

VOELPKER® WAX ADDITIVES



Proper  
dispersion



Higher tensile  
strength/  
impact strength



Flow  
improvement



Reduced  
ejection force

IMPROVE YOUR PLASTIC PRODUCTION  
WITH WARADUR® AND CEVO® PROCESSING AIDS

## ABOUT VOELPKER

With over 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 is an independent, family run company with around 100 employees and is part of the German »Mittelstand«. The production site is conveniently situated in central Germany. Our onsite Research and Development department continuously expands our range of possibilities by developing innovative solutions and products.

Satisfied customers in more than 50 countries around the world trust our products.

PREMIUM QUALITY  
MADE IN GERMANY



## WARADUR® AND CEVO® – MULTIFUNCTIONAL WAX ADDITIVES FOR ENGINEERING PLASTICS

At the heart of the WARADUR® and CEVO® special wax additives from VOELPKER is their unique multifunctionality. This enables the simultaneous resolution of different plastics processing problems. It leads to improved filler or pigment dispersion and surface quality, improved flow and mold release properties and the reduction of undesired friction peaks during the polymer

processing. The polymer and sensitive ingredients such as flame retardants are thus protected from unwanted degradation.

WARADUR® and CEVO® additives also enable the production of particularly high-quality compounds containing recycle.

### TABLE OF CONTENT

<b>WARADUR® WAX ADDITIVES – PERFORMANCE AND BROAD APPLICATION SCOPE</b>	<b>04</b>
Introduction: Montan waxes are the most multifunctional wax additives for engineering plastics	P. 04
Physical properties WARADUR®	P. 06
Thermogravimetric analysis   WARADUR®	P. 07
<b>CEVO® WAX ADDITIVES – SPECIALLY DEVELOPED FOR YOUR APPLICATION</b>	<b>08</b>
Introduction: CEVO® additives solve processing and application related issues	P. 08
CEVO® effects	P. 08
CEVO® results	P. 09
CEVO® wax additives: Polymer-specific formulations for engineering plastics	P. 10
<b>APPLICATION EXAMPLES</b>	<b>15</b>
POLYAMIDE (PA)	P. 15
POLYOLEFINS (PE, PP)	P. 18
POLYESTER (PET, PBT, PC)	P. 21
TPU	P. 24
POM	P. 24
PVC	P. 25
General advantages at a glance	P. 26
<b>PRODUCT OVERVIEW</b>	<b>28</b>
The unique multifunctionality of Voelpkers montan waxes	P. 30



# WARADUR® WAX ADDITIVES – PERFORMANCE AND BROAD APPLICATION SCOPE

## INTRODUCTION

WARADUR® montan waxes are proven 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.



## MONTAN WAX ADDITIVES ARE THE MOST MULTIFUNCTIONAL ADDITIVES FOR ENGINEERING PLASTICS

Polymer	Flow improvement	Release effect	Dispersion
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
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
PC	montan wax   wax esters	montan wax   PE wax   oxidised PE wax   polyol esters   wax esters	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
TPU	montan wax   complex esters   polyol esters	montan wax   amide wax   complex esters   polyol esters	montan wax
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

Table 1

### 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 molecular 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.

### 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.

### WARADUR® GSA

is a high-molecular complex ester of montanic acids.

## PHYSICAL PROPERTIES WARADUR®

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 2: Overview of physical data and typical applications

## THERMOGRAVIMETRIC ANALYSIS | WARADUR®

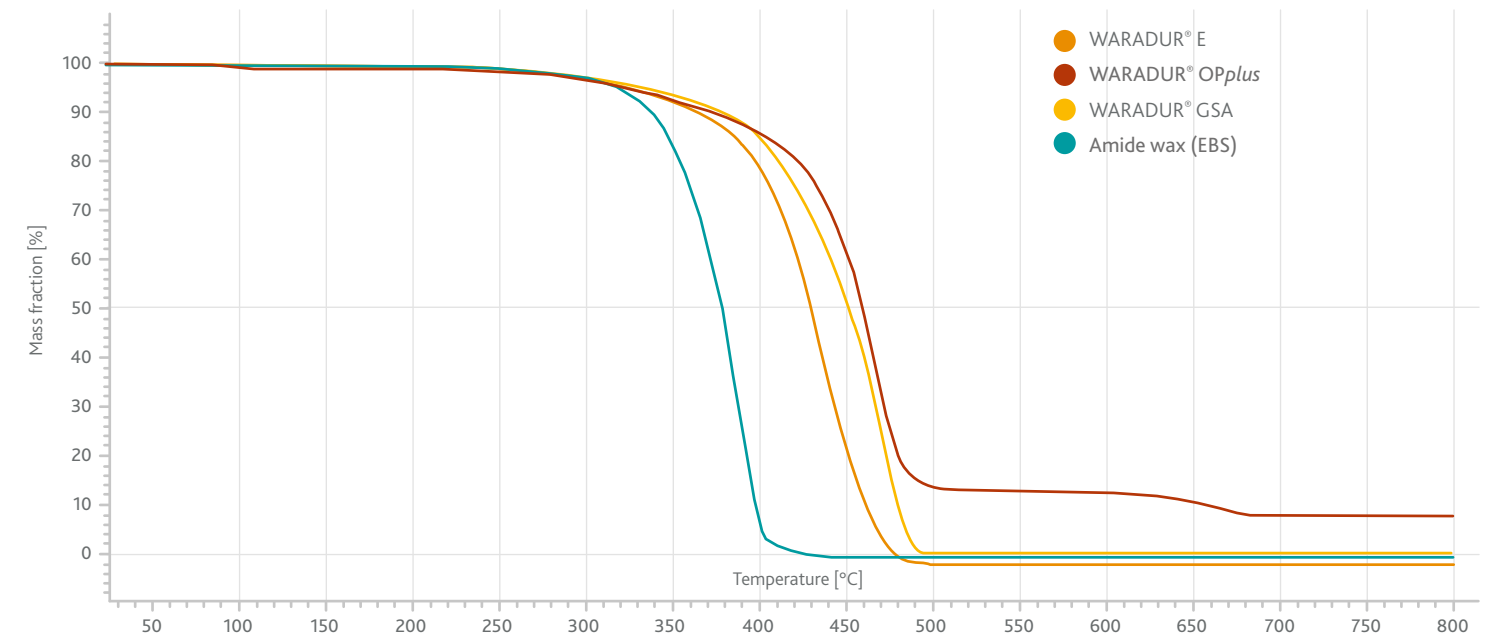


Figure 1

**Thermogravimetric analysis (TGA)** is an analytical technique used to determine a material's thermal stability and its fraction of volatile components by monitoring the weight change that occurs as a sample is heated at a constant rate.

TGA analyses shown in Figure 1 demonstrate the thermal stability and low volatility of our WARADUR® additives, proving that they fully meet the high demands in the processing of engineering plastics.

# CEVO® – SPECIALLY DEVELOPED FOR YOUR APPLICATION

## INTRODUCTION

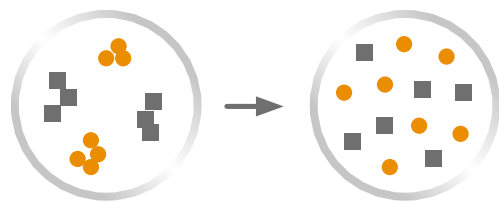
What began as a service for our customers has, over time, become a passion: additives developed by our chemists and experts that are perfectly focused to the required polymer and application. With the CEVO® products, the innovation potential of specialised waxes can be fully exploited. CEVO® additives can be used to solve processing- and application-related challenges.

For example, when it comes to good distribution of the material used, fast injection, filling long flow paths, the avoidance of friction peaks, fast demoulding, or the process stabilisation of the compound to be produced. This is how we help you to continue to improve your product performance and keep pace with technical progress.

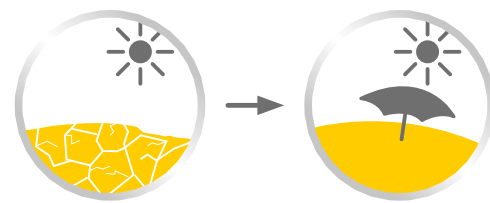
Montan wax additives have proven to be practically irreplaceable, particularly in demanding polymere applications. CEVO® is a forward integration of montan wax additives know-how in the direction of customer applications. We think ahead and strive to understand the requirements and challenges of our customers even better. We develop ready to use additives for specific processing challenges and final product quality requirements.

## CEVO® EFFECTS

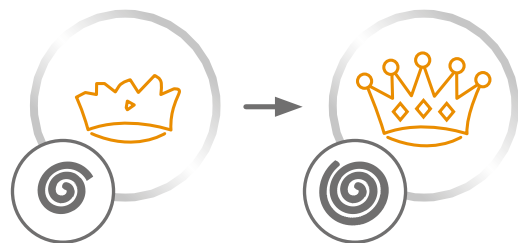
→ optimized dispersion



→ enhanced process stability



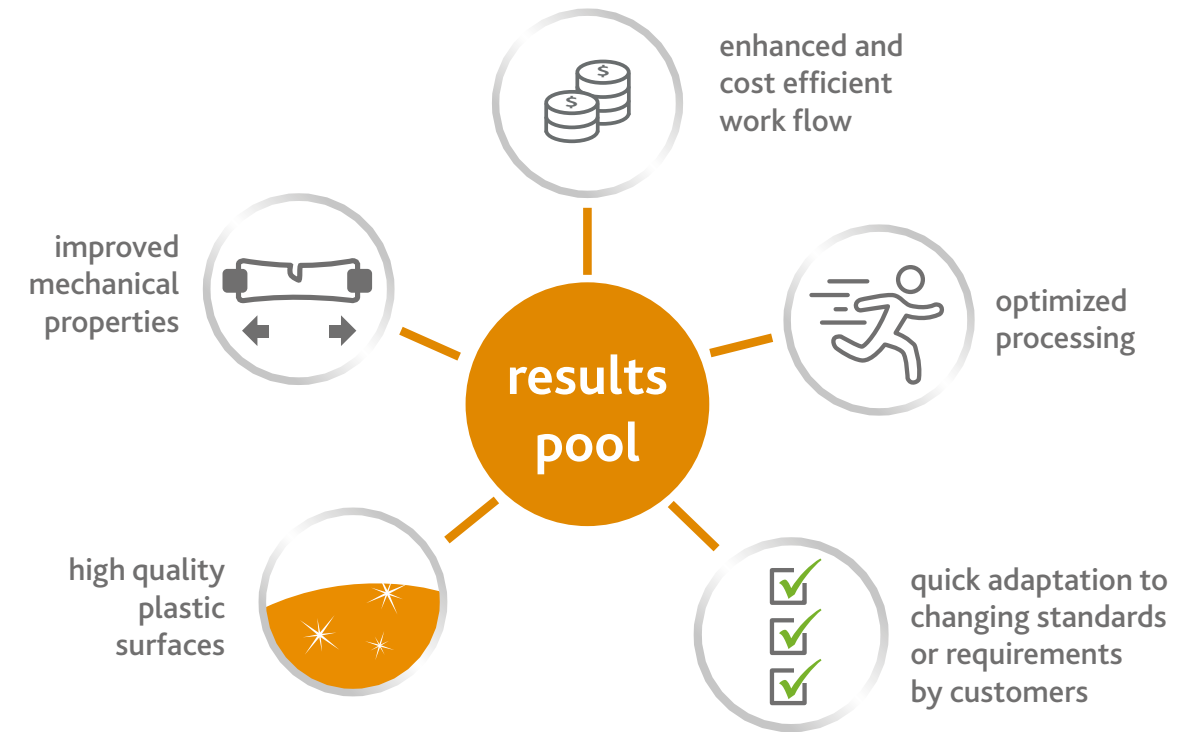
→ controlled flowability



→ lubricant and release agent



## CEVO® RESULTS



### The advantages that arise are manifold:

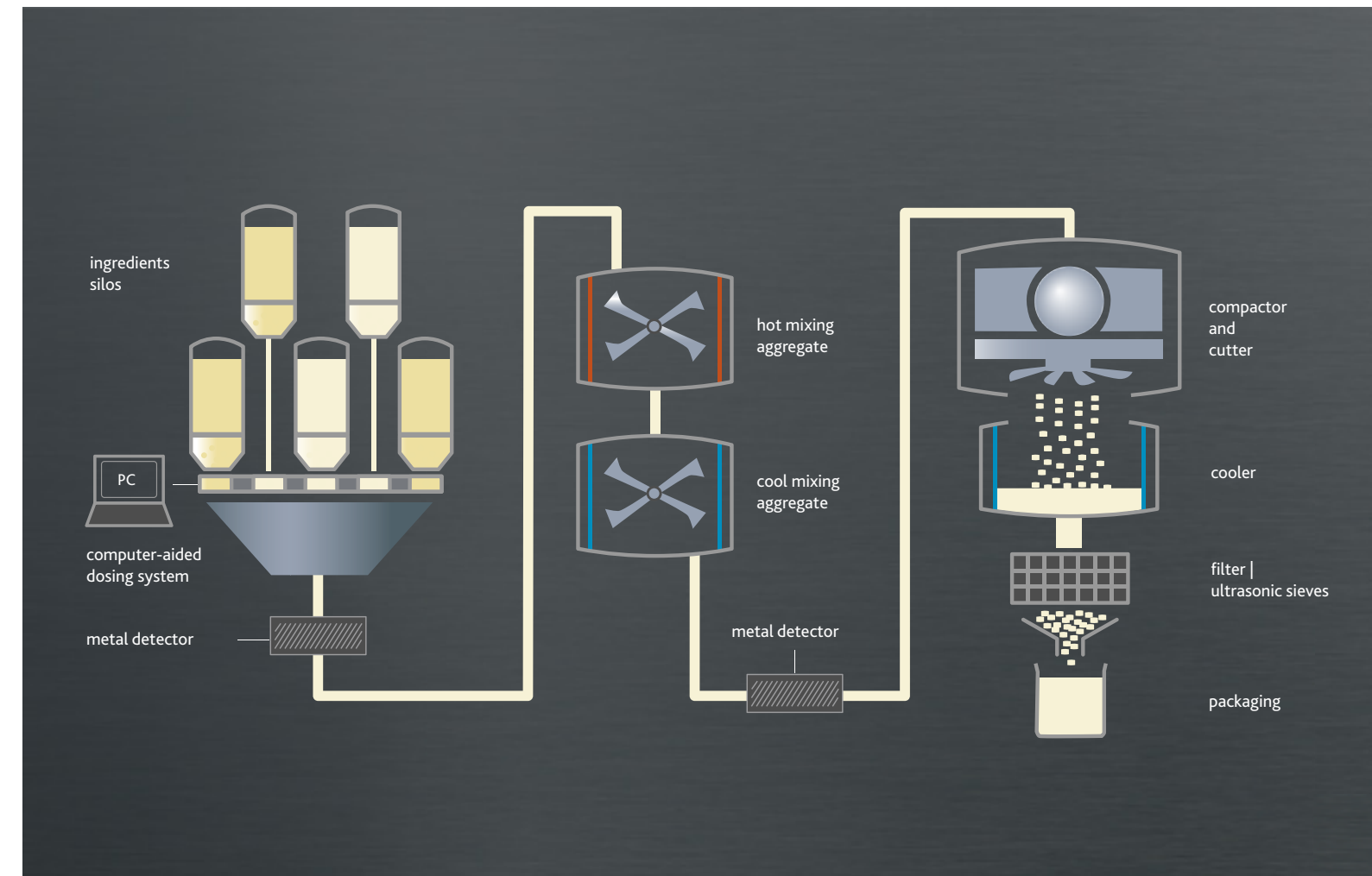
- Cost savings through shorter cycle times and, due to improved dispersion: optimized amounts of fillers, pigments etc.
- An even distribution of fillers also has a positive influence on the mechanical properties of the polymer and the surface quality.
- Flame retardants and other functional additives are protected from unwanted degradation by reducing friction peaks and their effectiveness is optimized through even distribution.

## CEVO® WAX ADDITIVES: POLYMER-SPECIFIC FORMULATIONS FOR ENGINEERING PLASTICS

Polymer	Product	Flow improvement	Release effect	Dispersion	Other
PA	CEVO®-process A-3100	+++	++	++	Surface improvement
	CEVO®-process A-3105	+++	++	+++	Friction reduction
	CEVO®-process A-3110	+++	+++	++	Stabilisation
PO (PP/PE)	CEVO®-process J-3460	++	+++	+++	Surface improvement
	CEVO®-process B-3680	++	++	+++	Compatibilization
	CEVO®-process B-5200	++	++	+++	One pack, stabilization
	CEVO®-master B-6000	+++	++	+++	Compatibilization
PET/PBT	CEVO®-process J-3400	++	++	+++	Dispersion, surface improvement
PC	CEVO®-process J-3400	+++	++	+++	Dispersion of CF
	CEVO®-process J-4055	++	++	++	Dispersion of CF
	CEVO®-master D-2050	+++	++	++	Chemical viscosity modifier
POM	CEVO®-process F-5515	++	++	++	Formaldehyde binding, stabilization
TPU	CEVO®-process J-3405	++	+++	++	Demolding

Table 3

## PRODUCTION SCHEME CEVO®



## THERMOGRAVIMETRIC ANALYSIS | CEVO®

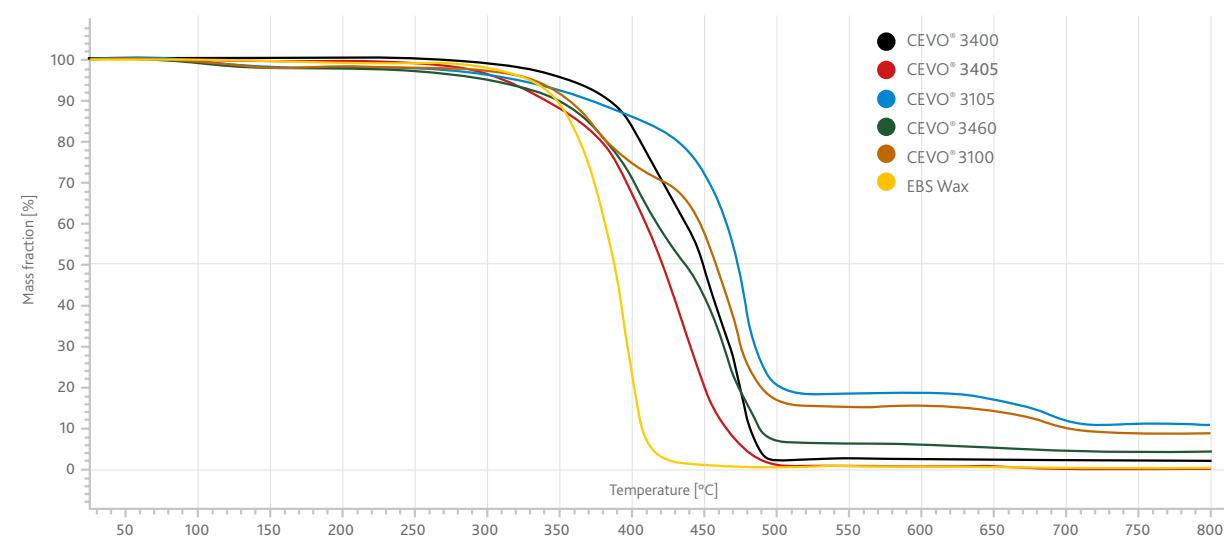


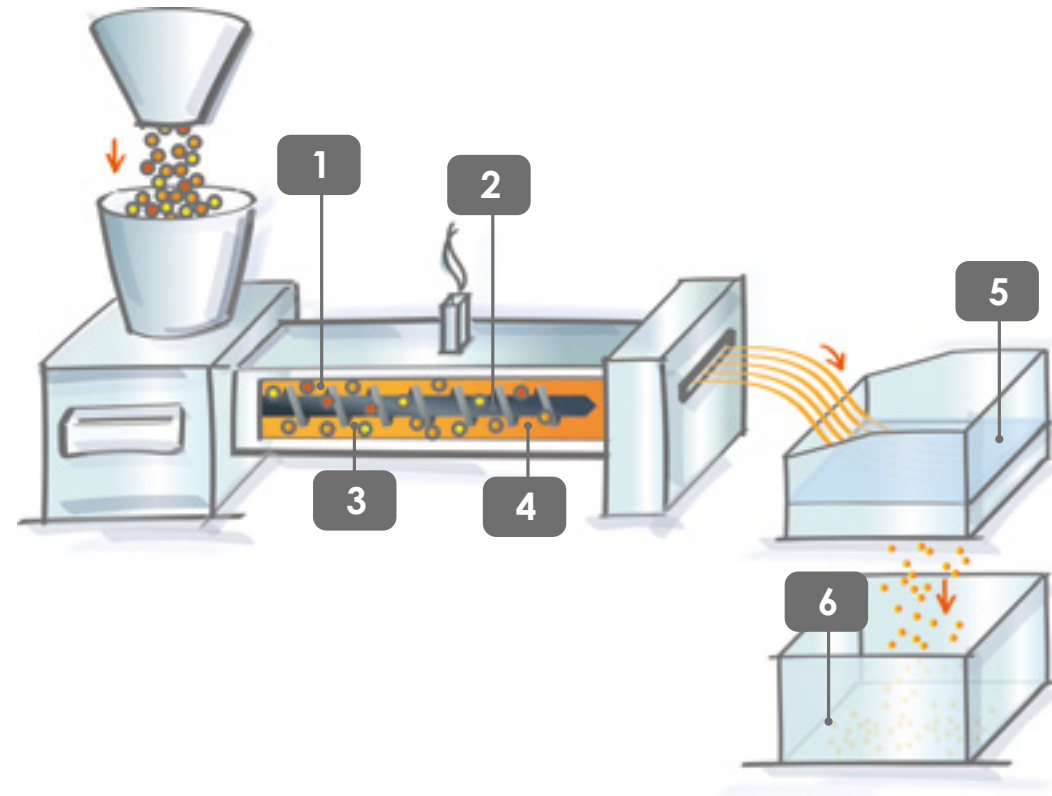
Figure 2

## ENERGY-EFFICIENT PRODUCTION OF PELLETS AND POWDER

Voelpker manufactures the CEVO® products in a new, energy-efficient compacting plant that was recently put into operation. In this process the components are dosed by a computer-aided receipt management and bonded in a hot mixing aggregate which imports energy by friction. Doing this, the components

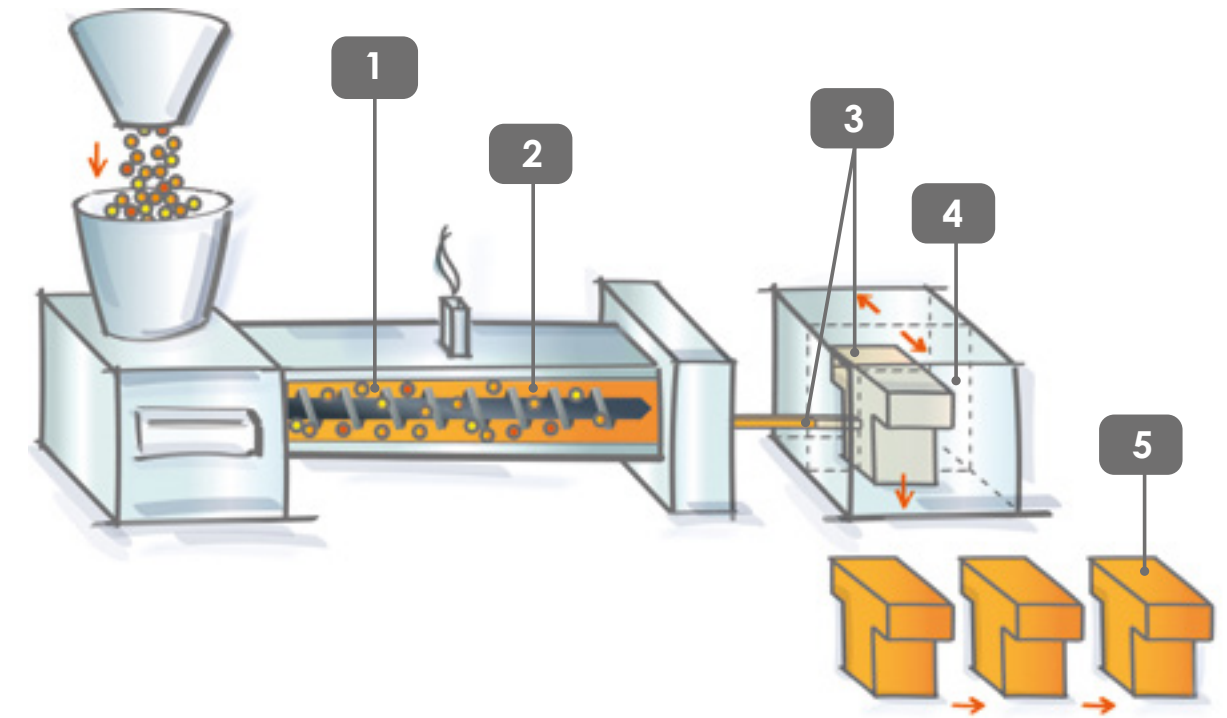
are coated by the ingredients with the lowest melting point, that avoids unmixing. The resulting dust reduced, coarse powder can be ejected from the process or pressed to obtain low dust compacted pellets.

## POSITIVE EFFECTS OF VOELPKER® WAX ADDITIVES PRODUCTION OF COMPOUNDS AND MASTERBATCHES



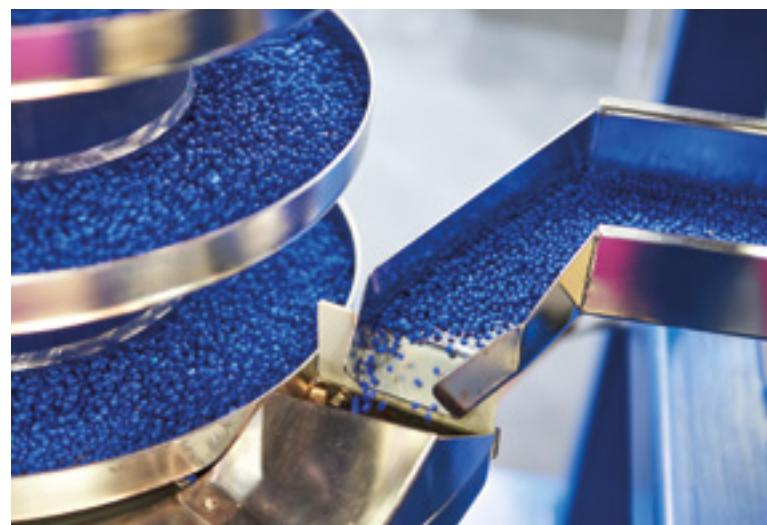
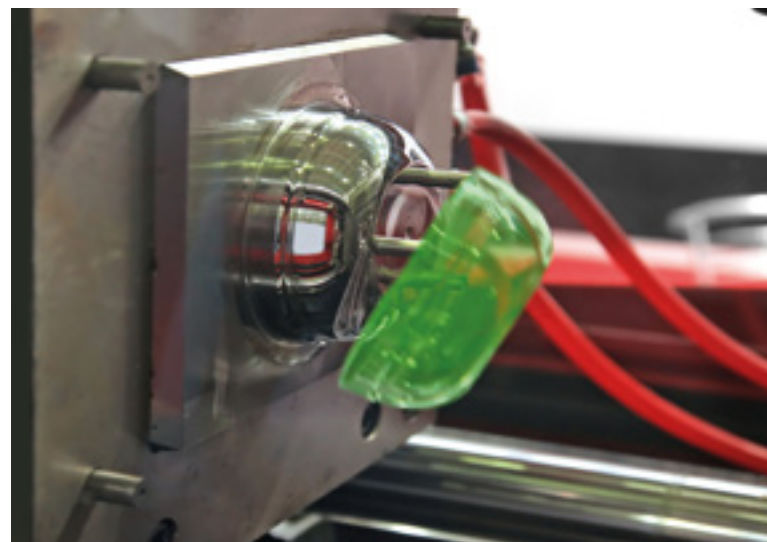
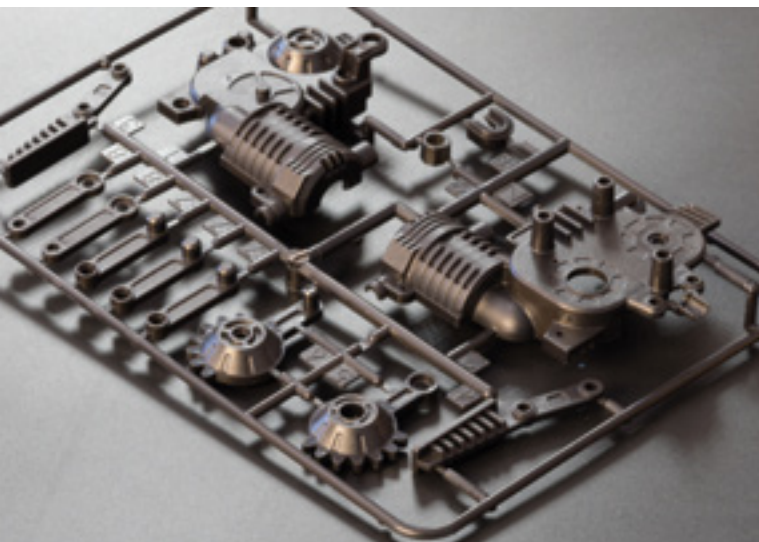
- 1 Excellent distribution of fillers, fibres, pigments and additives
- 2 Reduction of shear energy peaks → reduction of thermo-oxidative degradation of the melt
- 3 Stabilisation of the compound against stress during processing
- 4 For glass fibre-filled systems: lowered melt viscosity and partial coating of the glass fibres → better alignment of the glass fibres and thus significantly fewer surface defects resulting from extruding glass fibres (smoother surfaces)
- 5 In underwater pelletising, our products can prevent TPU regranulate from clumping together
- 6 Improved surface quality of granules, in some cases reduction of drying time of granules

## PRODUCTION OF EXTRUDED / INJECTION MOULDED PARTS



- 1 Excellent distribution of used additives, pigments and fillers
- 2 Stabilisation of the compound against stress during processing
- 3 Reduction of melt viscosity → realisation of long flow paths, lower injection time
- 4 Reduction of adhesive forces between part and mould surface → quicker demoulding → shorter cycle times
- 5 Improved surface on the final product





## APPLICATION EXAMPLES

### POLYAMIDE (PA)

#### Filler dispersion / mechanic properties WARADUR® E and WARADUR® OP

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 mould.

Glass fiber reinforced polyamides intended for processing by injection moulding often contain more than 20 – 30 % of glass fiber. 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 advantageous. 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.

#### WARADUR®: OPTIMIZED DISTRIBUTION OF THE GLASS FIBERS LEADS TO HIGHER TENSILE STRENGTH

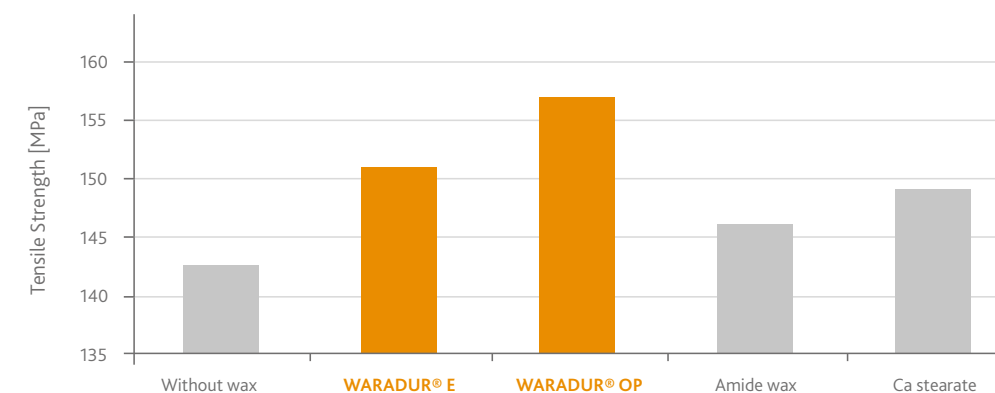


Figure 3





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 are achieved by better dispersion of the used glass fibers.

### Suppression of heavy foaming

WARADUR® OP

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).



### WARADUR®: IMPROVEMENT OF IMPACT STRENGTH

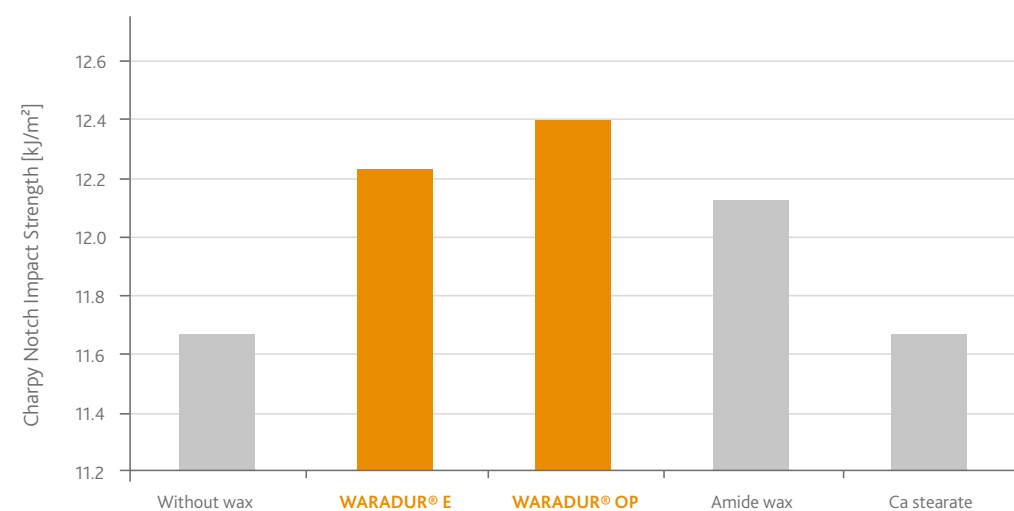


Figure 4

### Glasfiber distribution and reduction of friction peaks: CEVO®-process A-3105

By the addition of CEVO®-process A-3105 longer flow paths can be achieved and injected parts can be faster ejected. CEVO®-process A-3105 improves the hydrolysis stability of PA GF compounds that are, for example, used in engine cooling systems in which hot water/glycol mixtures circulate. CEVO®-process A-3105 aligns the glass fibers, smoothes the surfaces and reduces their porosity. Stabilizers are distributed homogeneously; lowered friction rates protect against unwanted degradation effects. We recommend to add amounts of 0.4 – 0.8 %.

### Boosting the effectivity of flame retardants: CEVO®-process A-3105

In flame retardant polyamide formulations (PA GF FR) CEVO®-process A-3105 supports the effective distribution of halogen-free flame retardants. In addition the friction rate is reduced significantly and decomposition of the flame retardant is effectively suppressed. This stabilizes the formulation and enables the optimisation of the formulation with regard to the amount of flame retardant to be used. We recommend to add amounts of 0.3 – 0.5 % of CEVO®-process A-3105 to achieve high quality requirements (e.g. V0 UL-94).

### Stabilizing one pack for thermally prestressed PA: CEVO®-process A-3110

This additive acts as flow improver and also contains thermo stabilizers (phenolic and phosphitic) which promote a re-polymerisation of partly decomposed PA. It can for example be used to upcycle agglomerate material based on milled PA fiber waste. Example of subsequent use: engine covers (GF/mineral-filled).

### Synergistic flow improver: CEVO®-process A-3100

CEVO®-process A-3100 is a synergistic formulation that improves the injection filling flow of PA GF and the surface quality of resulting injection moulded parts. Significantly lower cycle time can be achieved.



### Stable quality of recyclates

CEVO®-process A-3110

A compounder using re-milled and agglomerate-based polyamide for the production of polyamide compounds was not able to improve and stabilize the quality of his product. The quality of such polyamide compounds is normally more volatile than that of virgin based compounds. The reasons for this are primarily the degradation induced in the used

polyamides initiated by thermal preloads and processing-related inhomogeneities of the recycled material. The use of CEVO®-process A-3110 enabled the production of compounds with low variation in mechanical characteristics and consistent processing properties.





## POLYOLEFINS (PE, PP)

### WARADUR®: 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® OPplus could be demonstrated: When using 0.5 % in PP with 8 % CF, a two orders of magnitude reduction of the values for resistance [ $\Omega$ ] 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 [ $\Omega$ ]	$2.5 \times 10^4$	$4.5 \times 10^2$	$4.2 \times 10^2$
Specific electrical resistance [ $\Omega \text{ mm}^2/\text{m}$ ]	$1.2 \times 10^7$	$2.0 \times 10^5$	$2.0 \times 10^5$

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

### Generation of uniform conductivity

WARADUR® E

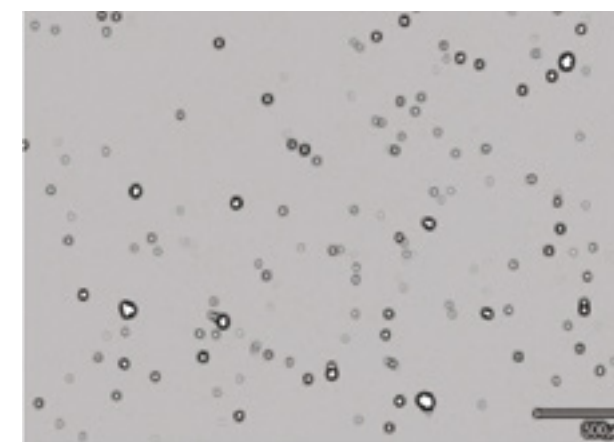


A manufacturer of a 25 % conductive carbon black-filled PP copolymer was unable to produce his compound without large variations in conductivity properties. WARADUR® E ensured uniform distribution even when using twin-screw extruders for the production. The use of WARADUR® E allowed in this case the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

### Recycling of post consumer polyolefins: CEVO®-process B-3680

CEVO®-process B-3680 is a particularly effective dispersion additive for recycling of post consumer polyolefins. Post-consumer HDPE/LDPE waste in most cases contains unwanted polymer particles and mineral — or other — contaminations that prove to be disruptive in the production of recyclates and that reduce the quality. Their proper dispersion as well as the dispersion of fillers resp. pigments - for example, carbon black - is mandatory in order to produce adequate recycling qualities, for example for injection moulding.

In a technical study with virgin HDPE containing 2% carbon black, the pigment is excellently dispersed when is added at 0.5% loading. Comparison of microscope images of manufactured foils – with and without the CEVO® additive – shows that the number of carbon black agglomerates can be significantly reduced. The images below (Fig. 5, 6) show that the carbon black particles are isolating, demonstrating the dispersing effect within the olefinic matrix.



### Better demoulding of glass fiber - filled PP: CEVO®-process B-3460

Better surface quality, better demoulding with CEVO®-process B-3460: When processing a polypropylene compound filled with 45% glass fiber, standard waxes like Ca stearate and/ or PE wax may cause problems with demoulding and the surface quality of the injection moulded parts. The substitute addition of 0.5% CEVO®-process B-3460 results in a very good distribution of the glass fiber.

The fibers are oriented in the direction of flow of the melt during processing and lead to a significant improvement of the component surfaces without any flow lines. In addition, the mould release properties of the compound are significantly improved.

### Excellent dispersion in (post-consumer) HDPE

CEVO®-process B-3680



A producer of recycled HDPE was able to achieve good dispersion of unwanted polymer particles and mineral (and other) contaminations. At the same time also the dispersion of carbon black (2 % loading) was improved and the number of agglomerates significantly reduced. The customer thus raised the material to a higher quality level and was able to produce adequate recycling qualities for injection moulding.



Figure 5, 6: Micrographs show the impact of addition of CEVO®-process B-3680 on dispersion of 2% carbon black agglomerates in HDPE. The left image contains no additive; the right image an addition of 0.5%.





## Improved quality of recycled PP

CEVO®-process B-5200

PP compounds resulting from the recycling of industrial waste are thermally pre-stressed and are therefore prone to degradation. Also processing-related inhomogeneities lead to fluctuating property profiles.

A compounder stabilized his compound with 0.5 % CEVO®-process B-5200. An effective distribution of fillers and reinforcing agents has been effected. Surface defects caused by the re-grinds used were eliminated and the lifetime of the components significantly increased.

## One pack for stabilization of recycled polyolefins: CEVO®-process B-5200

CEVO®-process B-5200 is a one pack that includes a synergistic combination of different lubricating and dispersing agents as well as a balanced mixture of diverse stabilizers and co-stabilizers. This formulation was engineered especially for the use in polyolefine compounds based on recycled polyolefines. Also advantageous when processing virgin material. The package improves the homogeneity of the filler distribution, reduces degradation by friction peaks and leads to an improved surface quality and increases the thermo-oxidative stability of produced compound. We recommend to add amounts of 0.5 %.

## Compatibilization, and stabilization of recycling HDPE: CEVO®-master B-6000

CEVO®-master B-6000 was designed for a wide range of applications in the field of polyolefin recycling. In the field of post-consumer recyclates as well as in the field of compounds based on post-industrial waste, the additive reduces the problems caused by impurities of foreign polymers due to its compatibilising effect. The flow behaviour of the respective compounds/regenerates can also be increased in a targeted manner. In parallel, the use of CEVO®-master B-6000 leads to a basic or processing stabilization of the resulting product. The distribution of further additives e.g., dyes, is also supported. CEVO®-master B-6000 is also suitable as a toughness improver.



## Talc-filled PP compounds: Flow improvement and better mechanical properties

CEVO®-master B-6000

A manufacturer of talc-filled PP compounds (PP T20) for use in the automotive sector was unable to achieve the required flow properties and the required notched impact strength values with the available post-industrial raw materials. The addition of 5% CEVO®-master B-6000 significantly improved the MFI and raised the notched impact value. In addition, the injection-moulded components had significantly improved surfaces.

Formulation	MFI 190° c/5 kg g/10 min
HDPE (foil mill material) <sup>1)</sup> + 2 % black master batch	1,5
HDPE (foil mill material) <sup>1)</sup> + 2 % black master batch + 2 % CEVO® -master B-6000	6
HDPE (foil mill material) <sup>1)</sup> + 2 % black master batch + 4 % CEVO® -master B-6000	12

Table 5: 1) with 5 % polymeric impurities due to PP and PA6

## POLYESTER (PET, PBT, PC)

### Mould release and glass fiber distribution in Polyesters: WARADUR® E

Glass fiber reinforced polyesters contain 20 – 30 % of glass fiber or even more and are normally processed by injection

moulding. 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 WARADUR® GE has been proven to be advantageous. WARADUR® OPplus is an excellent surface booster for PET.

### WARADUR® E: REDUCTION OF MOULD RELEASE FORCE

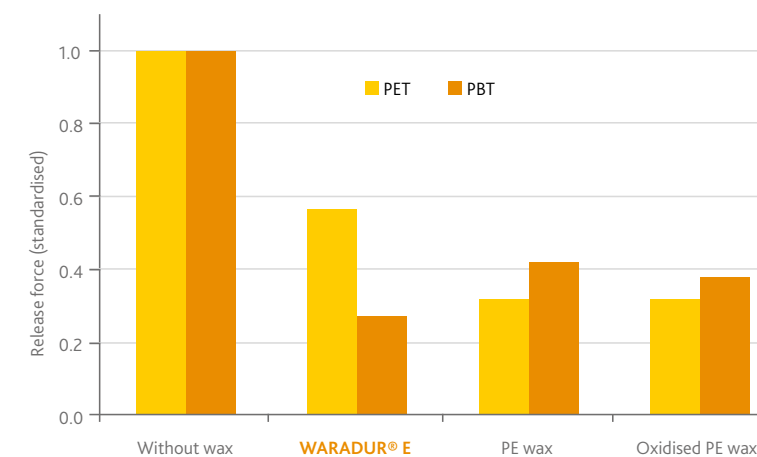


Figure 7

## Mechanical properties of PBT

CEVO®-process J-3400

Mechanical tests were carried out on a flame-retardant, Impact-resistant PBT type, which was added with CEVO-process J-3400. The mechanical properties (impact strength, flexural strength, tensile strength) were even better than with the previously used, unformulated standard montan wax ester.





## Adjusting the required flowability of PC

CEVO®-master D-2050



A manufacturer of PC compounds based on PC regrinds only had raw materials with an MFI value of ~ 7 g/10 min available to produce easy-flowing grades (MFI300° C/2.16 kg ≥ 20 g/10 min). The use of 1.5% CEVO®-master D-2050 resulted in the required flowability of 20 g/10 min. The other characteristic values of the compound were comparable to those of a virgin material with an analogous melt flow index.

## Chemical modifier and flow improver for PC: CEVO®-master D-2050

The modifier **CEVO®-master D-2050** was developed to increase the flow behavior of highly viscous polycarbonates for example from post-industrial areas and is primarily used in the production of easy-flowing polycarbonate compounds.

The amount of modifier added depends on the melt index of the polycarbonate used and on the extruder, rep. its screw geometry (friction energy, residence time) and must therefore always be adapted to the respective application.

Example: Conversion of Extrusion PC regrinds (MVR 7) to injection moulding quality (MVR >> 20) using a twin screw extruder. Not for full transparent applications. Further addition with release agent: for example CEVO®-process J-3400.

## CEVO®-MASTER D-2050: VISCOSITY REDUCTION DEPENDING ON THE AMOUNT ADDED

Characteristics	Unit	PC	PC +1,5% D-2050	PC +2,5% D-2050	PC + 4% D-2050	Lexan 121R <sup>1)</sup> Reference
MVR (300° C/1,2 kg)	cm <sup>3</sup> /10 min	7	20	27	45	21
Tensile strength	MPa	68	66	66	67	65
Unnotched impact strength	kJ/m <sup>2</sup>	no break	no break	no break	no break	no break
Notched impact strength	kJ/m <sup>2</sup>	80	50	25	10	65
VICAT B50	° C	145	140	140	140	140

Table 6

## Savings in carbon fiber consumption in PC: CEVO®-process J-3400

**CEVO®-process J-3400** is a synergistic, montan wax based combination of different lubricating, release- and dispersing agents. It has been developed especially for the application in polymers or polymer blends with high melt viscosities (PC, ABS, PLA, PS, POM, PBT etc.). Also advantageously applicable in PA. In a variety of different formulations injected parts can be faster ejected, which leads to shorter cycle times. The use in mineral filled, glass fiber reinforced and/or pigmented compounds improves the homogeneity of the filler and/or pigment distribution, reduces damages by friction peaks and leads to an improved surface quality. We recommend to add amounts of 0.3 – 0.5 %.

## Positive effects on mechanical properties

CEVO®-process J-3400 positively affects the mechanical properties of carbon fiber-reinforced polycarbonate compounds. Tests were carried out using Makrolon 2405, a general purpose, low viscosity, easy release grade from Covestro with an MVR (300°C/1.2 kg) of 19 cm<sup>3</sup>/10 min. Multi-purpose injection moulded 1A (DIN EN ISO 3167) test specimens were used and the results shown in Figures 8 and 9.

A study demonstrated that using CEVO®-process J-3400 can significantly improve both the tensile modulus and tensile strength. There is a significant correlation between the dispersing effect of this additive on filler material and the improvement in mechanical properties. The improved carbon fiber distribution allows a reduction in the carbon fiber content and thus leads to lower raw material costs. CEVO®-process J-3400 is available as powder and as compacted pellets.

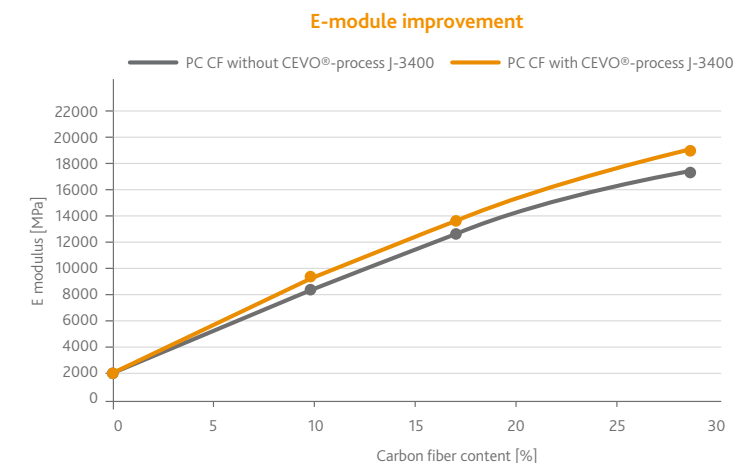


Figure 8: Effect of the inclusion of 0.3 phr of CEVO®-process J-3400 on tensile (E) modulus of PC reinforced with carbon fibre contents of 9.7, 17.2 and 28.5 phr

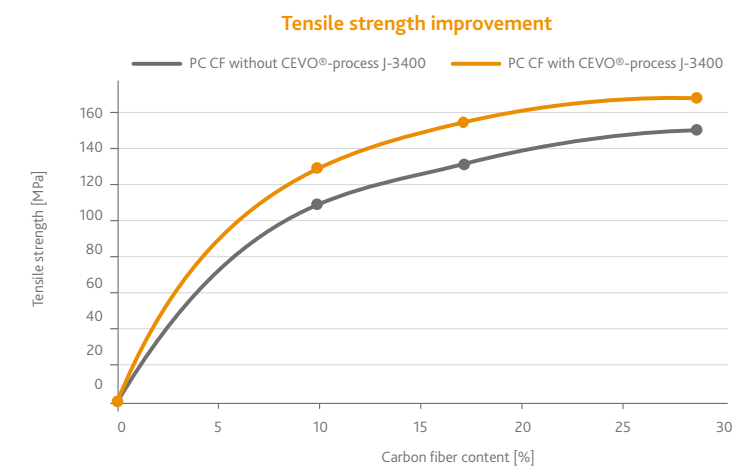


Figure 9: Effect of the inclusion of 0.3 phr of CEVO®-process J-3400 on tensile strength of PC reinforced with carbon fibre contents of 9.7, 17.2 and 28.5 phr

## Improved pigment dispersion

CEVO®-process J-4055



A compounder's high melt viscosity PC/ABS compound could not be evenly coloured. The pigment mixture itself was not allowed to be changed. 0.5% CEVO®-process J-4055 eliminated this problem.

## TPU

### Setting the standard: WARADUR® additives in TPU

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.

Montan waxes show no tendency to migrate and do not form surface deposits on the final product. At the same time, the distribution of the pigments used is been improved.

WARADUR® E or WARADUR® OP 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.

Even in less demanding TPU applications, the behavior of the often used commodity release agent EBS wax is problematic – due to its blooming out and plate out behavior. **CEVO®-process J- 3405** can provide the required improvement while also improving pigment dispersion. Depending on the application, **CEVO 3405®** can be a more cost-effective alternative to WARADUR® E.



### CEVO®-process J-3405

*Improved blooming and plate out behaviour*

A producer of TPU automotive parts needed to suppress blooming out on the surface of the produced parts and plate out of unwanted deposits in his machinery. With **CEVO®-process J-3405** (0,5 %) instead of EBS wax both targets were achieved. At the same time, the distribution of the pigments used has been improved.

leads to an irritating and pungent odour and may even cause undesirable bubble paths at the feeding region of injection moulded parts. The addition of 0.3 ... 0.5% radically reduces odour formation during compounding and prevents the described impairment of injection-moulded parts. Due to the described properties **CEVO®-process F-5515** also acts as an effective processing aid for POM Copo recyclates.

## POM

### Stabilizing POM Copolymers: CEVO®-process F-5515

**CEVO®-process F-5515** is a special one pack that includes a synergistic combination of different lubricating and dispersing agents as well as a balanced mixture of diverse stabilizers and a formaldehyde scavenger. **CEVO®-process F-5515** stabilizes the processing of POM Copolymer and suppresses thermo-oxidative decomposition: POM Copo splits off formaldehyde especially when exposed to thermal stress. This

## Elimination of free formaldehyde from POM-Copo recyclate

*CEVO®-process F-5515*

In the processing of polyacetal waste based on copolymers (POM Copolymer) a customer determined the undesired formation of free formaldehyde. The material had already been thermally pre-stressed in its processing history. This also resulted in blistering during injection moulding and other processing issues. Compounding with 0.4% **CEVO®-process F-5515** eliminated the processing problems and reduced the typical formaldehyde odour by suppressing the POM degradation at the chain ends and acting as a formaldehyde scavenger. Other customers also used **CEVO-process F 5515** successfully in POM Homopolymers.



## PVC

### Superior surfaces, excellent release effects and reduced melt viscosity: WARADUR®

The advantages of **WARADUR®** come to light in PVC especially when there are high demands made on the quality of the end

product. Among other properties, montan waxes function in PVC as release agents. They improve the surface quality and smoothness and provide the final product with a superior gloss. Montanic esters are used in high-quality packaging film materials (e.g. blister foils for the pharmaceutical industry, processed by calendaring).

### No plate out, better transparency, low volatility

**WARADUR® E** is often used as specialty high-quality release agent. Apart from the release action, in contrast to other waxes, it does not "bloom out", even at higher dosage.

**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.

For more Information consult our TechPaper: „Montan Waxes – High-Performance Additives for PVC“.

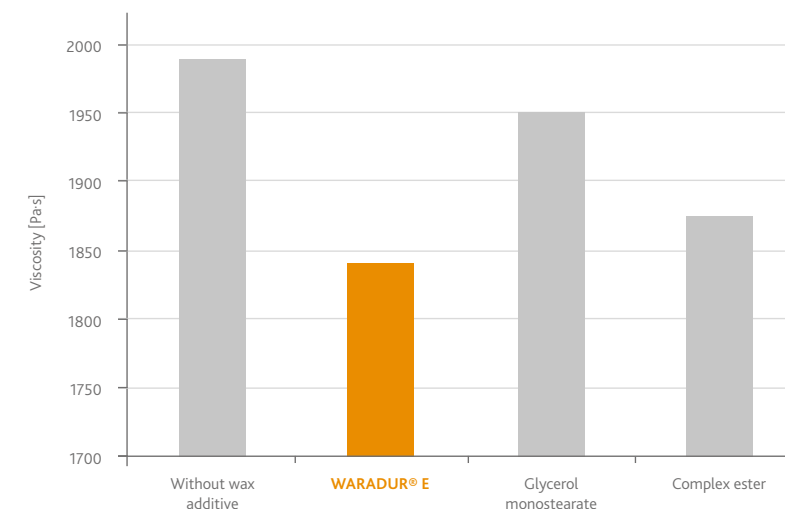


Figure 10: Effect of various waxes on the viscosity of PVC melts



## GENERAL ADVANTAGES AT A GLANCE

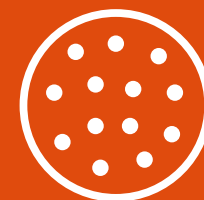
**WARADUR® montan waxes and CEVO® formulations deliver specific solutions which comprise:**

- Suitability for highly demanding plastic applications
- Improvement of processing and end product properties
- Internal lubrication: improvement of flow properties
- External lubrication: improvement of mould release
- Reduction of friction peaks, stabilization and protection of the materials
- No blooming-out, no exudation or product loss
- Improvement of pigment/filler/flame retardant dispersion
- Improvement of mechanical properties
- Effectiveness - improvements in functional additives
- Suitability for clear applications

### CEVO®-CLEAN J-1819 PURGING CONCENTRATE

- One 4 all – easy mixing: one granulate for all polymers
- Cost-effective concentrate 1:4
- Gentle cleaning and removal of even the most stubborn deposits
- Highly effective combined chemical and physical active mechanism of action

More info: see separate Product information sheet



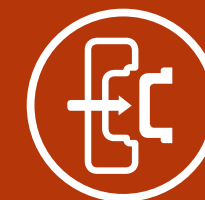
Proper  
dispersion



Higher tensile  
strength /  
impact strength



Flow  
improvement



Reduced  
ejection force





## OVERVIEW WARADUR® - AND CEVO® -PRODUCTS

Product	Description/ Properties	Polymers																Functions																				
		PA	PE	PP	PBT	PU/TPU	PET	PC	PS	ABS	PVC	TPE	POM	Styrenics	Thermosets	PLA	Others	Cleaning Concentrate	Dispersion	Lubricant	Lubricant, extern	Lubricant, intern	Plasticizer	Release agent	Gloss booster	Surface Improver	Viscosity regulator	Flow Improvement	Stabilization									
WARADUR® E	Montan glycol wax, internal and external lubricant for PA, TPU, PBT, PC, PS, PVC, epoxy resins, phenolic resins.	X		X	X	X	X	X		X	X		X		X	X			X	X	X	X		X	X	X	X	X										
WARADUR® ESM	Montan hybrid ester, internal and external lubricant.	X		X		X	X	X	X	X	X	X			X		X			X	X	X		X				X	X									
WARADUR® GE	Montan glycerol wax, internal and external lubricant for PC, PBT (filled).	X			X	X	X	X		X			X		X		X			X	X	X		X			X	X										
WARADUR® GSA	Complex montan ester wax. Low volatility, acts as a release agent and lubricant for engineering plastics, including PMMA.									X										X	X	X		X			X	X										
WARADUR® GSM	Montan hybrid ester, acts as a release agent and lubricant for Engineering plastics.									X														X					X									
WARADUR® OP	Calcium-saponified montan wax, multipurpose wax additive for Engineering plastics.	X		X	X	X	X	X		X	X		X		X	X			X	X	X	X		X	X	X	X	X	X	X	X	X						
WARADUR® OPplus	Saponified montan wax; high Calcium montanate content. Multi-purpose additive, suitable for PA, PET and other Engineering plastics.	X			X		X	X	X	X						X				X	X	X		X		X	X	X	X	X	X	X						
WARADUR® S	Montan acid wax, external release agent for Engineering Plastics and thermosets.									X					X					X	X			X	X													
CEVO®-master B-6000	Additive combination for post consumer PO. Dispersing, compatibilizing and flow improving effect.		X	X																			X							X								
CEVO®-master D-2050	Reactive chemical PC modifier. Increases the flow behavior Of highly Viscous polycarbonates.	X								X																	X	X										
CEVO®-process A-3100	Combination of different lubricating, release- and dispersing agents. Generates long flow paths and easy part ejection.	X																		X	X	X	X		X		X	X	X	X	X	X						
CEVO®-process A-3105	Additive formulation for longer flow paths and Surface improvement.	X																		X	X	X		X		X	X	X	X	X	X	X						
CEVO®-process A-3110	Flow improver and also contains thermo stabilizers which Promote a re-polymerisation of partly decomposed PA.	X																		X	X			X		X	X	X	X	X	X	X	X	X				
CEVO®-process J-3460	Additive formulation for mold release and surface improvement.		X	X																X	X	X	X		X		X											
CEVO®-process B-3680	Particularly effective dispersion additive for recycling of Post consumer polyolefins.		X	X																X	X	X	X			X	X	X										
CEVO®-process J-3405	Multipurpose, synergistic combination of different lubricating, Release- and dispersing agents.					X							X							X	X	X	X		X			X										
CEVO®-process J-3400	Multipurpose, synergistic combination of different lubricating, Release- and dispersing agents.	X	X	X	X			X	X	X	X	X	X		X	X	X			X	X	X	X		X		X	X	X	X	X	X	X	X				
CEVO®-process J-4055	Multipurpose, synergistic combination of different lubricating, Release- and dispersing agents.	X	X	X	X			X	X	X	X	X	X		X	X	X			X	X	X	X		X		X	X	X	X	X	X	X	X				
CEVO®-process B-5200	Synergistic combination of different lubricating and dispersing agents as well as a balanced mixture of diverse stabilisers and co-stabilisers.		X	X																X	X	X	X		X		X								X			
CEVO®-process F-5515	One pack that includes a synergistic combination of different lubricating and dispersing agents. Formaldehyde scavenger.												X							X	X	X								X								
CEVO®-clean J-1819	Highly efficient cleaning concentrate for plastic processing machines. Suitable for various polymers. Based on a combined chemical-physical Mode of action which uses Solid solvents and non-abrasive minerals.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X															



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