

Processing Guideline Extrusion

vibers™ BP EX Grades

Application and properties

- vibers™ BP EX is developed for extrusion.
- Are biodegradable Miscanthus fiber filled compounds.
- Easy to process and can be converted on conventional processing equipment.
- Can be processed at low temperatures, saving energy.
- Are biobased alternatives for fossil-based plastics.

Important: do not pre-dry vibers™ BP EX before processing!

Melt processing & start up conditions

Before starting up production and introducing vibers™ BP EX, the processing system should be thoroughly cleaned and purged to prevent any polymer cross contamination. Insure that the feeding and blending equipment is properly cleaned and free from contamination and dust and all metal parts have been wiped clean. The following purging procedures are recommended for optimal removal of other polymers, in particular high melting and low MFI polymers such as PA, PP and PET.

1. Purge with a polymer like LDPE or EVA or PS at normal operating temperatures. Purge as necessary, at least 10-30 minutes. Let system empty as much as possible. Clean out the hoppers completely.
2. Introduce an adequate transition polymer, e.g. a high melt flow, low melt temperature LDPE or EVA or PS (>5 MFI), purge and change to the for the specific grade advised Solanyl® operating temperatures (see further-on in this document). If the transition polymer has relatively high viscosity at these temperature settings keep the die temperature at a higher level close to the indicated maximal processing T for the respective Solanyl grade. Purge 10-30 minutes as long as necessary to clean out the system. Let system empty. Reduce the temperature further to the advised settings. Completely clean all hoppers, elbow, slide gates, dryers, hopper loaders bins, hopper loader, filters and material conveying lines of residual polymers such as PET, PA, HDPE or PP.
3. vibers™ BP EX is preferably run without filter systems. Low MFI PE, PA, PET and PP will not flow or melt sufficient at normal processing temperatures for vibers™ BP EX and potentially can block the filter as such.
4. Load vibers™ BP EX into material handling system. Transition to purge vibers™ BP EX and purge with open nozzle until melt is clear of any contamination. Keep the output and torque during transition relatively low. We recommend to

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Note

For general product information, please refer to our technical datasheets. Our technical services/department is available to discuss your requirements.

Additional information

This information is intended as a guide line for the injection molding of vibers™ BP EX grades. The document contains generalized information for safety, processing guidelines and tooling. Processing and use of vibers™ BP EX is the sole responsibility of the purchaser. All legal and other regulations must be complied with. Since injection molding covers a broad range of applications and products, an experimental approach at your facility will have to determine what tooling and mode of operation will work best. Testing of the end products is also recommended in order to make sure it meets customer requirements.

Packaging

Packaging; 25 kg bags, 1000 kg octabins. Identification: Grade name, Lot nr. and production location.

Transport, storage and shelflife

vibers™ BP EX must be stored in a cool dry place, out of direct sunlight and protected against humidity. After use bags should be sealed back.

vibers™ BP EX should be maintained in a closed bag and processed within several hours after opening.

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Pre-treatment and drying

Vibers™ BP EX require some moisture (bonded to the thermoplastic starch) to enable melting and to ensure the flow properties during processing. vibers™ BP EX have been preconditioned during manufacturing to the correct moisture content before packaging. Therefore specific vibers™ BP EX grades are **not to be dried** for standard applications or uses. Drying will affect processing and properties. **Important: do not pre-dry vibers™ BP EX before processing!**

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change the filter or screen before production when present. Run at relative low output and torque conditions during the transition, too avoid pressure build-up by polyolefin.

5. Immediately after completion of the production run, purge vibers™ BP EX from the extrusion system, using a moderate to low melting temperature, low MFI PE.

At start-up material can be metered with an open die and if necessary adjustments to screw speed, back pressure and temperature profile can be made to arrive at even feeding. No obvious discoloration compared to pellet color should be observed and the material should exit the barrel as a uniform melt. Discoloration of the material indicates that this combination is incorrect (leading to shear rates being too high). When metering with an open nozzle into free air, small clouds of fume (water vapor), could emerge from the nozzle depending on vibers™ BP EX grade. This is normal behavior for vibers™ BP EX.

Degradation (hydrolysis)

Please note that vibers™ BP EX has a degradation temperature of 170-210°C. The possibility of degradation of the natural components in vibers™ BP EX exists during prolonged exposure to elevated temperatures. When the machine is idle and vibers™ BP EX is present in the barrel, idle times should not exceed 5-10 minutes. Prolonged idle times, even at the proposed temperature profile, can lead to a significant decrease of product quality. When longer idle times are foreseen, we strongly suggest purging the barrel to prevent loss of dosing properties and overall material quality. Symptoms of degradation are: chewing gum effect in the first phase, then increase of brittleness and increased discoloration or beige/brownish burning spots will occur. Preferably the feed zone is not to be overfed and cleaned out and cooled during prolonged idle times to avoid degradation and blocking of the feed zone.

Extrusion machine recommendations

vibers™ BP EX grades can be processed on most conventional single-screw extrusion lines with standard screw settings but there could be some torque limitations if the screw design has a high compression ratio. Compression ratios of 2-3 are in general considered to be adequate for vibers™ BP EX. Preferred screw design is a PS or PE type. Processing on double-screw PVC lines is possible as well in most cases. However processing will deviate from standard conditions and specific conditions should be discussed with our technical service department. Products can be processed with barrier elements like with a Maddock element and filter screens, although high shear conditions are not needed and preferably avoided. Standard screen pack configurations can help to protect melt pumps and dies from incidental contamination that may occur during material handling. Screen mesh sizes of 100-200 mesh are generally sufficient. Finer filtration leads to excessive shear & heating and should be avoided.

vibers™ BP EX process well on mono and co-ex lines. Temperature profiles during extrusion are typically lower than conventional polymers, providing energy savings for the converter.

The residence time of vibers™ BP EX material in the barrel at temperatures over 170°C should be kept low. It requires to rule out the remain material in the barrel in order to avoid discoloration, decomposition, charring and plugging the die head.

Re-use & compatibility

The leftover materials can be reclaimed and reprocessed if they are free from dust and contamination. Recyclability: clean waste can be shredded or re-granulated (typically up to 5-15%) and used with virgin material. However, the leftover materials should be collected, shredded and sealed quickly in order to avoid humidity absorption. Addition levels should be controlled within a reasonable and constant addition range. It is strongly recommended that the reclaiming materials will be reprocessed to grains in good time. Pre-drying to appropriate moisture levels before reprocessing would be needed if the reclaiming materials have been stored without sealing. The leftover materials should be stored sealed in a dry cold environment.

Temperature profile and processing

Typical extrusion conditions are described in the next sections below. vibers™ BP EX results in a non-transparent, beige product with a natural soft feel. Properties may depend on water content, humidity, processing and thickness. Prospective clients should evaluate vibers™ BP EX in their own laboratories to establish optimal conditions for use in their processes and applications. vibers™ BP EX can be colored with biodegradable masterbatches.

Overheating of products should be avoided. Before production, make sure that all temperatures zones work correctly. Do not allow material to remain hot inside the extruder for extended periods as the material can degrade. Therefore, do not heat products over indicated maximal process temperatures for long times and not over 160°C when machine is not running.

The suggested regular temperature profile (from inlet, feed to melt zones to the die) consists in most cases of a gradually increasing temperature to higher temperatures at the die. However, the profile may depend on extruder type & design, die type & design and also on type of product made.

To avoid sticking in the inlet it advised to cool the inlet. The inlet should be kept cold, below 35°C. The optimal temperature is depending on the screw design features of the inlet zone. It is advised to avoid overfeeding the inlet zone. This is in particular important during start-up.

Additional equipment information

Materials described in the tables below were all run on a laboratory Collin ZK 50 single screw extruder (30 mm diameter, L/D=25 with 6 heating zones, water cooled). The system has no degassing, melt pump or filter. Motor power 4,4 kW. PE screw with Banbury dispersion barrier element. The line has a sheet die and a water-cooled 3-roll calander.

- 30 rpm (0-120 max.)
- Die gap 0.4-2 mm
- Die width range 8-10 or 15-20 cm
- 2-15 kg/h output.

vibers™ BP EX grades have been run on other industrial scale equipment as well including melt-pump, degassing and filter systems. The data shown are indicative for various machineries. Several commercial lines have extruder screws optimized to run polyolefins at the maximum output for the screw diameter. Due to the different rheology vibers™ BP EX, they do not shear thin as readily and therefore could require additional power input from the drive. This additional power input could manifests itself as an excessive increase in melt temperature, which could limit screw speed limited to be able to avoid excessive increase in melt temperature.

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In the table the suggested profile for a screw with various heated zones are tabulated. The suggested profile is intended as a starting point. If flow and processing is good it is possible to reduce the temperature settings. If the flow of the material needs to be improved or gel particles or die lines appear with a particular product, there is the possibility to increase the temperature. We strongly recommend you to apply the decrease or increase to zones 3 and 4 first with steps of 5°C and evaluate the result. It is advised not to exceed the maximal processing temperature.

Data presented was generated using various standard laboratory and industrial equipment. Using different machineries with differences in screw, output, smaller dies and die design can lead to differences in optimal conditions. Differences in die gap will create changes in orientation in the machine direction. Thus: Processing can vary with type of equipment used. Data are as such indicating conditions for processing. During production excessive shear induced material heating should be avoided as much as possible.

When during continuous production, an emergency stop occurs, it is advised to reduce the extruder barrel T to about 120-140°C to avoid degradation of vibers™ BP EX. During restart temperatures can be increased and further processing can be started with open die first to clean screw.

Grade	Inlet Section	Temperature (°C)				Maximal Process T	ideal T melt or material
		Feed Zone 1	Melting Zone 2	Metering Zone 3	Die head		
Standard grades							
vibers™ BP EX	25-35	120-140	135-140	140-150	140-150	170	140-150

Monitor melt temperature continually. One should use sufficient cooling for extruder and forming equipment (calander, thermoform etc..). Reducing the output in combination with screw speed could help in keeping melt T under control. The melt is softer than most polyolefins when emerging from the die. The products need some time to get their final properties. Some property changes can occur after production due to for instance recrystallize or changes in water content due to changes in humidity.

vibers™ BP EX grades have higher die swell and lower shrinking than polyolefins which could make further downstream converting different. To increase the surface quality of the product it may be needed to use low cooling temperatures during shaping products such as sheets or plates with low calander temperatures. Because of the limited shrinkage it can lead to different size of formed products such as tubes compared to polyolefin based products such as PP and PE. The tension control through the web path has to be controlled well and all driven rolls must be maintained in top working condition.

Material safety data sheets

Material Safety Data Sheets (MSDS) for vibers™ BP EX grades are available. MSDS is provided to help customers satisfy their own handling, safety & disposal needs, and those required by locally applicable health and safety regulations.

Chemical control law compliance

Across the globe regulations exist for local environmental authorities to evaluate materials to assure the protection of human health & environment from any unreasonable risks associated with chemicals. Components used in vibers™ BP EX grades as supplied comply with the European Union (EINECS)/REACH chemical inventory.

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If the product is edge trimmed or slit, sharp knives or rotary shear trimming wheels are preferred to prevent breaks.

Melt-pump

For single-screw extrusion systems, melt pumps can in most cases be used for sheet or shape profile consistency. When using a melt or gear pump system, the suggested T at the melt pump is 150-185°C. Again, as with the suggested temperature profile, these temperatures are intended as starting point.

Filters

Standard screen or filter pack configurations can be used to protect melt pumps and dies from incidental contamination that may occur during material handling. Screen mesh sizes of 20-50 are generally sufficient. Finer filtration leads to excessive shear-heating with vibers™ BP EX and should be avoided. Because of the viscous nature of vibers™ BP EX some pressure build can be reduced by having a 0-10°C higher temperature at the filter compared to the mass temperature.

Degassing

The use of degassing can help in optimisation the processing and properties of vibers™ BP EX. In particular in the case of open product forming techniques water vapor will be reduced (for instance in cast sheet or thermoforming). Atmospheric degassing is advised, due to the relative low melt viscosity the product can be pushed out when using vacuum.

Storage finished products

Storage conditions: Sheets on rolls and other finished products best are stored dry and cold or room temperature. It is recommended to seal goods in black PE films to protect them against moisture and UV radiation. In any case we recommend to use products as soon as possible and not to store them for long time periods (> 6-12 months). Storage time depends on processing parameters and on climate conditions in the respective area. Because of these essential and complex interacting parameters, vibers™ cannot give any shelf life guarantees for finished goods. The conditions mentioned relate to our customers' experiences. Each customer should execute individual storage tests according to product specifications and storage requirements.

Certification

Presuming appropriate processing, the composition of vibers™ BP EX grades comply with EC Plastics Regulation 10/2011 and as such has potential to be used in the EC countries for materials or articles according to article 3 of Regulation EC No 1935/2004 on materials and articles intended to come into contact with food and repealing Directives 80/590/EEC & 89/109/EEC and FDA food contact standards



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codes of federal regulations CFR 21. Compliance with the provisions of these regulations, especially the suitability of the articles for the given application, the effect on smell and taste of the food, and observance of any given limitations, must be ensured by the person who introduces the articles into circulation. The specific restrictions mentioned in EC Plastics Regulation No 10/2011 and amendments have to be ensured. Migration should be measured on finished articles placed into contact with the foodstuff or appropriate food simulants for a period and at a temperature which are chosen by reference to the contact conditions in actual use.

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