Processing Bioplastics. Sustainable Compounding with Coperion Technology.

BlueValue
Efficient. Sustainable. Responsible.

coperion K-TRON

coperion
confidence through partnership

Bioplastics are biodegradable, bio-based, or both. They represent a market-ready solution and are already in use in a variety of applications.

Bioplastics manufacturing places very high demands upon the compounding process due to the number of possible base polymers and the vast differences in recipe mixtures. Every process step in the compounding systems must be precisely aligned with the mechanical properties required in the end product.

Coperion and Coperion K-Tron have decades of experience in realizing systems for bioplastics manufacturing. We possess unique process expertise and comprehensive system know-how for the entire process chain – from raw material conveying to premixing, feeding, extrusion, pelletizing and drying, as well as the gentle conveying of biocompounds. As a result, you profit from our in-depth knowledge, acquired in the fields of plastics compounding and cooking extrusion.

TYPICAL APPLICATIONS FOR COPERION SYSTEMS

- Starch-based bioplastics
- Thermoplastic starch (TPS)
- Compounds made of various biopolymers such as PLA, PVOH, PBS, PBAT, PHA, PCL, CA
- Biopolymer filling with up to 80% filler (e.g. $CaCO_3$, talc)
- Masterbatch for bioplastics

- ZSK TWIN SCREW EXTRUDER WITH HIGH-ACCURACY FEEDERS, ZS-B SIDE FEEDER AND ZS-EG SIDE DEVOLATILIZATION

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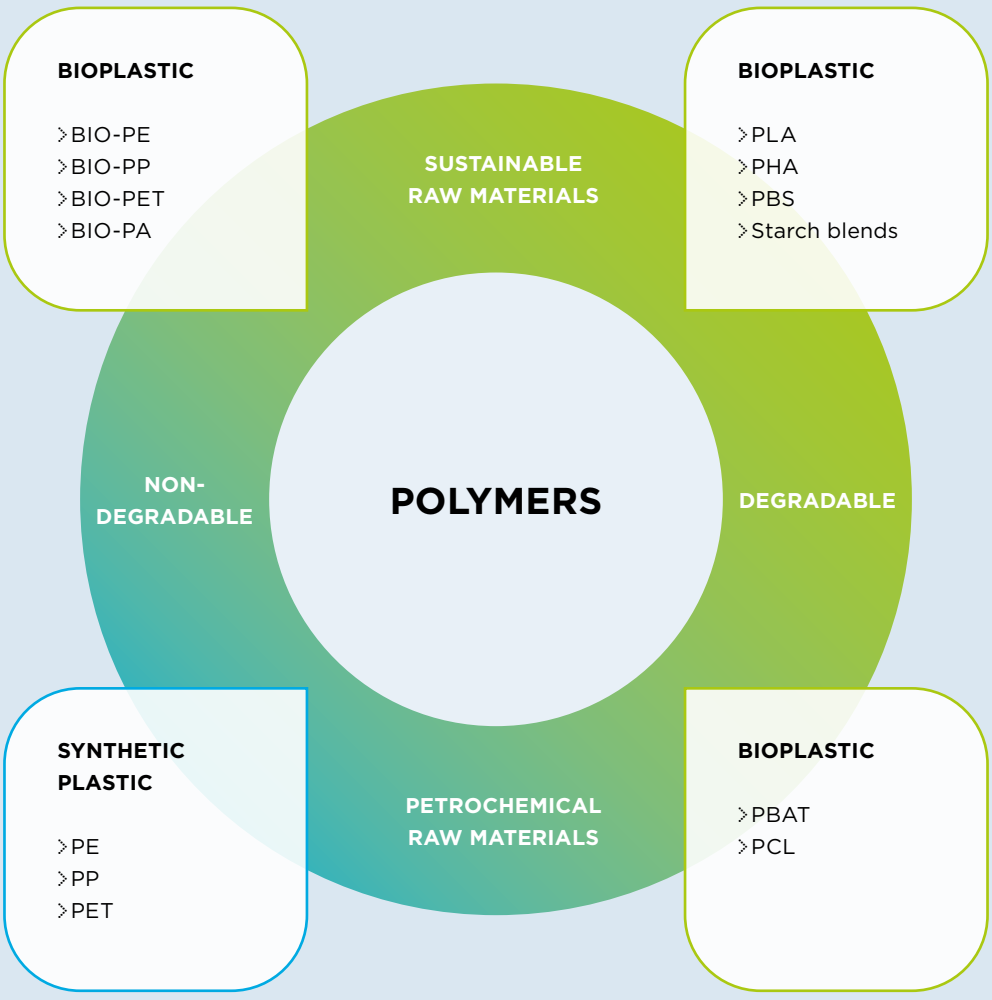
Everyday life without plastics has become unthinkable. The vast majority of plastics used today incorporate fossil-based resources. However, bio-based plastics from renewable raw materials are a viable forward-looking alternative.
Primarily sugar, starch, proteins, cellulose, lignin, fats or oils harvested from plants such as corn, sugarcane, sugar beets or lumber are used as source materials for manufacturing bio-based plastics.
Compared to the use of fossil-based resources, renewable raw materials lead to a reduced carbon footprint and increased sustainability of the plastic products.

Fewer fossilized hydrocarbons are used, resulting in less multi-million-year-old CO_2 being released into the atmosphere. Moreover, it promotes independence from increasingly scarce and costly fossil-based resources. Bio-based plastics can be comprised entirely or partially of sustainable raw materials. They can be biodegradable, though some are only partially so. Conversely, biodegradable plastics are not necessarily bio-based.
At Coperion, we have made it our goal to support the plastics industry on its path to a circular economy with our BlueValue process solutions – for a sustainable future.



Our products.

FEEDING

For free-flowing bulk materials, our single screw feeders and bulk solids pumps are ideal solutions. For ingredients with poor flow properties, we recommend our twin screw feeders, which can be equipped with flow aids such as ActiFlow™ technology when needed. Vibratory feeders and weigh belt feeders are well suited for flakes or fibers. For feeding liquids, we build pump systems with hanging or platform scales that can be individually designed for any viscosity. All of our loss-in-weight feeders are equipped with Smart Force Transducer (SFT) weighing technology to ensure high-accuracy bulk material feeding, batching and metering. If space is limited, up to six feeders can be grouped around the process inlet using the K4G feeder line.

COMPOUNDING

Our ZSK and STS series of twin screw extruders form the core of processing systems for bioplastics. The process section's modular design allows us to custom-tailor the design of the extruder to each process individually. Processing in the Coperion extruder features intensive dispersion and mixing performance at very low shear stress and low temperatures. The product is handled very gently in the process section with a short residence time, while at the same time achieving reliably high throughputs and highest product quality.

To obtain specific product properties, fibers, fillers, and additives can be introduced downstream into the process using side feeders. Our Feed Enhancement Technology (FET) ensures a very high intake capacity for feed-limited products with vacuum applied to the feed zone from the outside. Volatile materials are reliably removed by degassing, devolatilization domes and the ZS-EG side devolatilization, thus achieving consistently high product quality.

BULK MATERIAL HANDLING

We offer solutions for handling the full spectrum of bulk materials in the bioplastic manufacturing process, encompassing both individual components as well as complete conveying systems. Solutions include, for example, rotary valves for material discharge from silos, bulk bins, or small bag dump stations, as well as continuous feeding into the process. Using continuous vacuum and pressure conveying systems specifically tailored to the material, ingredients are gently transported to the feeders and twin screw extruders.
After extrusion, we take over further process steps using additional technologies, such as cooling/warming, devolatilization, cleaning/sifting or homogenization as well as conveying of the finished product.

PELLETIZING

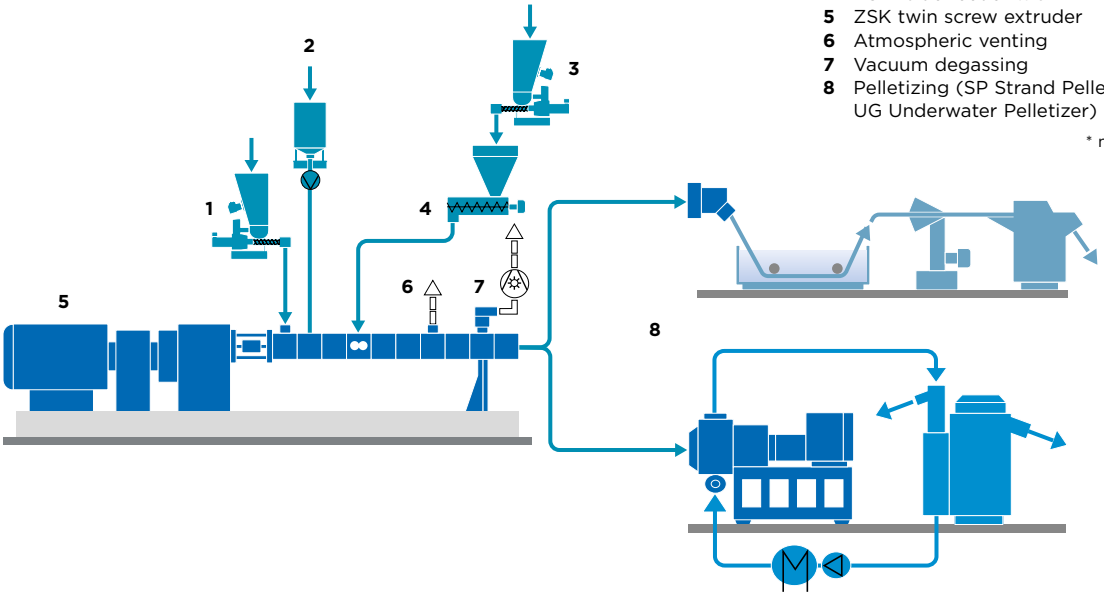
The method used for polymer melt pelletizing depends strongly upon the product's water sensitivity. Coperion underwater and water ring pelletizers may be used, as well as air pelletizers. Alternatively, bioplastics can be cooled in a water bath and cut using our strand pelletizers. For the automatic transfer of extruded strands from the die head to the strand pelletizer, we offer both the ASC fully Automatic Strand Conveying System as well as the semi-automatic SCP Strand Conveying System.

Typical processes.

FILLING AND MIXING OF BIOPOLYMERS

1 Loss-in-weight feeder for biopolymers/additives/fillers
2 Liquid feeder for additives
3 Loss-in-weight feeder for filler (e.g. talc)*
4 ZS-B side feeder with FET*
5 ZSK twin screw extruder
6 Atmospheric venting
7 Vacuum degassing
8 Pelletizing (SP Strand Pelletizer/ UG Underwater Pelletizer)

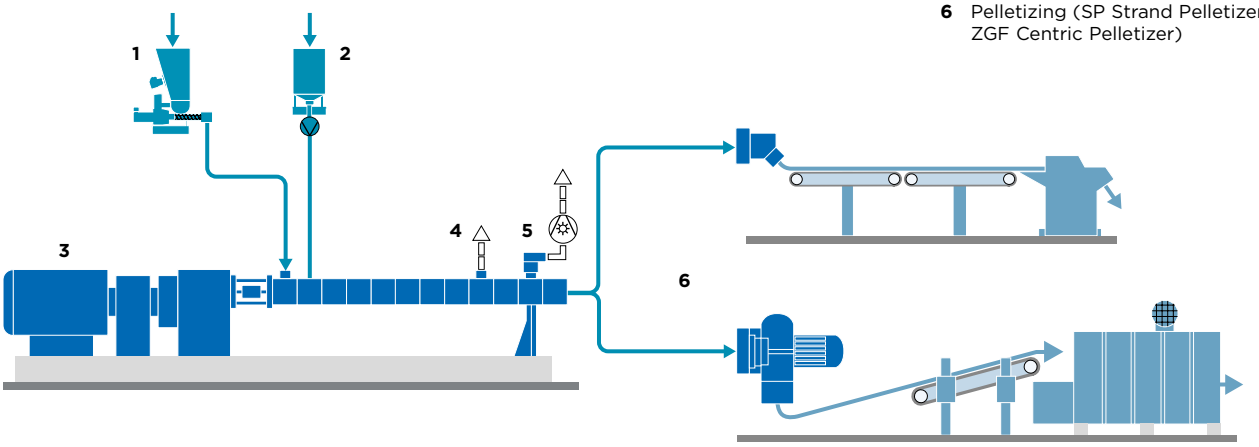
* not necessary for mixing processes



When filling and mixing biopolymers, we achieve throughputs with our systems that are comparable to those of fossil-based engineering plastics. A wide range of feeding technologies allows us to provide an optimized feeding system for any bulk material. Using patented FET technology, the extruder's intake section is equipped with a porous, gas-permeable wall to which a vacuum is externally applied. The resulting gas vacuum markedly increases the material intake capacity and throughput when processing feed-limited products. Due to the intensive mixing and devolatilization in the extruder, very high product quality is achieved.

THERMOPLASTIC STARCH MANUFACTURING USING COOKING EXTRUSION (TPS)

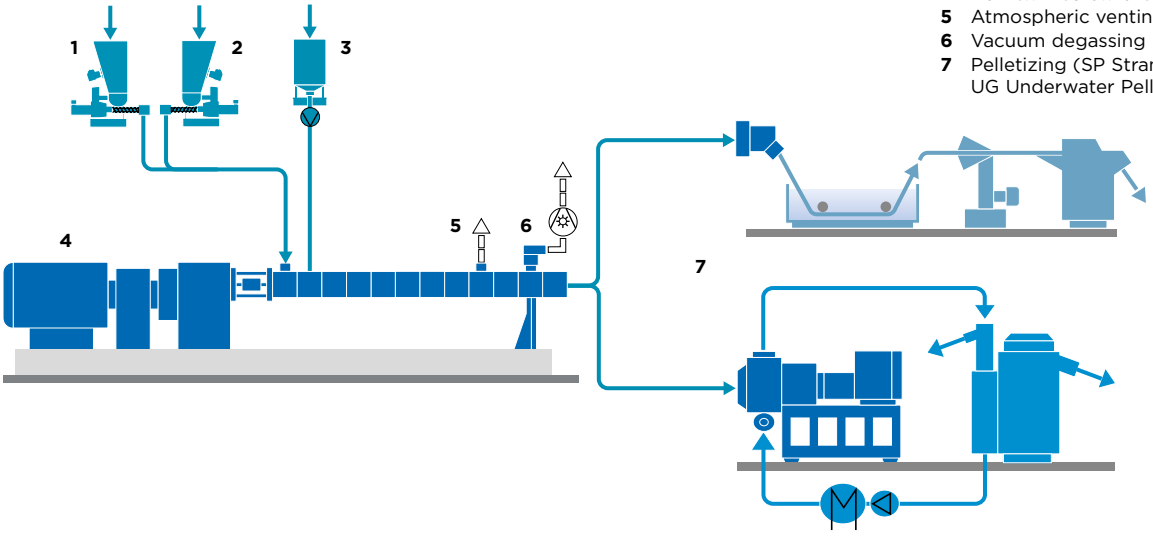
1 Loss-in-weight feeder for starches
2 Liquid feeder for plasticizer/water
3 ZSK twin screw extruder
4 Atmospheric venting
5 Vacuum degassing
6 Pelletizing (SP Strand Pelletizer/ ZGF Centric Pelletizer)



Since native starch cannot be melted using heat, it must be converted into thermoplastic starch (TPS). In this process, the starch powder (i.e. from corn, potatoes, or tapioca) is gelatinized (cooked) in the extruder. While adding liquid, heat and shearing energy, the starch's partially crystalline structure is transformed into a completely amorphous structure. This process is irreversible. To give the TPS more flexibility, plasticizers, such as glycerin, can be added to the process. Gravimetric liquid feeders ensure that additives are added with very high accuracy, even at low feed rates.

STARCH BLEND COMPOUNDING

1 Loss-in-weight feeder for starches
2 Loss-in-weight feeder for biopolymers
3 Liquid feeder for plasticizer
4 ZSK twin screw extruder
5 Atmospheric venting
6 Vacuum degassing
7 Pelletizing (SP Strand Pelletizer/ UG Underwater Pelletizer)



Starch blends are mixtures of thermoplastic starch (TPS) and plastics made from fossil-based or sustainable raw materials. Manufacturing of this type of bioplastic, currently comprising the largest share of all bioplastics, can be accomplished within the twin screw extruder in a single process step. The biopolymer is fed directly into the extruder along with components for TPS.

The recipes and properties of starch blends vary greatly depending upon the purpose of the end product. Using high-accuracy feeders, raw materials are introduced into the twin screw extruder. With the smart flow aid device ActiFlow, gravimetric twin screw feeders can reliably feed even difficult-flowing starches with high accuracy. Within the ZSK extruder the raw materials are modified by means of intensive energy introduction and homogeneously mixed. The melt is reliably devolatilized and, depending upon product properties, can be processed into compounds using strand or underwater pelletizing.

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