



# WHEN PERFORMANCE COUNTS

Montan waxes – high performance lubricants for various plastics – made in Germany



## VOELPKER: TO MAKE IDEAS WORK

### Introduction

With more than 100 years of production history, Voelpker is among the most long-standing wax producers in Europe and is internationally renowned as a reliable manufacturer and supplier of montan waxes and special wax blends.

True to the motto “to make ideas work”, we do everything to improve and optimize our customers’ products and processes.

### Montan waxes – when performance counts

WARADUR® montan waxes are used as high performance additives in the plastics industry, due to their unique properties. They serve as combined external and internal lubricants, nucleation additives and dispersing agents in many types of plastics and processing methods. Montan waxes are particularly valued for technically demanding tasks in the engineering plastics field.

WARADUR® montan waxes in addition also provide excellent lubricating and mold release properties for thermosets.

### Applications and effects of lubricants classes in different thermoplastics

Thermoplastics	Flow improvement	Release effect	Dispersion
Styrenics	montan wax   oxidized 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   oxidized PE wax   polyol esters   fatty acids	amide wax polyol esters
PC	montan wax   wax esters	montan wax   PE wax   oxidized 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	

Table 1: Montan waxes are multifunctional additives for most engineering plastics.<sup>1</sup>



## MONTAN WAXES

### Structure

WARADUR® S is a mixture of linear montanic acids (C28-32).

WARADUR® E and WARADUR® OP consist of esters of montanic acids with ethylene glycol respectively butylene glycol. WARADUR® OP in addition to the montanic acid esters also contains calcium montanate.

WARADUR® GE is the glycerol ester wax of the montanic acids.

As a result of the long, linear carbon chain, the montan waxes exhibit have a good thermal stability and a low volatility.

	Chemical nature	Drop point [°C]	Acid number [mg KOH/g]	Viscosity @ 120 °C [mPas]	Applications (examples)
WARADUR® E	Ethylene glycole esters of montanic acids	ca. 83	ca. 18	ca. 20	Internal and external lubricant for PA, TPU, PBT, PC, PS, PVC, epoxy resins, phenolic resins
WARADUR® OP	Butylene glycole esters of montanic acids; Ca montanate	ca. 99	ca. 10	ca. 150	Internal and external lubricant for PA, TPU, PBT, PC, PS, PVC, epoxy resins, phenolic resins
WARADUR® GE	Glycerol esters of montanic acids	ca. 81	ca. 25	ca. 20	Internal and external lubricant for PC, PBT (filled)
WARADUR® S	Montanic acids C28-32	ca. 83	ca. 140	ca. 20	external release agent for thermosets and engineering plastics

Table 2: Chemical nature, physical data and typical applications of montan waxes

## APPLICATION EXAMPLES

### SMALL CAUSE, GREAT EFFECTS – HIGH EFFECTIVENESS AT LOW CONCENTRATIONS



#### Polyamide

Polyamides are processed in many different modifications leading sometimes to critical processing properties, which often show a strong tendency to adhere to hot machine parts. Especially highly filled compounds normally do not flow easily in the injection molding tool. This may lead to partial decomposition of the polymer and subsequently to reduced quality of the final product.

WARADUR® E and especially the partially saponified WARADUR® OP improve the flowability of polyamides through internal lubrication. At the same time they also reduce the demoulding force and provide a better external release effect than e.g. amide waxes. A concentration of ca. 0.5 % WARADUR® E or OP in unfilled polyamide is typically used.

Glass fibre reinforced Polyamides often contain more than 20–30 % of glass fibre and are processed in injection moulding processes. To improve the dispersion of the glass fibre particles, the flow properties and mold release, the addition of up to 1.0 % WARADUR® E or OP in the case of filled or reinforced materials has been proven to be advantageous.

Ca salts of montanic acid - as contained in WARADUR® OP - act as a nucleating agent in PA. The use of nucleating additives is essential in industrial PA processing to control the structure formation and to shorten the cycle time. Significantly reduced cycle times can be achieved e.g. in injection moulding of PA 6.6.

#### Polyolefins (PE, PP)

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.

#### Polyester (PET, PBT, PC)

Glass fibre reinforced polyesters contain 20–30 % of glass fibre or even more and are processed in injection moulding processes. To improve the dispersion of the glass fibre particles, the flow properties and mold release, the addition of up to 1.0 % in the case of filled or reinforced materials has been proven to be advantageous.

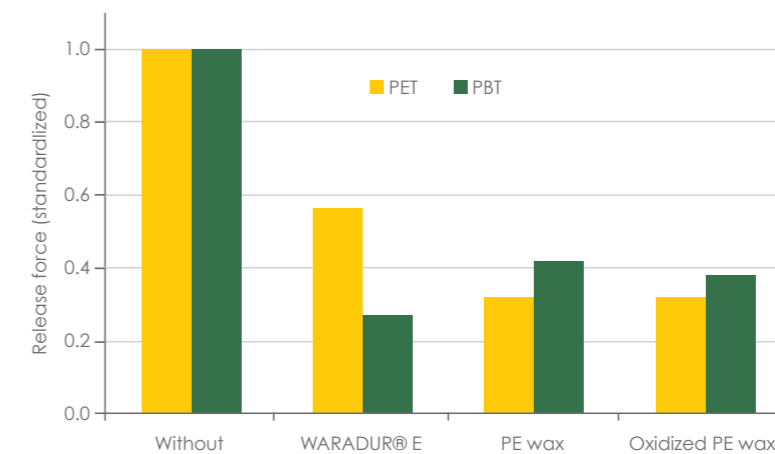


Table 3: Release force of PBT as a function of different lubricants (0.2 %)<sup>1</sup>

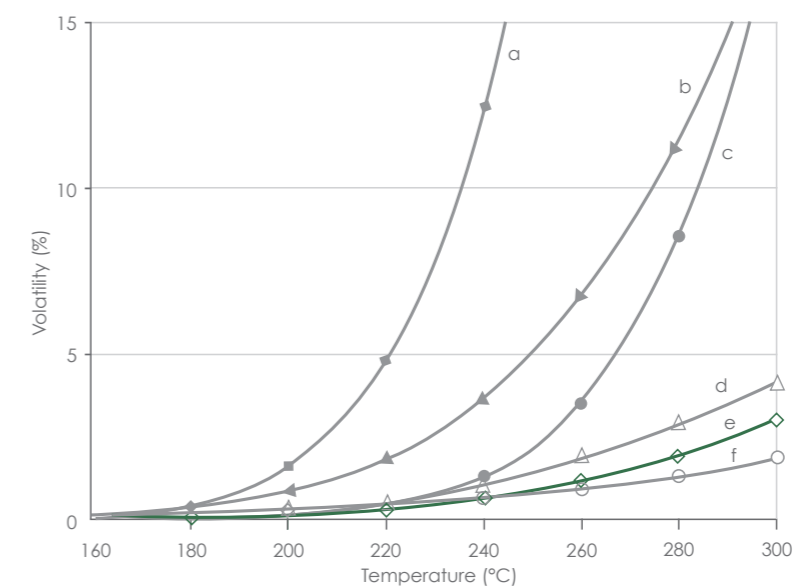


Table 4: Volatility comparison of lubricants, mass loss as function of the temperature. a) stearic acid, b) glycerol monostearate, c) paraffine wax, d) oligomeric fatty acid ester, e) WARADUR® E, f) polyethylene wax<sup>1</sup>

<sup>1</sup>derived from: H. Zweifel et. al, Plastics Handbook, Carl Hanser Verlag



**TPE**

TPEs (thermoplastic elastomers) have generally achieved widespread usage and popularity in thousands of products, owing to their durability, softness and colorability and other benefits. TPUs (thermoplastic polyurethanes = "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 thermoplastic polyurethanes (TPUs) an important class of materials. The production of TPU comprises a wide range of very soft to hard types. Due to its flexible, rubbery nature TPU 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 neglectible.

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, TPE-V montan waxes or special blends of montan waxes with other lubricants have been exhibiting positive application results.

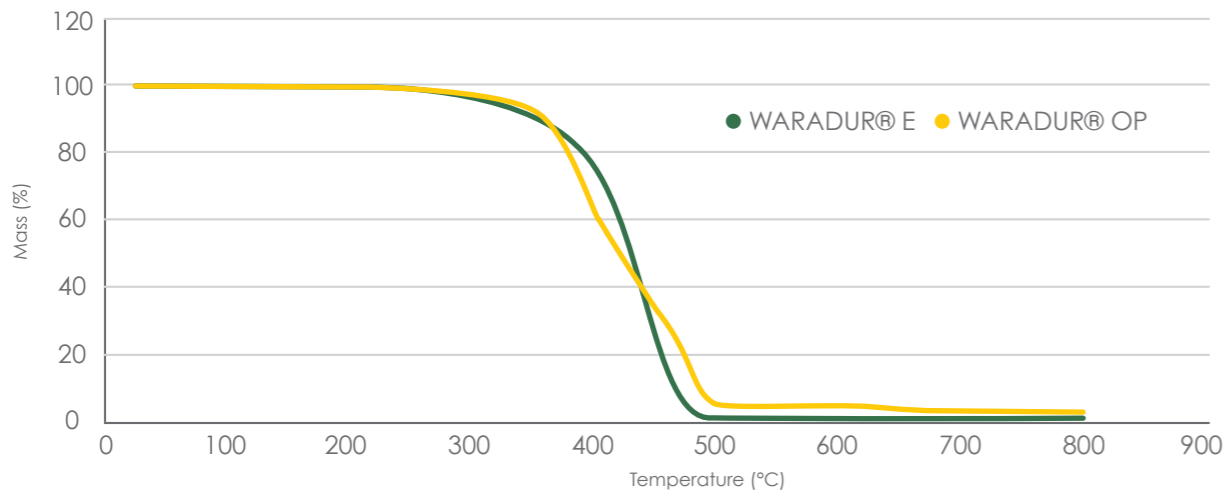


Table 5: Volatility: mass loss as a function of the temperature (TGA Analysis)

**PVC**

WARADUR® OP and WARADUR® E are excellent processing additives for PVC. They provide superior plate out properties, wide processing latitude and are ideal for clear applications. Primary applications are rigid PVC and plasticized PVC during calendaring, extrusion or injection moulding. Only small amounts are required to provide a significant increase in internal and external lubrication.

**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 reduce the adhesion of the molding compound to hot machine parts and improve mold release. WARADUR® OP and also the special wax blend VOELPKER® 6611 are well-introduced in phenolic resins processing.

**Lubricating effect (in polar plastics, e.g. PVC)**

Lubricant	Internal	External
Fatty alcohol	High	Low
Aromatic dicarboxylic acid ester	High	Low
Fatty acid ester (short-chain alcohol)	High	Low
Fatty acid ester (polyfunctional alcohol) liquid	High	Low
Fatty acid ester (polyfunctional alcohol) solid	High	Low
Fatty acid ester (univalent alcohol)	High	Low
Calcium stearate	High	Low
Lead stearate, neutral	High	Low
Ethylene bisstearamide	High	Low
Stearic acid	High	Low
Ester of montanic acid, partly saponified	High	High
Ester of montanic acid	High	High
Montanic acid	High	High
Paraffin wax, melting point 74°C	High	High
Polyethylene, high-molecular-weight, unoxdized	High	High
Polyethylene wax, slightly oxydized	High	High
Polyethylene wax, unoxdized	High	High

Table 6: Due to their unique properties montan waxes serve as combined external and internal 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 mold 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



**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 thermo stability 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, PBT, TPE, 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	15 – 20 mg	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 <sup>3</sup>	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 minimum remaining period is 1.5 years and is defined as the minimum shelf life at the customer. Thereafter, tests of the chemical characteristics are recommended. The maximum shelf life of 5 years is indicated.

**Safety**

- WARADUR® E
- is made from a fossil biological source
  - 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. According to our raw material supplier, the global supply will be secure at least until 2030. At the same time new sources are already being explored to ensure product availability also beyond the year 2030.

**Legislation**

- Food contact legislation:
- FDA 175.105 Adhesives ("montan wax")
  - FDA 177.2600 Rubber articles intended for repeated use ("montan wax")
  - 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:
- RoHS and CONEG compliant
  - Listed in all relevant National Inventories

For further information, please contact [plastics@voelpker.com](mailto:plastics@voelpker.com).

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**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 thermo stability 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, PBT, TPE, 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	7 – 14 mg	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 <sup>3</sup>	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 minimum remaining period is 1.5 years and is defined as the minimum shelf life at the customer. Thereafter, tests of the chemical characteristics are recommended. The maximum shelf life of 5 years is indicated.

**Safety**

- WARADUR® OP
- is made from a fossil biological source
  - 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. According to our raw material supplier, the global supply will be secure at least until 2030. At the same time new lignite deposits are already being explored to ensure product availability also beyond the year 2030.

**Legislation**

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  - Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food

- Other legislation:
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## WARADUR® GE

## Product Information for Plastics Applications

### Product Description

WARADUR® GE is a glycerol ester wax of montanic acids and exhibits a slightly higher molecular weight as 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 ca. C60 avg. and provide this wax with a low volatility, good thermo stability 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, 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 mg	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 <sup>3</sup>	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 minimum remaining period is 1.5 years and is defined as the minimum shelf life at the customer. Thereafter, tests of the chemical characteristics are recommended. The maximum shelf life of 5 years is indicated.

### Safety

- WARADUR® GE
- is made from a fossil biological source
  - 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. According to our raw material supplier, the global supply will be secure at least until 2030. At the same time new sources are already being explored to ensure product availability also beyond the year 2030.

### 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:
- RoHS and CONEG compliant
  - Listed in all relevant National Inventories

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## WARADUR® S

## Product Information for Plastics Applications

### 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 thermo stability 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 mg	ISO 2114
Saponification value *	mg KOH/g	155 – 180	ISO 3681
Drop point *	°C	80 – 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 <sup>3</sup>	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 minimum remaining period is 1.5 years and is defined as the minimum shelf life at the customer. Thereafter, tests of the chemical characteristics are recommended. The maximum shelf life of 5 years is indicated.

### Safety

- WARADUR® S
- is made from a fossil biological source
  - 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. According to our raw material supplier, the global supply will be secure at least until 2030. At the same time new sources are already being explored to ensure product availability also beyond the year 2030.

### Legislation

- Food contact legislation:
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