waxes like WARADUR® E are often used as specialty high-quality release agents. Apart from the release action, in contrast to other waxes, they tend not to "plate out", even at

higher dosage. This ensures good removal of finished parts from the mould and also a high-quality glossy surface (Fig. 2). Additionally, downstream processing steps such as metalising, printing and bonding are not significantly influenced⁴.

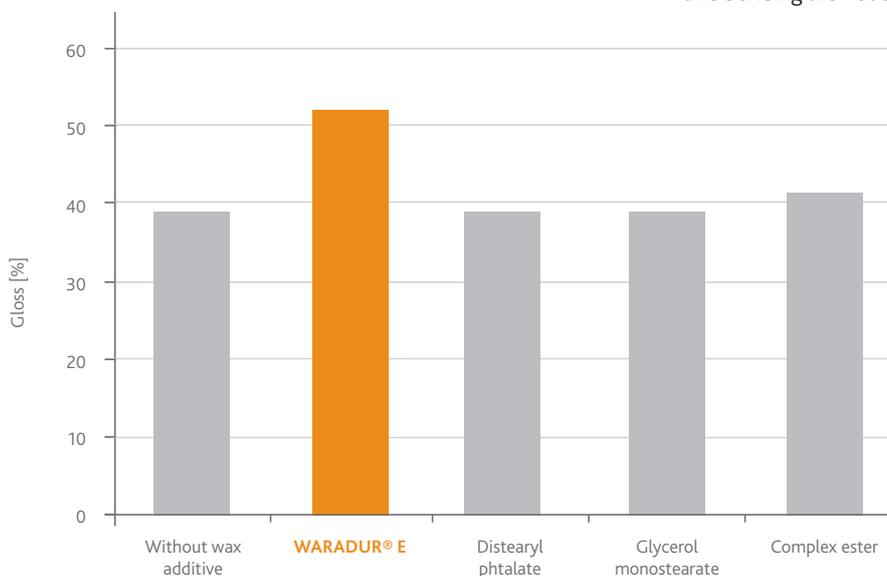


Figure 7: Effect of various waxes on gloss of extruded PVC window profiles

⁴VOELPKER TechPaper 01/2018: M. Schiller, U. Zander, L. Matthes: High-Performance Additives for PVC

WARADUR® GSM is especially used in rigid PVC processing as an efficient multifunctional lubricant. WARADUR® GSM is an innovative chemical hybrid, that combines structure elements of montan esters and oleo acid esters.

Also WARADUR® GSA combines internal and external lubrication effects in PVC and provides very low volatility, high thermal stability and low migration tendency.

Thermosets & epoxides

Montan waxes combine internal lubrication with strong release. Therefore, they are also suitable for the processing of thermosets like epoxy resins and phenolic resins (Novolacs). Internal lubrication helps to improve flow properties whilst external lubrication reduces the adhesion of the moulding compound to hot machine parts and improves mould release. WARADUR® OP and also the special wax blend CEVO®-protect O-6211 are well-introduced in phenolic resins processing.

Lubrication effect (in polar plastics, e.g. PVC)

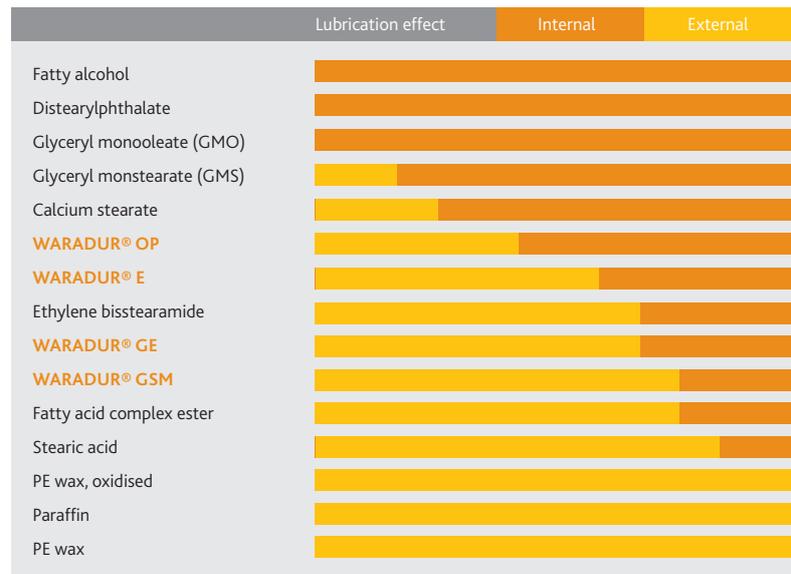


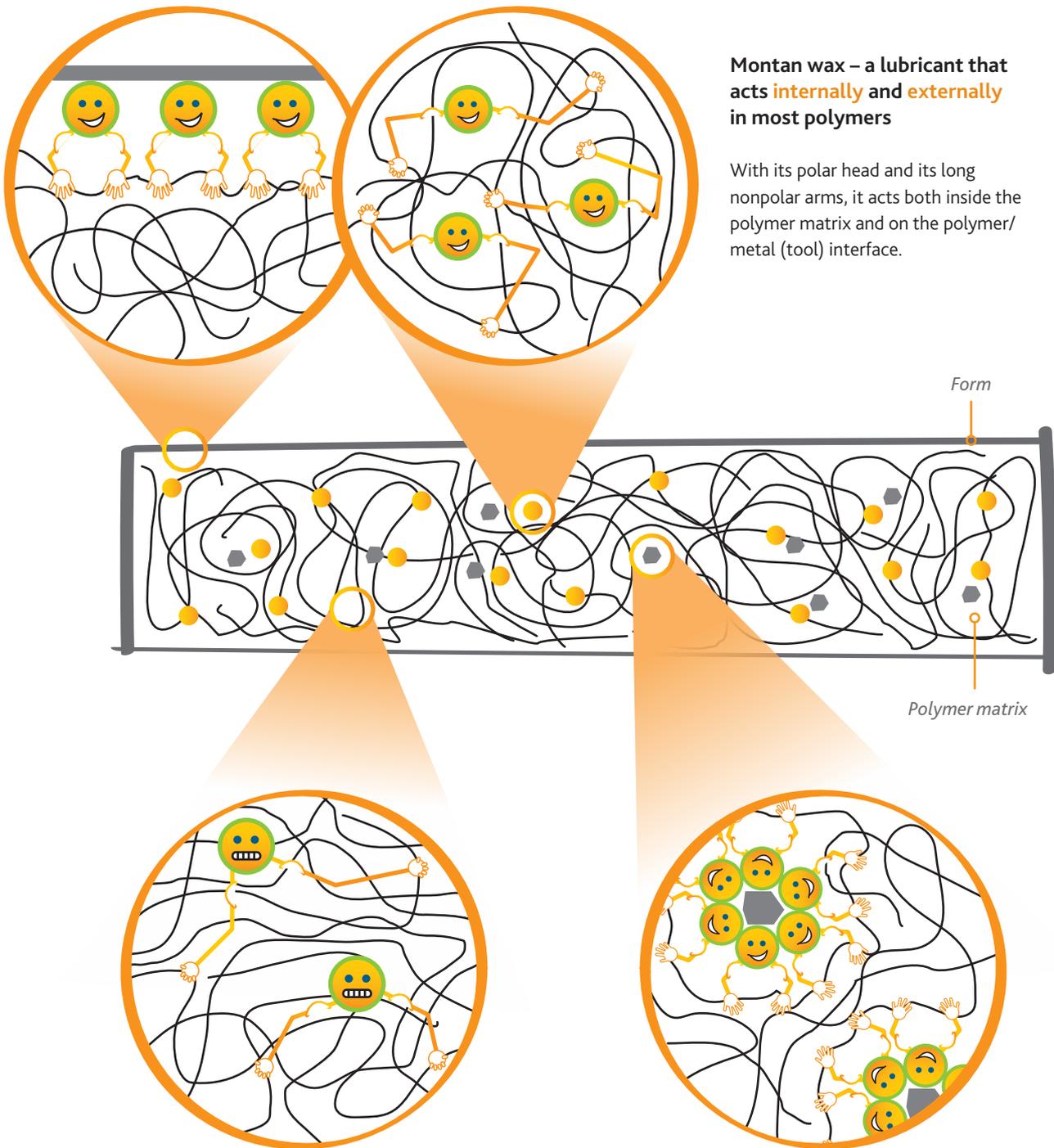
Figure 5: Thanks to their unique molecular structure, montan ester waxes serve as well-balanced internal and external lubricants

WARADUR® MONTAN WAXES: GENERAL ADVANTAGES AT A GLANCE

- For highly demanding plastic applications
- Improvement of processing and end product properties
- Internal lubrication: improves flow properties
- External lubrication: improves mould release
- Wide processing window thanks to high-performance lubrication effects
- Non-blooming, no exudation or product loss
- Improvement of pigment/filler dispersion
- Ideal for clear applications

THE UNIQUE MULTIFUNCTIONALITY OF VOELPKER MONTAN WAXES

visualised by Monty, the montan wax molecule with a clever head and strong arms



Low volatility / no 'plate out'

Thanks to its long arms, its unique structure enables the montan wax to adhere so well in the plastic matrix that it only partially migrates to the component surface and does not cause inconvenient 'plate out'.

Dispersing effect of montan wax

The unique structure of the montan wax with the polar head and long non-polar arms means that it acts like a surfactant in the plastic matrix. Therefore, very polar ingredients are dispersed excellently in non-polar polymers and their distribution is maintained. And it works the other way as well, which leads to better mechanical results or higher cost efficiency for the masterbatch or compound.

PRODUCT INFORMATION

WARADUR® S

Product Description

WARADUR® S is a mixture of montanic acids. Montanic acids are straight-chained monocarboxylic acids with a chain length in the range of C28 – C32 and exhibit a good thermostability and a low volatility.

General Advantages

High effectiveness at low concentrations: WARADUR® S is suitable for a wide range of plastics applications, mainly as external release agent, dispersing agent, gloss booster and surface improver. WARADUR® S is suitable for engineering plastics, thermosets, etc.

Examples of Use

- Thermoplastics: ABS and copolymers
- Thermosets: epoxy resins, phenolic resins
- Dispersing agents for colour masterbatches

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	mg KOH/g	135 – 160	ISO 2114
Saponification value *	mg KOH/g	155 – 180	ISO 3681
Drop point *	°C	82 – 88	ASTM 3954
Colour	–	pale yellow	AA 3.2.1.505
Viscosity @ 120 °C	mPas	10 – 15	AA 3.2.1.520
Density	g/cm ³	1.00 – 1.02	Ph. Eur. 2.2.5

Packaging and Handling

Physical form	Flakes or powder
Packaging	Paper bag or Big Bag
Storage	Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight. The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended. After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety

WARADUR® S

- is made from a fossilised plant wax
- is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Legislation

Food contact legislation:

- FDA 175.105 Adhesives
- FDA 177.2600 Rubber articles intended for repeated use
- FDA 176.210 Defoaming agents used in the manufacture of paper and paperboard
- Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food

Other legislation:

- REACH, RoHS and CONEG compliant
- Listed in all relevant national inventories

For further information, please contact application@voelpker.com.

The information contained herein is believed to be accurate and reliable as of the date issued. However, we do not warrant or guarantee the accuracy or reliability, in particular not for any specific intended use by the customer. It is the responsibility of those to whom we supply our products directly or indirectly to ensure that their use of the products complies with existing regulations, laws, legislations and proprietary rights. The information given by Voelpker Spezialprodukte does not exempt the customer from carrying out inspections and analyses on goods purchased.

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PRODUCT INFORMATION

WARADUR® GE

Product Description

WARADUR® GE is a glycerol ester wax of montanic acids and exhibits a slightly higher molecular weight than WARADUR® E. Montanic acids are straight-chained monocarboxylic acids with a chain length in the range of C28 – C32. The corresponding glycerol esters exhibit chain length in the range of approx. C60 avg. and provide this wax with a low volatility, good thermostability and low migration rates.

General Advantages

High effectiveness at low concentrations: WARADUR® GE is extremely versatile and suitable for a wide range of plastics applications as a multi-purpose additive, e.g. release agent, flow improver, dispersing agent, gloss booster, surface improver. WARADUR® GE is suitable for engineering plastics, thermosets, PVC, etc.

Examples of Use

- Thermoplastics: PA, PBT, TPE, PET, PC, PVC, styrenics
- Thermosets: epoxy resins, phenolic resins, polyurethane
- Dispersing agents for colour masterbatches and filled plastics (talc, glass fibre)

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	mg KOH/g	13 – 30	ISO 2114
Saponification value *	mg KOH/g	130 – 165	ISO 3681
Drop point *	°C	80 – 88	ASTM 3954
Colour	–	pale yellow	AA 3.2.1.505
Viscosity @ 120 °C	mPas	15 – 30	AA 3.2.1.520
Density	g/cm ³	1.00 – 1.02	Ph. Eur. 2.2.5

Packaging and Handling

Physical form	Flakes or powder
Packaging	Paper bag or Big Bag
Storage	Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight. The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended. After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety
WARADUR® GE

- is made from fossilised plant wax
- based on data from similar montan ester waxes: expected to reach the criteria for inherent biodegradability (OECD Guideline 301 D, Closed Bottle Test)
- is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Legislation
Food contact legislation:

- FDA 175.105 Adhesives ("montan wax")
- FDA 177.2600 Rubber articles intended for repeated use ("montan wax")
- Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food

Other legislation:

- REACH, RoHS and CONEG compliant
- Listed in all relevant national inventories

For further information, please contact application@voelpker.com.

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PRODUCT INFORMATION

WARADUR® GSM

Product Description

WARADUR® GSM is an ester wax consisting of an ester mixture of long-chain aliphatic acids.

General Advantages

High effectiveness at low concentrations (0.3 – 0.8 phr), release agent, flow improver.

Examples of Use

Lubricant for rigid PVC processing, especially films and profiles. Flow improvement, mould release of TPU.

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	mg KOH/g	10 – 15	ISO 2114
Saponification value *	mg KOH/g	155 – 180	ISO 3681
Drop point *	°C	75 – 80	ASTM 3954
Colour	–	pale yellow	AA 3.2.1.505
Viscosity @ 120 °C	mPas	approx. 10 – 20	AA 3.2.1.520
Density	g/cm ³	approx. 1.00 – 1.02	Ph. Eur. 2.2.5

Packaging and Handling

Physical form	Flakes or powder
Packaging	Paper bag or Big Bag
Storage	Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight. The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended. After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety

WARADUR® GSM

- is made from regrowing and fossil biological sources
- is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Legislation

Food contact legislation:

- Product for technical applications; not food contact compliant.

Other legislation:

- REACH, RoHS and CONEG compliant
- Components listed in all relevant national inventories

For further information, please contact application@voelpker.com.

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PRODUCT INFORMATION

WARADUR® E

Product Description

WARADUR® E is an ester wax consisting of esters of montanic acids with multihydroxyl alcohols. Montanic acids are straight-chained monocarboxylic acids with a chain length in the range of C28 – C32. The corresponding esters exhibit chain length in the range of C58 – C66 and provide this wax with a low volatility, good thermostability and low migration rates.

General Advantages

High effectiveness at low concentrations: WARADUR® E is extremely versatile and suitable for a wide range of plastics applications as a multi-purpose additive, e.g. release agent, flow improver, dispersing agent, gloss booster, surface improver. WARADUR® E is suitable for engineering plastics, thermosets, PVC, etc.

Examples of Use

- Thermoplastics: PA, PP, PBT, PU/TPU, PET, PC, PVC, TPE, styrenics, PLA, others
- Thermosets: epoxy resins, phenolic resins, polyurethane
- Dispersing agents for colour masterbatches and filled plastics (talc, glass fibre)

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	mg KOH/g	15 – 20	ISO 2114
Saponification value *	mg KOH/g	140 – 160	ISO 3681
Drop point *	°C	82 – 88	ASTM 3954
Colour	–	pale yellow	AA 3.2.1.505
Viscosity @ 120 °C	mPas	15 – 20	AA 3.2.1.520
Density	g/cm ³	1.00 – 1.02	Ph. Eur. 2.2.5

Packaging and Handling

Physical form	Flakes or powder
Packaging	Paper bag or Big Bag
Storage	Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight. The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended. After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety
WARADUR® E

- is made from fossilised plant wax
- reached the criteria for inherent biodegradability (OECD Guideline 301 D, Closed Bottle Test)
- is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Legislation
Food contact legislation:

- FDA 175.105 Adhesives
- FDA 177.2600 Rubber articles intended for repeated use
- FDA 178.3770 For use in lubricants in the fabrication of vinyl chloride plastic food contact articles
- Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food

Other legislation:

- REACH, RoHS and CONEG compliant
- Listed in all relevant national inventories

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PRODUCT INFORMATION

WARADUR® ESM

Product Description

WARADUR® ESM is a hard, special ester wax with a crystalline structure, mainly consisting of esters of montanic acids with mono- and multihydroxyl alcohols. Montanic acids are straight-chained monocarboxylic acids with a chain length in the range of mainly C16 – C32. The corresponding esters exhibit chain length in the range of mainly C34 – C66.

General Advantages

WARADUR® ESM was designed to combine the lubrication properties of oleochemical esters with those of montan wax esters. The typical advantages of montan wax esters are maintained.

Examples of Use

Lubricants, mould release agents, dispersing agents, process auxiliaries for: PA, PP, PU/TPU, PET, PC, PS, ABS, PVC, TPE, POM, thermosets, polymer blends

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	mg KOH/g	28 – 38	ISO 2114
Saponification value *	mg KOH/g	148 – 180	ISO 3681
Drop point *	°C	80 – 85	ASTM 3954
Colour	–	yellow	AA 3.2.1.505
Viscosity @ 120 °C	mPas	approx. 20	AA 3.2.1.520
Density	g/cm ³	1.00 – 1.02	Ph. Eur. 2.2.5

Packaging and Handling

Physical form	Flakes, also available as powder
Packaging	Paper bag or Big Bag
Storage	Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight. The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended. After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety

WARADUR® ESM is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings.

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Remark: Voelpker's R&D department is permanently developing new special wax blends for the preparation of aqueous dispersions. Please contact us for your individual requirements.

Legislation

Food contact legislation:

- Product for technical applications

Other legislation:

- REACh, RoHS and CONEG compliant

For further information, please contact application@voelpker.com.

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PRODUCT INFORMATION

WARADUR® OP

Product Description

WARADUR® OP is an ester wax consisting of esters of montanic acids with multihydroxyl alcohols. Montanic acids are straight-chained monocarboxylic acids with a chain length in the range of C28 – C32. The corresponding esters exhibit chain length in the range of C58 – C66 and provide this wax with a low volatility, good thermostability and low migration rates. WARADUR® OP contains calcium montanate in addition to the montanic acid esters.

General Advantages

High effectiveness at low concentrations: WARADUR® OP is extremely versatile and suitable for a wide range of plastics applications as a multi-purpose additive, e.g. release agent, flow improver, dispersing agent, nucleation agent, gloss booster, surface improver. WARADUR® OP is suitable for engineering plastics, thermosets, PVC, etc.

Examples of Use

- Thermoplastics: PA, PP, PBT, TPE, PET, PC, PVC, PLA, styrenics
- Thermosets: epoxy resins, phenolic resins, polyurethane
- Dispersing agents for colour masterbatches and filled plastics (talc, glass fibre)

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	mg KOH/g	7 – 14	ISO 2114
Saponification value *	mg KOH/g	110 – 130	ISO 3681
Drop point *	°C	99 – 105	ASTM 3954
Colour	–	light yellowish	AA 3.2.1.505
Viscosity @ 120 °C	mPas	150 – 300	AA 3.2.1.520
Density	g/cm ³	1.00 – 1.02	Ph. Eur. 2.2.5

Packaging and Handling

Physical form Flakes or powder

Packaging Paper bag or Big Bag

Storage Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight.
The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended.
After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety

WARADUR® OP

- is made from fossilised plant wax
- in a test for ready biodegradability showed 22 % biodegradability, which can be considered as indication for inherent primary biodegradability, according to OECD (2006)
- is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Legislation

Food contact legislation:

- FDA 175.105 Adhesives
- FDA 177.2600 Rubber articles intended for repeated use
- FDA 178.3770 For use in lubricants in the fabrication of vinyl chloride plastic food contact articles
- Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food

Other legislation:

- REACH, RoHS and CONEG compliant
- Listed in all relevant national inventories

For further information, please contact application@voelpker.com.

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PRODUCT INFORMATION

WARADUR® OPplus

Product Description

WARADUR® OPplus is a montan wax based special wax consisting of esters of montanic acids with multihydroxyl alcohols. In addition, WARADUR® OPplus contains an increased amount of calcium montanate, and fatty acid salts and -esters.

General Advantages

WARADUR® OPplus is suitable for engineering plastics, thermosets, PVC, etc. WARADUR® OPplus is extremely versatile and suitable for a wide range of plastics applications as a multi-purpose additive.

The use of WARADUR® OPplus can lead to the following positive effects in the processes compounding, injection moulding and extrusion/blow moulding:

- Reduction of mould temperature in injection moulding
- Reduction of melt temperature (compounding, injection moulding, extrusion/blow moulding)
- Increasing injection speeds in injection moulding
- Realisation of higher filler contents under the same processing conditions
- Realisation of long flow paths
- Easy processing in tools that implement very different component thicknesses
- Improvement of the surface quality of injection moulded parts

Examples of Use

- Thermoplastics: PA, PBT, PET, PC, PVC, ABS, PLA, styrenics
- Thermosets: epoxy resins, phenolic resins, polyurethane
- Dispersing agents for colour masterbatches and filled (talc, glass fibre) plastics
- We recommend the using from 0.3 to 0.6 %.

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	°C	< 10	ISO 2114
Melting range *	°C	approx. 88 – 114	DSC
Solidification range	°C	approx. 92 – 65	DSC
Colour	–	pale yellow	AA 3.2.1.505

Packaging and Handling

Physical form	Powder
Packaging	Paper bag or Big Bag
Storage	Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight. The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended. After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety

WARADUR® OPplus

- is made from fossilised plant wax
- is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Legislation

Food contact legislation: information available upon request

For further information, please contact application@voelpker.com.

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PRODUCT INFORMATION

WARADUR® GSA

Product Description

WARADUR® GSA is an ester wax consisting of esters of montanic acid with multihydroxyl alcohols.

General Advantages

High effectiveness at low concentrations (0.3 – 0.8 phr). High compability and low migration tendency; acts internally as flow improver and also externally as release agent.

Examples of Use

Especially for engineering plastics and Ca/Zn stabilised rigid PVC extrusion.

Delivery Specifications *

Characteristics	Unit	Target value	Method
Acid value *	mg KOH/g	13 – 26	ISO 2114
Saponification value *	mg KOH/g	165 – 195	ISO 3681
Drop point *	°C	72 – 80	ASTM 3954
Colour	–	pale yellow	AA 3.2.1.505
Viscosity @ 120 °C	mPas	approx. 60	AA 3.2.1.520
Density	g/cm ³	approx. 1.00 – 1.02	Ph. Eur. 2.2.5

Packaging and Handling

Physical form	Pastilles or powder
Packaging	Paper bag or Big Bag
Storage	Store at ambient temperature on a dry place. Protect from heat/overheating and direct sunlight. The maximum shelf life is 5 years after production. Thereafter, tests of the chemical characteristics are recommended. After delivery, a minimum remaining shelf life at the customer of 1.5 years is warranted.

Safety

WARADUR® GSA

- is made from fossilised plant wax
- is not classified as carcinogenic, mutagenic or reprotoxic; no health or environmental hazards are known, provided it is applied in industrial and professional settings

Delivery Time and Availability

Standard delivery time: 2 – 3 weeks. Preconditions can be met for achieving shorter delivery times on standard products when demanded by the market.

Legislation

Food contact legislation:

- Product for technical applications; not food contact compliant

Other legislation:

- REACH, RoHS and CONEG compliant

For further information, please contact application@voelpker.com.

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