

FILM EXTRUSION

Extruders and extrusion lines



DIRECT EXTRUSION

Twin screw extruders - the energy-efficient melting machine

Standard compounding process (multi-stage): raw material → film



Direct extrusion (single-stage): raw material → film



Energy savings of up to 40% possible (depending on the process)

Direct extrusion or inline-compounding facilitates the production of extruded parts in a very economical way by merging various process steps. The stage after the compounding step is shaping. Here the extrudate is processed to semi-finished products. Typical examples of this

process are the production of sheets made of sound-absorbing films using BaSO₄, the manufacturing of soft-PVC, PP and PET floorings, as well as the processing of undried PET, PLA and PP to thermoforming films and biaxially oriented films.

ADVANTAGES OF DIRECT EXTRUSION

- ↗ **More gentle material processing:** The polymer is exposed to only one heating and shearing step.
- ↗ **More economical production:** entire process steps are eliminated (e.g. pelletizing and melting) → higher added value, material and energy cost savings
- ↗ **Cost benefits through direct incorporation of raw materials:** Virgin polymers, powders, flakes etc. are fed instead of pre-compounded pellets.
- ↗ **High flexibility:** Formulations can be changed and adjusted more flexibly.
- ↗ **Non-disclosure:** formulation know-how stays in-house
- ↗ **Space-saving:** high throughput with minimum space requirements

PRODUCT DIVERSITY



ADVANTAGES OF TWIN SCREW EXTRUDERS IN COMPARISON TO SINGLE SCREW EXTRUDERS

- ↗ **Higher product quality:** A reduced polymer degradation leads to an improvement of the product quality (clarity, firmness) due to the optimal adaptation of the extruder to the processing task (modular system concept)
- ↗ **Additional degree of freedom:** The filling degree can be determined by setting the through put and torque parameters independently
- ↗ **Facilitated formulation change:** The self-cleaning effect of the twin screws makes it easier to change the formulation.
- ↗ **Better homogenization:** optimal incorporation of recipe components with different bulk densities and physical properties (e.g. liquids, powders, pellets, flakes)
- ↗ **Advantages in the incorporation process:** trouble-free processing of film shreds and ground production waste, edge trimmings of up to 100%
- ↗ **Re- and upcycling:** processing of film waste that is coated with a non-stick or heat-sealable layer
- ↗ **Better degassing performance**
- ↗ **Optimum temperature adjustment:** Each barrel segment temperature can be controlled separately
- ↗ **Multipurpose screw geometry:** processing of various materials with only one screw geometry in a wide process window

CALENDER FILM

Processing recycled and virgin material

For the production of calender films, the pellets are first melted in the extruder. A wide slot die then directs the melt onto a calender stack. Compared with using a single screw, this process enables high production speeds and a

good homogeneity of the film. The polymers processed in this way include virtually all materials that can be processed thermoplastically. A film thickness of 150 µm or more is possible.

Example of a PET film extrusion line with main components in the extrusion process



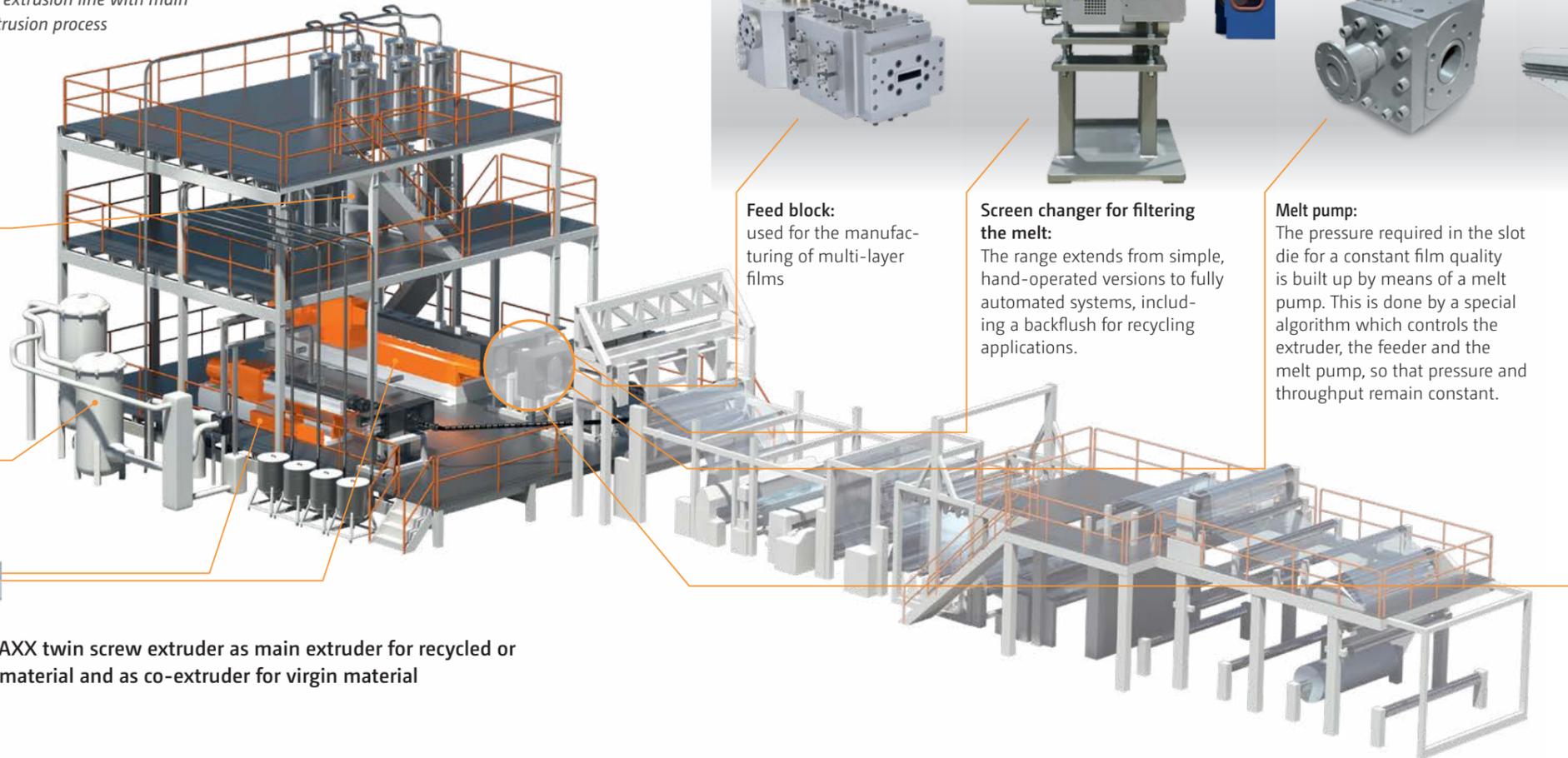
gravimetric feeder:
metering of low bulk density possible, e.g. regrind



high performance vacuum system:
by using a vacuum system, pre-drying can be omitted



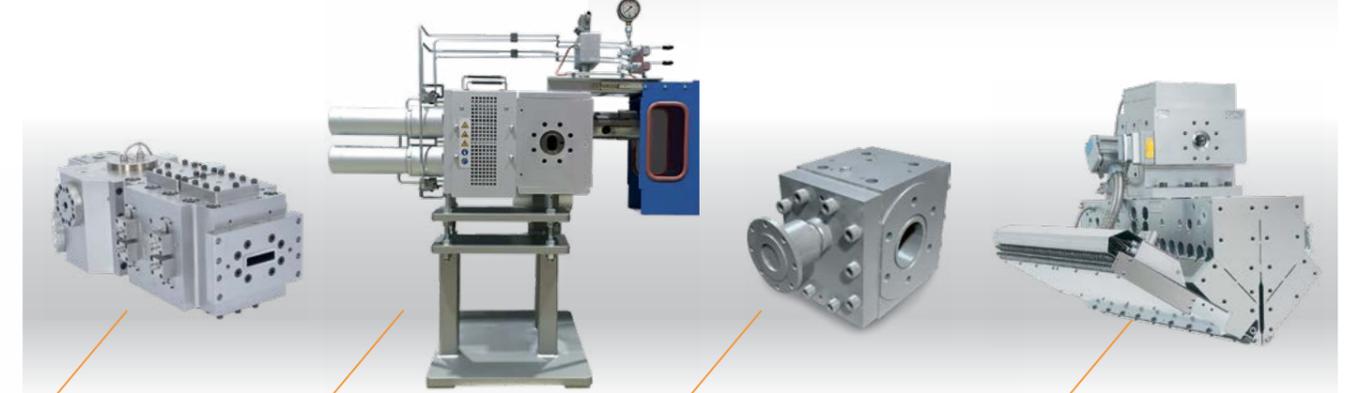
ZSE MAXX twin screw extruder as main extruder for recycled or virgin material and as co-extruder for virgin material



» Energy savings of up to 40% and more by eliminating entire process steps

PROCESSING ADVANTAGES WHEN PRODUCING PET CALENDER FILM

- high level of flexibility: both recycled materials and blends can be processed
- low IV degradation due to special vacuum technology



Feed block:
used for the manufacturing of multi-layer films

Screen changer for filtering the melt:
The range extends from simple, hand-operated versions to fully automated systems, including a backflush for recycling applications.

Melt pump:
The pressure required in the slot die for a constant film quality is built up by means of a melt pump. This is done by a special algorithm which controls the extruder, the feeder and the melt pump, so that pressure and throughput remain constant.

Wide slot die:
The adjustment of the die gap can be done by hand or automatically.

PP film and PS film

Compared to PE films, PP films have a higher transparency, better stiffness and abrasion resistance. They are more resistant against oils and greases and have an increased temperature stability. The thickness of PP calender films usually ranges from 300 to 2,500 µm.

If PS film is produced with standard PS, the result will be a crystal clear, brittle and very stiff film. Its properties can – depending on their application area – be optimally adjusted by means of modification with e.g. impact resistors. PS films have a very good formability when exposed to heat. Therefore, they are mainly used as packaging material. The thickness of a PS film usually ranges between 200 and 2500 µm.

In combination with fillers and further additives like CaCO₃ or TiO₂, PP and PS can be processed in a direct extrusion process. **Some application areas are:** food packaging, yoghurt cups, drinking cups and disposable plates.

PET film

PET calender films are used in the packaging industry as well as for technical applications. PET is a semi-crystalline material: Depending on its type and processing conditions, it is mainly amorphous and therefore transparent (A-PET) or mainly crystalline and opaque (C-PET). The film thickness for thermoforming applications ranges from approx. 150 µm to max. 1.2 mm. In contrast to working with a single screw, the raw material does not have to be pre-dried when using twin screws. In order to prevent hydrolytic degradation a special vacuum technology is applied. The compounder saves the complete energy consuming predrying step.

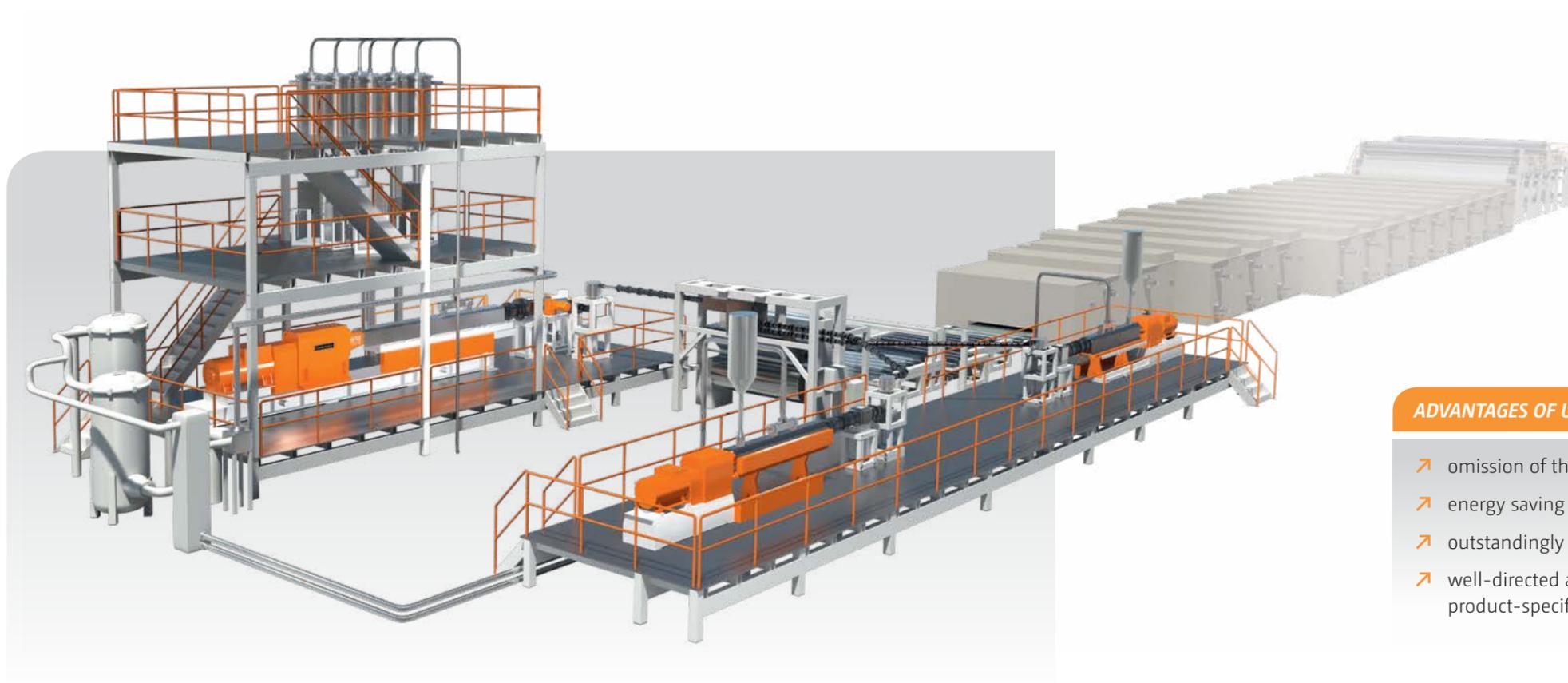
Oftentimes this kind of film is produced as a composite, using recycled material for the middle layer. This results in a further advantage of the twin screw: the easy processing of, for example, PE-contaminated PET (e.g. by glue or labels). FDA and EFSA compliant versions are available in conjunction with additional equipment.

BIAXIALLY ORIENTED FILMS

High-performance films for packaging and technical applications

These films are extruded through a wide slot die onto a large rotating roll - a so-called chill roll - and are then biaxially stretched, i.e. the film is stretched in both longitudinal and transverse direction. Thereby, its properties (firmness, barrier function, transparency) can exactly be determined. After extrusion, the melt is cooled down quickly in order to either remain in the amorphous phase or attain a fine-crystalline state, depending on the

polymer. In the subsequent stretching process, the film is stretched either sequentially (i.e. first in longitudinal, then in transverse direction) or simultaneously in both directions. After that, a substantial reduction of mechanical stresses and a "freezing" of the film structure is achieved in a tempering step. The thickness of biaxially oriented films varies between less than 1 µm and more than 350 µm, depending on the application.



BOPET

The process described above optimizes the properties of so-called BOPET films. As a result, the oriented polyester films are extremely tear-resistant, shock- and abrasion-proof, and highly ductile. Their optical properties, such as the highest possible transparency, are outstanding as well. Their resistance to cold and heat (approx. -70 °C to +150 °C) is remarkable even after long-term use. Usually the films are multi-layered. **Some application areas are:** optically attractive and transparent packaging, aroma-sealed food packaging - also in metalized form, e.g. for crisp bags or as thermal insulation material for capacitors, solar panels and monitors.

BOPA

Just like PET, polyamide is hygroscopic - this special characteristic needs to be considered when manufacturing PA films. Leistriz applies a special vacuum system in this process. The advantage is that the entire predrying step is omitted. Furthermore, the amount of small molecules in the melt is reduced and, therefore, the machine availability increased (dross accumulation at the die). The importance of PA films for packaging purposes is based on their great strength, heat resistance and sterilizing capability. Their excellent barrier properties with respect to gases, especially oxygen and flavoring agents, are of enormous benefit. In combination with e.g. PE, PA films are used in flexible multi-layer films. The PA layer serves as a gas and aroma barrier and gives the composite increased mechanical strength. **Some application areas are:** vacuum packaging of food, such as meat, sausages and cheese, as well as the non-food segment and niche applications in the technical field.

Battery separator films (BSF)

Battery separator films are microporous films that have the task of preventing, in a safe way, the anode and cathode from coming into contact. At the same time, however, they must be permeable to charge carriers. In general, battery separator films are biaxially oriented polyolefin films with a thickness range between 8 and 25 µm. Widely used is the so-called wet process, where up to 85 % of a highly purified mineral oil is incorporated into ultrahigh-molecular PE (UHMWPE) in the extruder. After the film has been stretched, the oil is extracted with a solvent, creating the desired micropores. In the dry process, a PP film with specific additives is likewise biaxially stretched. The pores in this case arise directly from the stretching process due to the internal PP structure. Applications include lithium-ion batteries for portable electronic devices of all kinds, electric vehicles, power tools and electrical devices as well as stationary energy storage.

ADVANTAGES OF USING A TWIN SCREW EXTRUDER

- omission of the predrying step
- energy saving
- outstandingly homogeneous melt
- well-directed and homogeneous incorporation of product-specific additives

BOPP

About 80% of all polypropylene films are so-called BOPP films. By means of biaxial stretching, mechanical properties like tensile strength and puncture resistance are greatly optimized. To improve the barrier properties, BOPP films can be metalized or co-extruded with other polymers. PP films are not heat-sealable without further processing. In order to achieve this property, sealing layers made of suitable co-polymers are applied. Co-polymers made of ethylene and a high amount of propylene or of vinyl acetate, ethylene and propylene serve as sealing layers.

Some application areas are: food packaging, e.g. of bakery products or confectionery, snack or potato products, pasta or dried fruit, packaging of stationery, textiles, cosmetic and medical products, as well as technical applications such as adhesive tapes, capacitors and synthetic paper.



SPECIAL FEATURES

Additional extras for film production

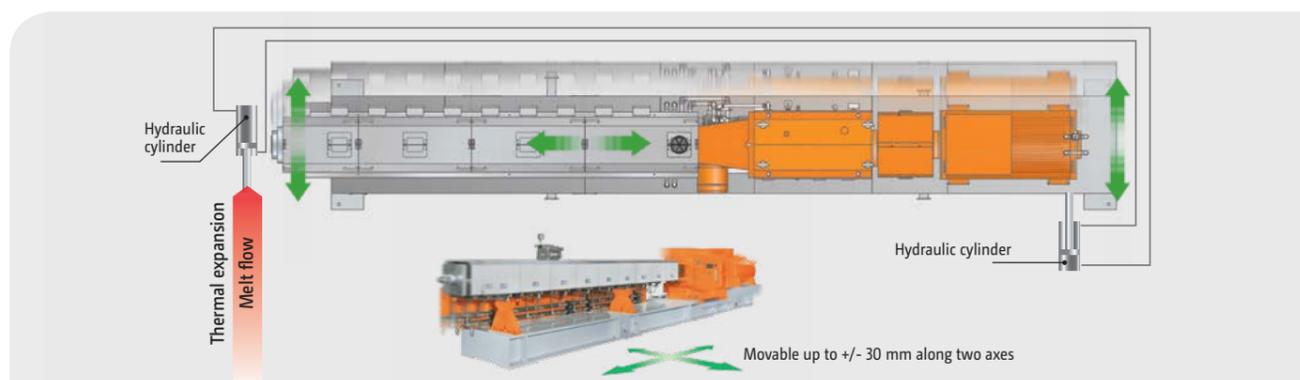
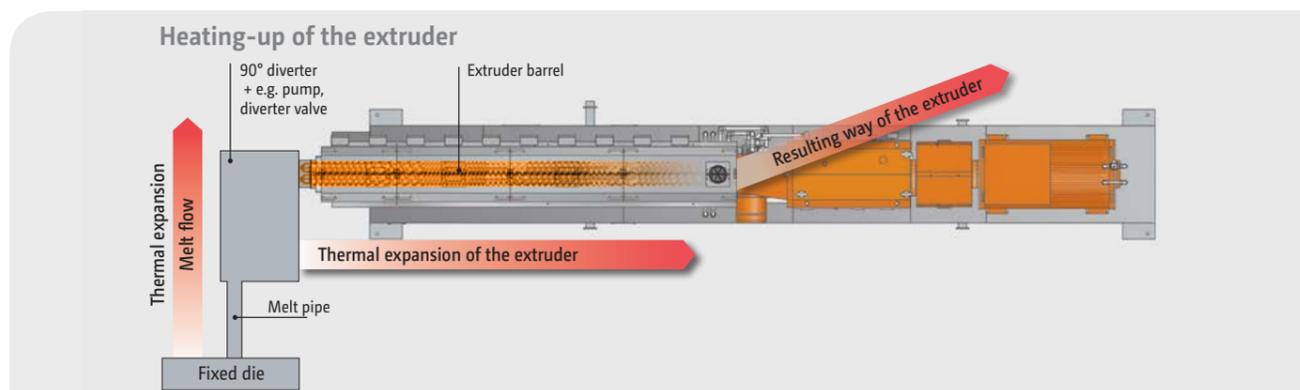
Longitudinal compensation system

Extruders and extruder components expand when heated. As a result, the extruder length changes, which leads to stresses in the downstream equipment. Leistritz has developed the perfect solution for you! The longitudinal compensation system absorbs the thermal expansion of the affected components up to the fixed point. The extruder is moved in the

direction parallel to the axis by means of a hydraulic cylinder. It can be moved up to +/- 30 mm along two axes.

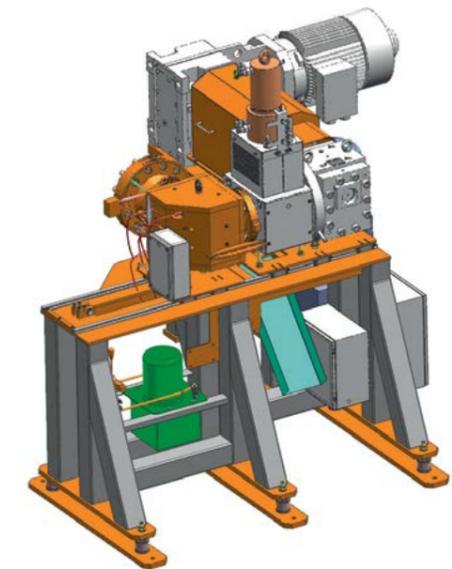
The special thing about this hydraulic solution:

- it does not need any additional energy
- due to its two closed pipelines, this system does not require any maintenance



90° Diverter on a frame

The 90° diverter can be installed subsequent to the material discharge adapter. This enables optimal adaptation to the spatial requirements and direct access to the chill roll. The screws can be removed easily.

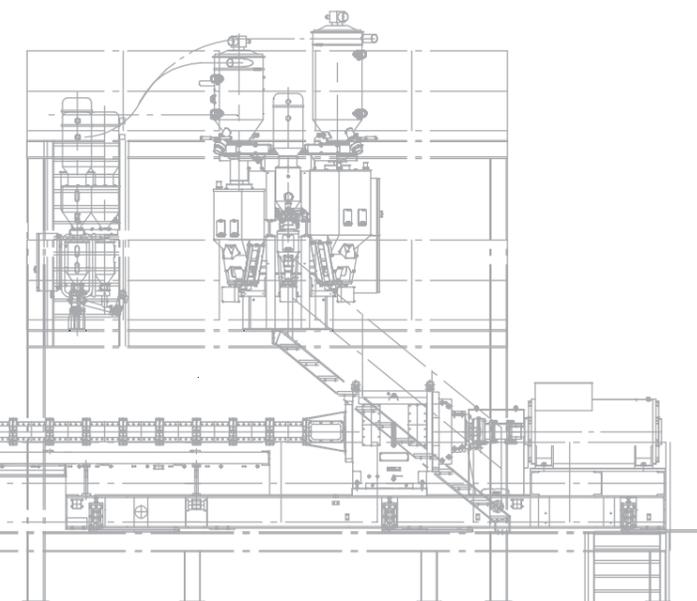
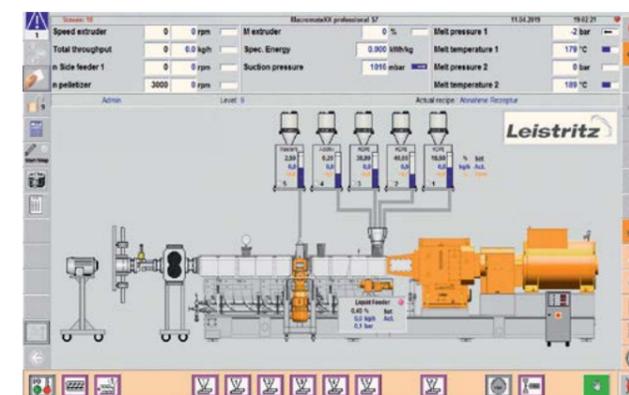


Control unit

Economic and optimum interaction of material feeding, extruder and downstream equipment distinguishes the Leistritz controls from others. With the data gathered and entered at the HMI (human machine interface) the whole extrusion process can be monitored, controlled, documented and analysed.

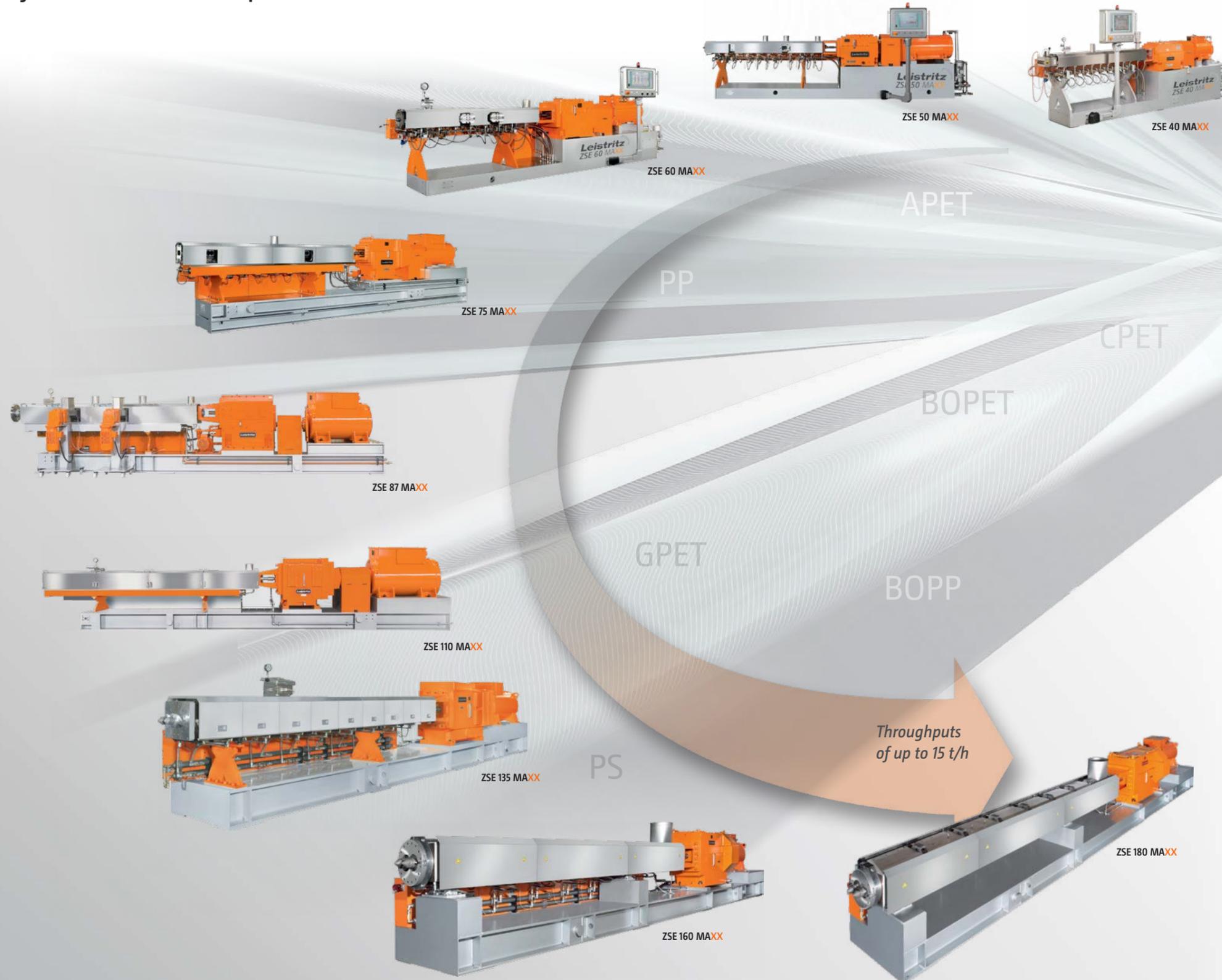
Depending on machine and customer requirements, the control system MacromateXX professional S7 (made of Siemens hardware) is individually programmed by Leistritz. The screens of the control panel are pre-configured according to the layout of the actual extrusion line. Only the relevant parts of the extrusion line are displayed. The exact

control of all involved components is essential, especially for direct extrusion of films, sheets and profiles. Parameters dependent on the automatic start-up procedure and production mode, like feeding throughput, extruder speed and melt pump speed, are controlled and determined here. The aim is to achieve a constant pressure and throughput at the discharge die. Leistritz attaches great importance to easy plant handling and has a comprehensive visualization concept for each plant component.



ZSE MAXX SERIES FOR FILM APPLICATION

The system for maXXimum possibilities



ZSE MAXX	Screw-diameter (in mm)	Torque (in Nm)
40	41.4	1,128
50	51.0	2,144
60	61.6	3,750
75	77.0	7,324
87	89.4	11,432
110	113.1	22,982
135	138.7	42,148
160	159.9	64,400
180	178.8	91,460

» The ZSE MAXX series is the largest twin screw extruder range with continuous OD/ID and high torque, which enormously facilitates upscaling from small machines to large production plants.

EXTRUSION TECHNOLOGY

Available for you all over the world



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