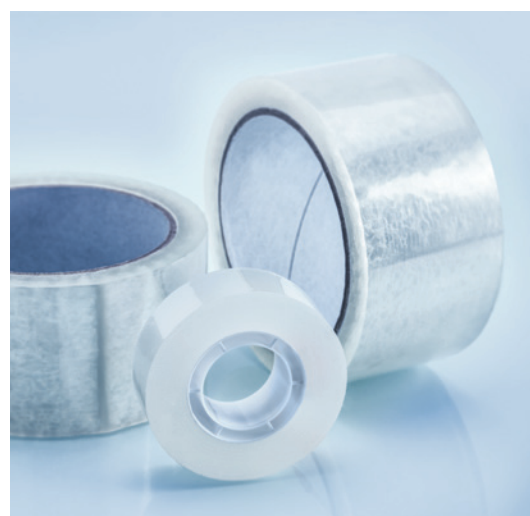
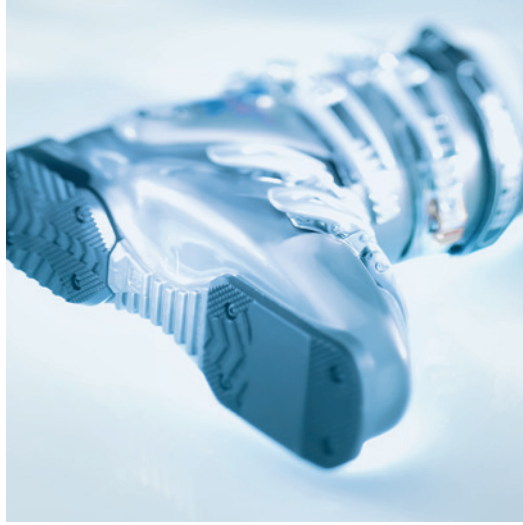
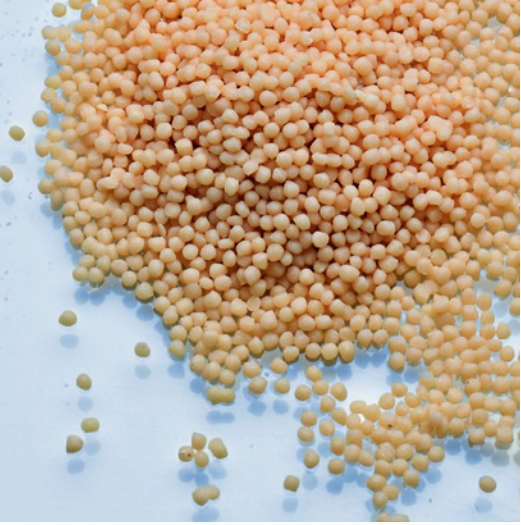


First class compounding and extrusion technology for continuous, highly efficient production processes.

»» State of the art technology for the highest quality products. We put our comprehensive know-how, stringent quality standards and many years of experience to good use when designing systems for your products, so that we can deliver exactly what you expect: compounding and extrusion processes that are individually tailored to your applications. After all, it's only with the aid of first-class processing technology that you achieve the highest throughput rates while still maintaining maximum efficiency and the highest product quality.

Coperion has been a partner to the processing industry for many years and possesses significant know-how in compounding and extrusion technology. Manufacturers of adhesives, automobiles, paint, construction materials and general chemical products place their trust in the outstanding compounding and extrusion technology supplied by Coperion, formerly Werner & Pfleiderer, and Coperion K-Tron. We design plants and systems

for a variety of applications. Our main source of motivation comes from developing solutions which are precisely tailored to your requirements. We are able to deliver high quality compounding and extrusion systems and we stand by your side throughout, from project planning and implementation through to commissioning of the systems and comprehensive after-sales service packages.



»» From batch process to continuous production. Nowadays continuous extrusion using twin screw extruders is considered a pioneering production process for a very large number of products.

You want to switch your production from batch to continuous process using twin screw extruders? We are the right partner for you. Coperion has many years of experience in this area and already successfully converted numerous processes. In

our comprehensively equipped test labs in Germany, the USA and China it is possible to test your applications in advance, and provide you with full support from our process engineers.

A continuous production process using twin screw extruders has numerous advantages over batch processing:

Excellent mixing behavior and consistently high product quality	Able to process a broad range of viscosities
Short residence times in the extruder and low thermal stress on the material	Reproducible process and product quality
Excellent feeding behavior, even when processing raw materials with low bulk density	Low labor costs due to highly automated systems
Reliable devolatilization, even of materials that are difficult to degas	Modular system design allows the configuration of the machine to special process requirements
Self-wiping screw profile and less set up time needed for cleaning and changing recipes	Reduction of raw material costs possible
	Production cost reduction due to reduced cleaning effort with less hazardous waste for disposal
	Reliable scale-up from laboratory to production scale

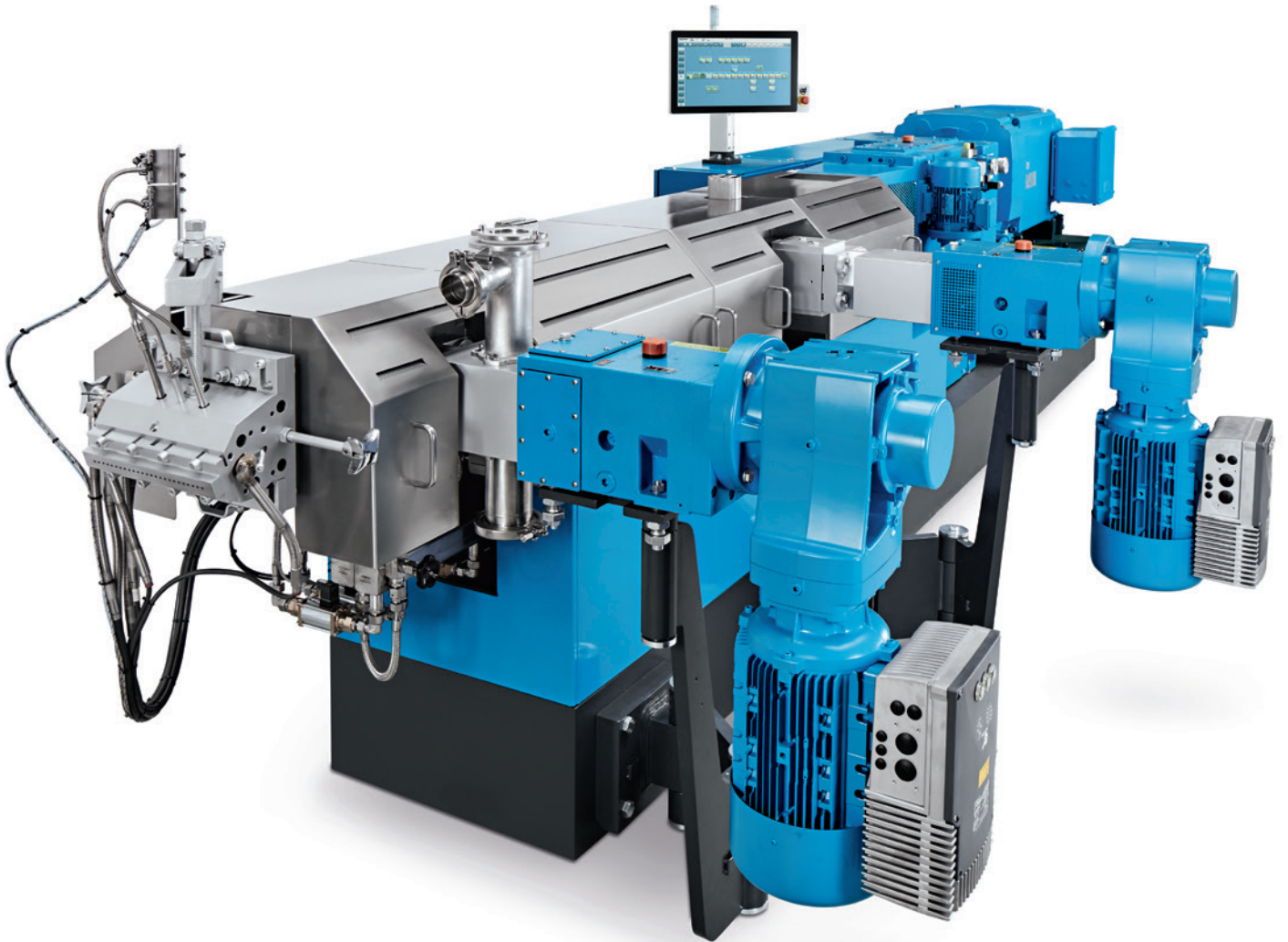


SUCCESS STORIES

SUCCESSFUL CONVERSION OF EXISTING BATCH PROCESSES TO CONTINUOUS EXTRUSION

» PROCESSING OF SEALANTS

The ZSK extruder is ideal for the continuous production of sealants. One example is the continuous processing system we developed together with one of our customers. This system has since been implemented several times all over the world. Coperion supplies all the necessary engineering specifications, from handling the raw materials to packaging the finished product. The development process was based on our extensive process engineering know-how, and a number of test series carried out at our test lab in Stuttgart, Germany.



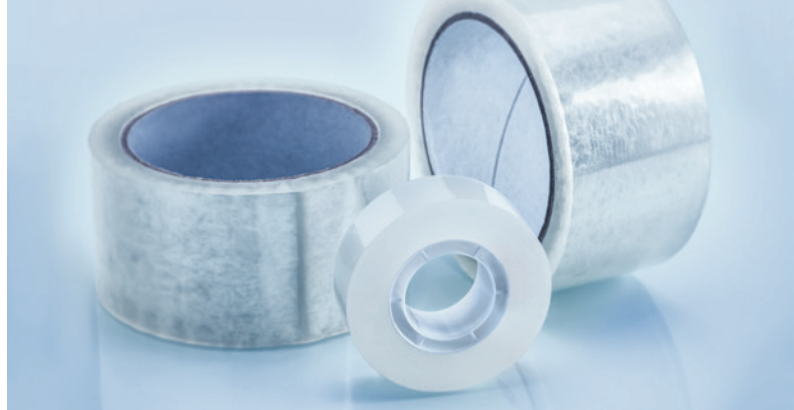
› ZSK TWIN SCREW EXTRUDER WITH ZS-EG SIDE DEVOLATILIZATION UNIT AND ZS-B SIDE FEEDER

› REACTIVE EXTRUSION OF THERMOPLASTIC POLYURETHANE (TPU)

Originally, TPU was exclusively produced in batch process. Yet as early as the 1950s, the first pioneers began producing thermoplastic polyurethane continuously by means of reactive extrusion. Currently more than 400,000 tons of TPU are produced annually around the world - most of these continuously, using twin screw extruders. Coperion has already installed over 100 ZSK extruders for this application.

› CONTINUOUS PRODUCTION OF ALKALI-BASED DETERGENT

In a successful collaboration, we helped a manufacturer of alkali-based detergent to convert their existing batch process to continuous production using a ZSK twin screw extruder. We provided comprehensive process engineering support. Using the continuous process, our customer now produces 300 kg alkali-based detergent per hour with consistently high product quality. At the same time, their raw material handling complies with the highest safety requirements.

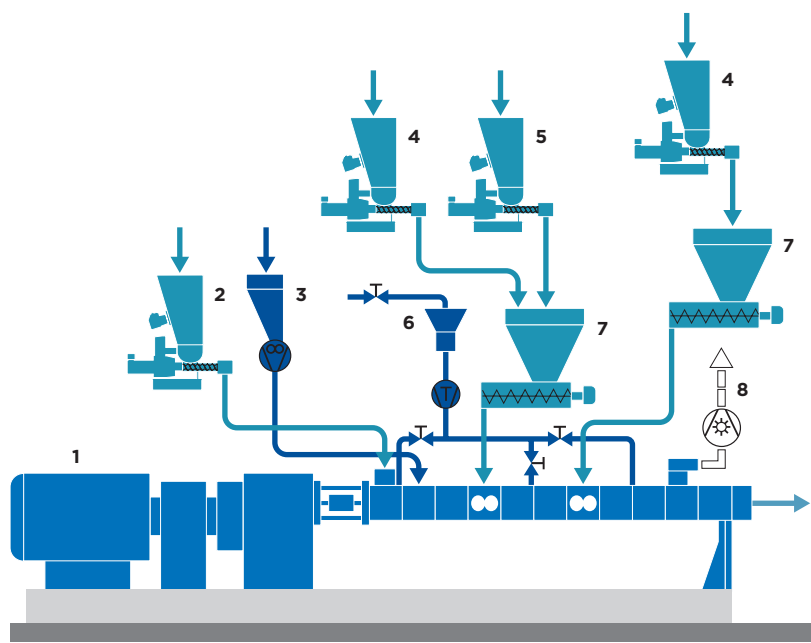


➤ Hot melt and pressure sensitive adhesives.

Using Coperion's ZSK twin screw extruders to produce hot melt adhesives and pressure sensitive adhesives allows the use of a wide range of different recipe components and ensures consistently high product quality without batch-to-batch variations. Hot melt adhesives are applied while hot and molten. A functional binding is formed when the adhesive cools and solidifies. Pressure sensitive adhesives are highly viscous, permanently tacky substances that are applied by pressure to a substrate. The ZSK twin screw extruder in modular design and individually configured to the product group combines various process steps in one machine: plasticizing/masticating, melt-

ing, mixing, homogenization, venting and devolatilization. By using special equipment, even non free flowing raw materials (e.g. rubber bales) can be fed into the continuous process in a controlled manner. Large volumes of resins and/or softeners can be incorporated. Entrained air, moisture and volatile organic components are removed from the product flow by applying a vacuum. Pressure sensitive adhesives can be directly discharged to application systems, processed further in-line, granulated and powdered or even filled into containers. Hot melt adhesives are usually underwater pelletized and filled into bags.

➤ TYPICAL SET-UP FOR PRODUCING HOT MELT ADHESIVES AND PRESSURE SENSITIVE ADHESIVES



- 1 ZSK Mv PLUS twin screw extruder
- 2 Gravimetric feeder for SIS/SBS/SEBS
- 3 Volumetric feeder for S-SBR/PIB (can also be fed as baled material using a special gear pump)

- 4 Gravimetric feeder for resin
- 5 Gravimetric feeder for filler
- 6 Gravimetric liquid feeder for oil/liquid resins (in the split-feed process)
- 7 ZS-B twin screw side feeder
- 8 Vacuum devolatilization

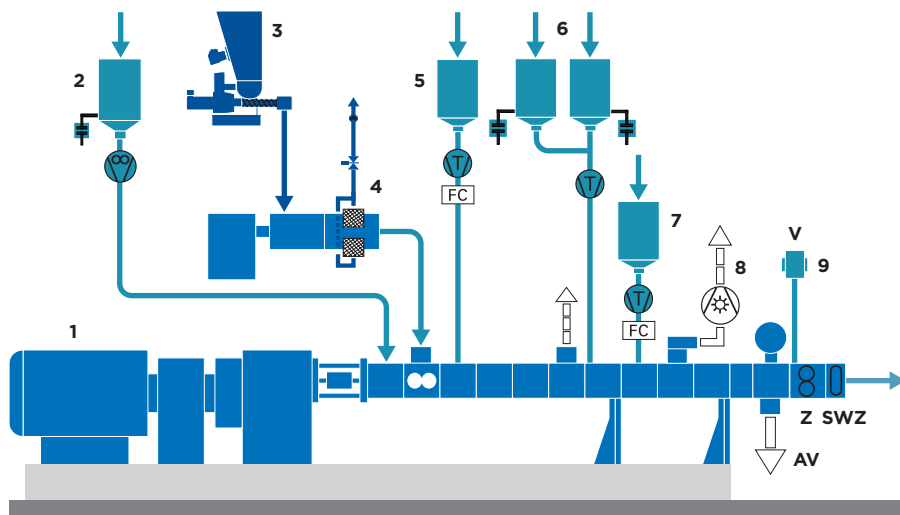


➤ Reactive sealants.

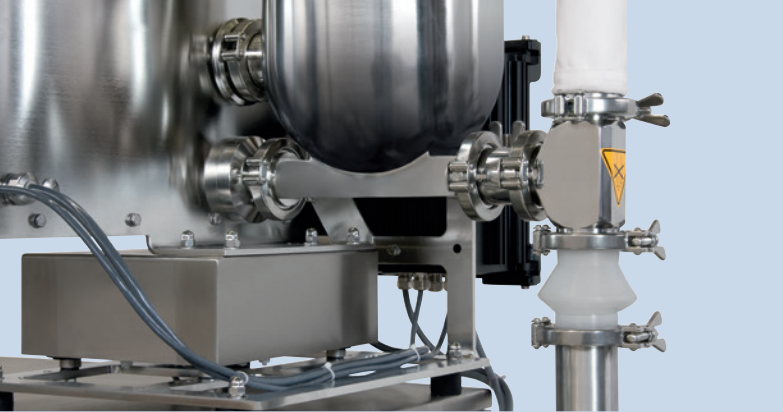
“Reactive sealants” are chemically hardening single component systems. The cross-linking of the substrate is initiated by exposure to humidity (RTV) and/or heat (HTV). Coperion has already developed many processing systems for the production of reactive sealants. The core of these systems is the ZSK twin screw extruder, which ensures a reproducible reaction with high process stability at consistently high product quality without batch-to-batch variations.

Low bulk density and fluidizing raw materials (e.g. silica), are introduced via ZS-B side feeders. These are equipped with the patented Feed Enhancement Technology FET developed in-house by Coperion. The FET applies a vacuum in the ZS-B feeding zone by means of a porous, gas-permeable wall. Considerably improved feeding and flow rates are achieved, even for silica amounts above 10% of the overall formulation. Using the ZSK extruder, processing can take place without moisture, preventing unwanted cross-linking of RTV sealants (e.g. PUR sealants) in the process section.

➤ TYPICAL SET-UP FOR PRODUCING REACTIVE SEALANT COMPOUNDS



- | | | |
|---|---|--|
| <p>1 ZSK Mv PLUS twin screw extruder</p> <p>2 Gravimetric liquid feeder for silicone polymer</p> <p>3 Gravimetric feeder for silica (bulk weights << 0.1 g/cm³)</p> | <p>4 ZS-B side feeder with Feed Enhancement Technology FET</p> <p>5 Gravimetric liquid feeder for cross-linking agent</p> <p>6 Gravimetric liquid feeder for silicon oil</p> | <p>7 Gravimetric liquid feeder for catalyst</p> <p>8 Vacuum devolatilization</p> <p>9 Discharge parts comprising the start up valve AV, online viscometer V, gear pump Z and screen pack changer SWZ</p> |
|---|---|--|



>01

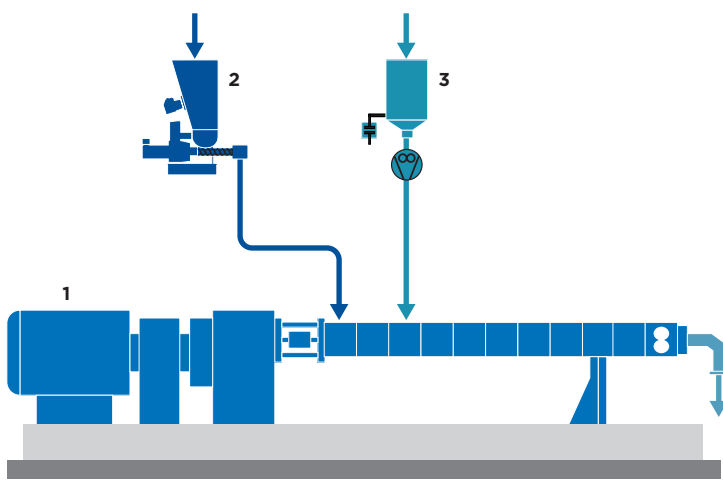
» Battery materials.

ZSK twin screw extruders from Coperion are ideal for producing a wide variety of battery components. The focus is on the continuous extrusion of electrode materials and separator films.

Ensuring consistently high product quality is one of the key advantages of the continuous production of electrode compounds. Active materials, binding agents, conductive carbon and liquids are used as raw materials. These are fed either via independent feeders or premixes. Precise adherence to the

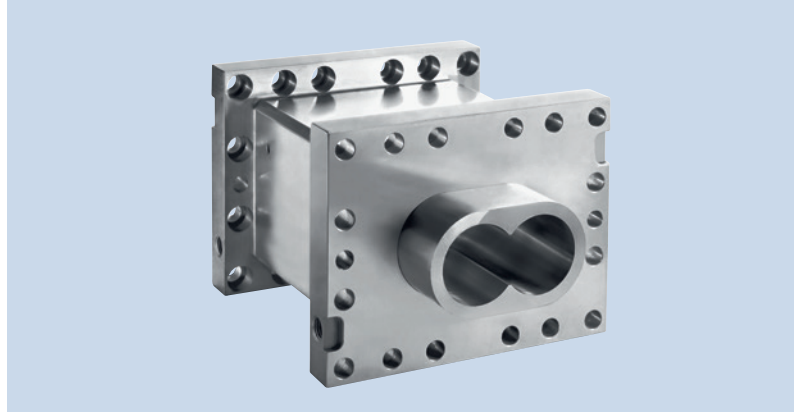
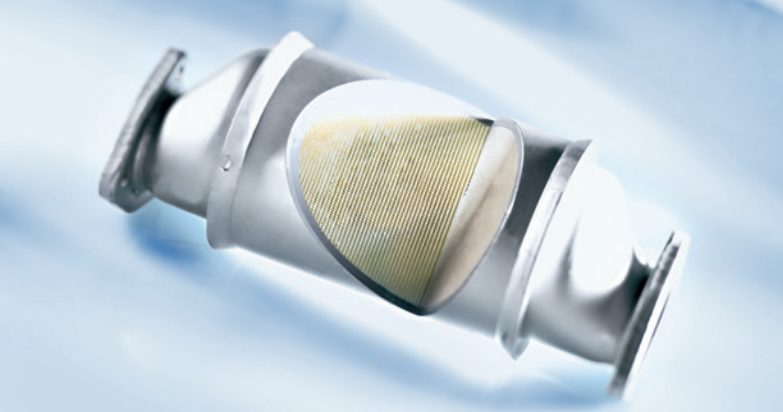
formula ensures the high quality of the end products. Certain raw materials are toxic and abrasive. For this reason, processing in the ZSK extruder takes place under controlled conditions, from feeding the raw materials through to discharging the compound. Feeding the raw materials with dust-tight equipment is just as important as avoiding metal contamination in the end product. Furthermore, ZSK systems intended for producing battery compounds are designed in compliance with stringent explosion protection regulations.

» TYPICAL SET-UP FOR PRODUCING BATTERY COMPOUNDS



- 1 ZSK twin screw extruder
- 2 Gravimetric feeder for premix (feeding devices designed to be dust-tight/ with explosion protection if required)
- 3 Gravimetric liquid feeder

>01 GRAVIMETRIC SOLIDS FEEDER
IN DUST-TIGHT DESIGN
(HEPA FILTER)



»» Catalyst and catalyst carrier compounds.

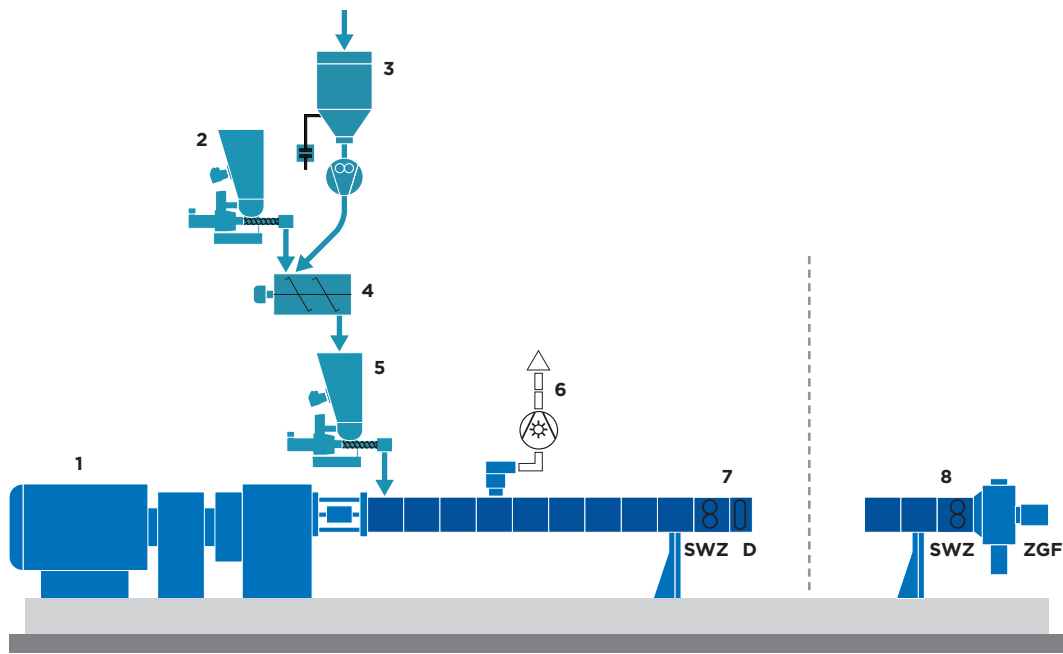
Catalyst and catalyst carrier compounds for exhaust treatment or chemical processes are also produced continuously using twin screw extruders. This comprises both bulk material catalysts as rods with different cross-sectional shapes, and directly extruded honeycomb structures.

Thanks to its extensive range of material solutions, the ZSK twin screw extruder is particularly suited to producing catalyst and catalyst carrier compounds. Our experts choose the

precise combination of materials to ensure that the components are reliable and durable, even for raw materials with seriously abrasive and corrosive properties such as silicium carbides and acids.

The ZSK twin screw extruder gently processes the products. In order to adhere to very low temperature limits, the machines are able to be operated with cooling media at well below 0 °C.

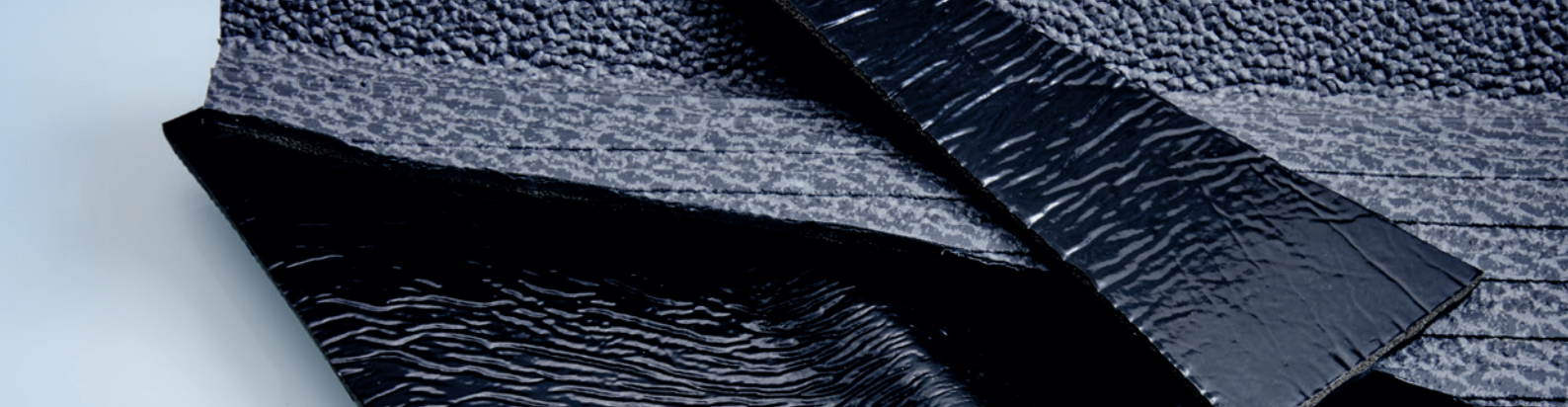
» TYPICAL SET-UP FOR PRODUCING CATALYST AND CATALYST CARRIER COMPOUNDS



- 1 **ZSK twin screw extruder (in special material for barrels and screw elements)**
- 2 Gravimetric feeder for powder
- 3 Gravimetric liquid feeder for binding agent
- 4 Continuous premixer

- 5 Gravimetric feeder for premix
- 6 Vacuum devolatilization
- 7 Discharge parts comprising screen pack changer SWZ and special nozzle for extruding honeycomb structures D

- 8 Alternative discharge for bulk material catalysts: screen pack changer SWZ and centric pelletizer ZGF



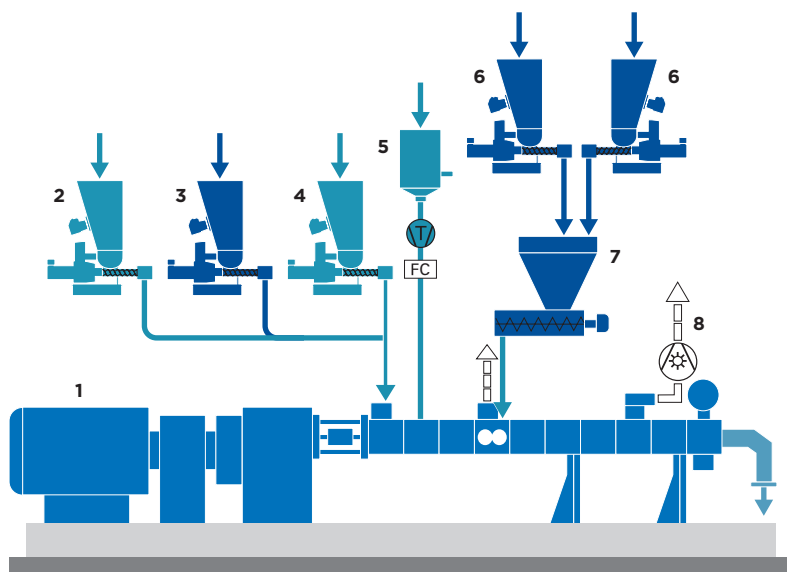
» Highly filled heavy layers.

When producing heavy layers, such as those used for sound insulation in the automotive industry, the homogeneous dispersion of high filler and regenerate content presents a major challenge.

Coperion implements the split-feed extrusion process for producing highly filled heavy layers, whereby the raw material is

fed into the ZSK twin screw extruder at two different positions. Filler percentages of up to 80% can be achieved in this way. The advantages of the split-feed process are in the gentle handling of the raw materials and the associated outstanding product quality. It is also possible to achieve a reduction in wear costs when using fillers with heavily abrasive properties.

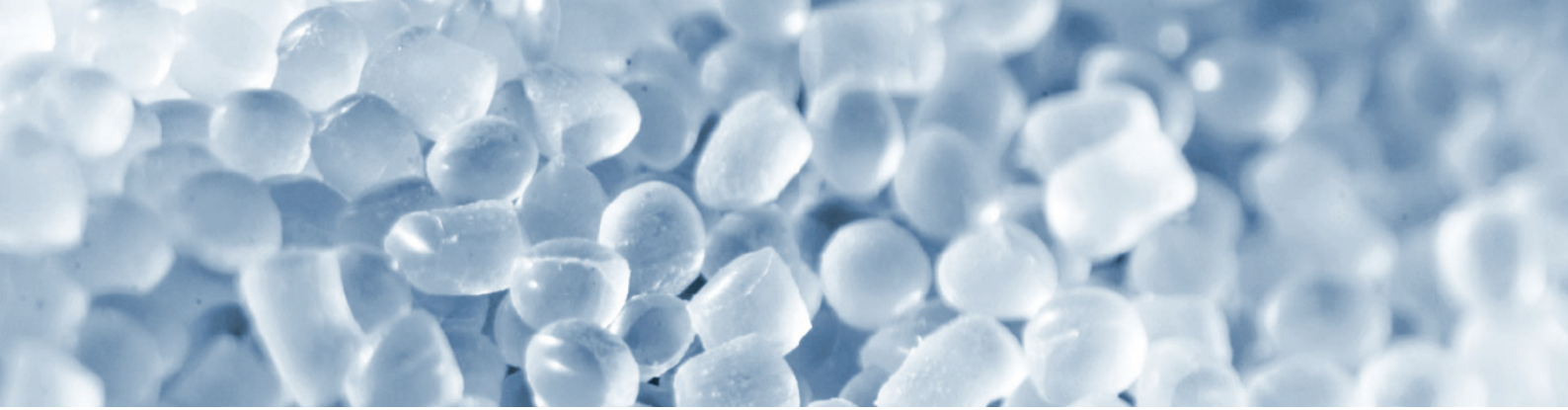
» TYPICAL SET-UP FOR PRODUCING HIGHLY FILLED HEAVY LAYERS



- 1 ZSK twin screw extruder
- 2 Gravimetric feeder for EPDM/EVA/PVA
- 3 **Gravimetric feeder for filler**

- 4 Gravimetric feeder for recycled material/regenerate
- 5 Gravimetric liquid feeder for softeners

- 6 **Gravimetric feeder for filler/additives**
- 7 **ZS-B twin screw side feeder**
- 8 Vacuum devolatilization



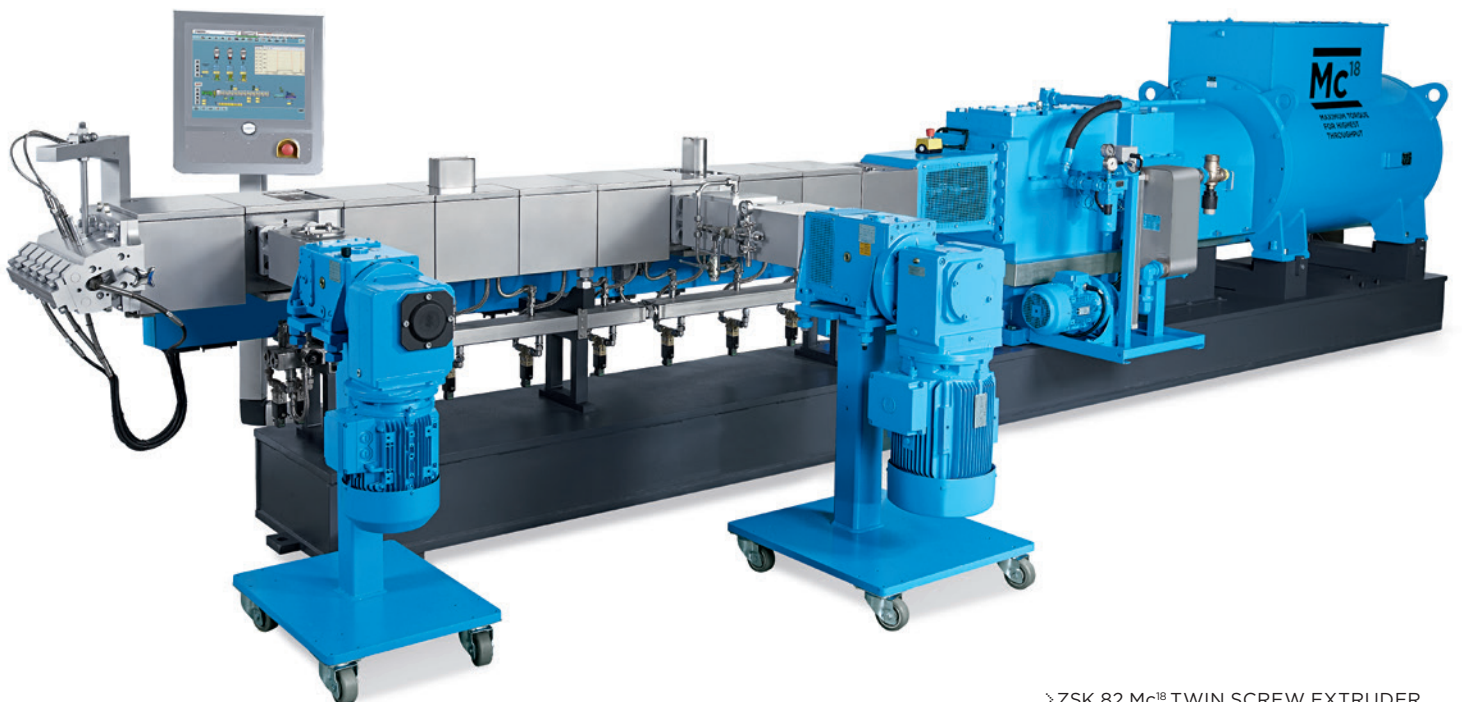
» Chemical reaction processes.

Coperion has already developed many ZSK twin screw extruders for a wide variety of chemical reaction processes. The continuous process ensures consistent, outstanding product quality. It can be reproduced at any time and only subjects the raw materials to low thermal stress. The range of viscosities is

very broad. Even highly viscous products, some of which may cause problems in the batch process, can be processed without difficulty using the ZSK extruder. A reliable scale-up from laboratory to production scale is possible at any time with the ZSK twin screw extruder.

SELECTION OF CHEMICAL REACTION PROCESSES WHICH HAVE ALREADY BEEN REALIZED ON ZSK TWIN SCREW EXTRUDERS:

- > PMMA
- > Polyamide 6
- > TPU



> ZSK 82 Mc¹⁸ TWIN SCREW EXTRUDER



»» Linear thermoplastic polyurethanes TPU.

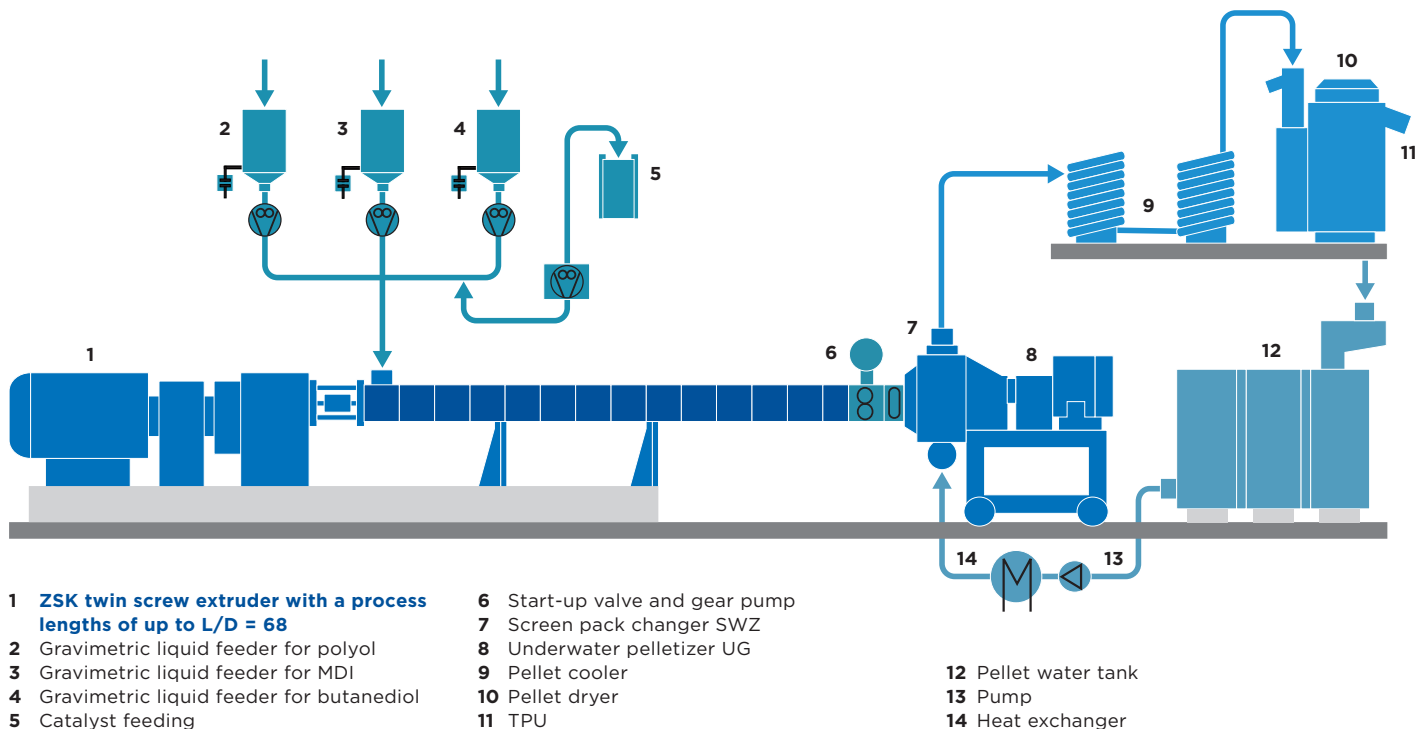
TPU is used in countless applications: technical components, housings for electrical devices, decorative trim parts for cars, sneaker soles, ski boots, housings for external car mirrors and many more.

Thanks to its modular design, the ZSK twin screw extruder is ideally suited to producing TPU. The chemical reaction process that turns the liquid raw materials into polyurethane takes

place during constant mixing and kneading. In order to achieve the longest possible residence time in the extruder, Coperion has already designed ZSK extruders with process lengths of up to $L/D = 68$.

Thanks to the self-wiping profile of the ZSK twin screw extruder and the narrow residence time distribution, high product quality can also be guaranteed with long machine runtimes.

» TYPICAL SET-UP FOR PRODUCING LINEAR THERMOPLASTIC POLYURETHANE, TPU





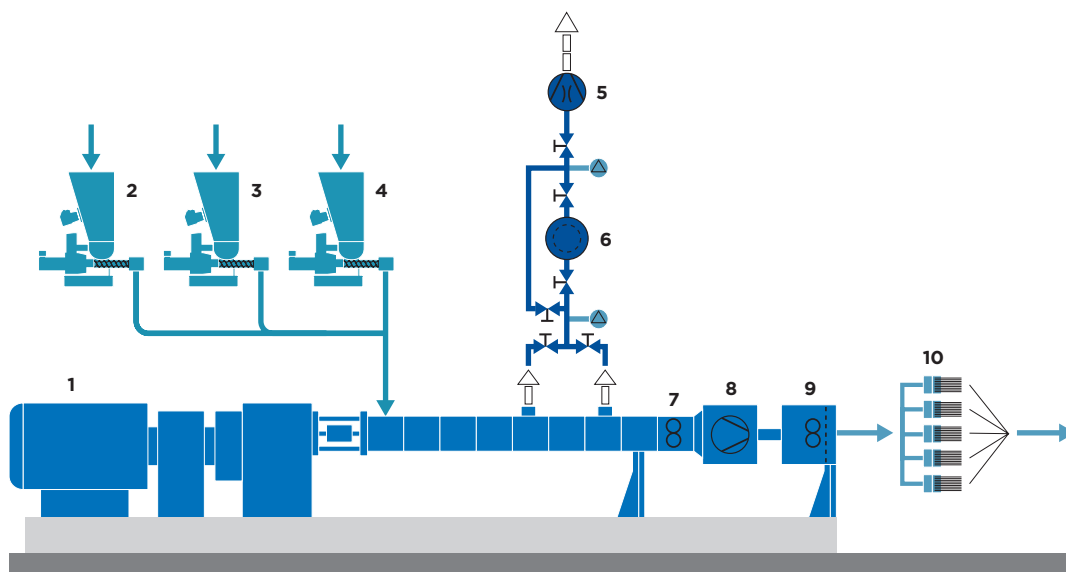
» Devolatilization of recycled material – Bottle to Fibre.

Thanks to its excellent devolatilization properties, the ZSK twin screw extruder is ideally designed for the "bottle to fibre" process in which used PET bottles are recycled and turned directly into fibres.

Processing shredded PET bottles with a single screw extruder requires a complex laborious drying process. By contrast, the

ZSK twin screw extruder can process the PET while being essentially non-dried, and devolatilize the melt with a low energy expenditure in a vacuum of 1-5 mbar (absolute). Volatile contaminations and oligomers are extracted from the melt and separated from the exhaust gas flow in suitable separators upstream of the vacuum pump.

» TYPICAL SET-UP FOR DEVOLATILIZING RECYCLED MATERIAL - BOTTLE TO FIBRE



- | | | |
|--|---|---|
| 1 ZSK Mc ¹⁸ twin screw extruder | 4 Gravimetric feeder for masterbatch | 7 Screen pack changer SWZ |
| 2 Gravimetric feeder for recycled PET bottles (flakes) | 5 Vacuum devolatilization at 1-5 mbar (absolute) | 8 Melt pump |
| 3 Gravimetric feeder for new PET product | 6 Separator | 9 Backwash screen pack changer |
| | | 10 Spinning pumps with filters and spinnerets |



HYGIENIC DESIGN

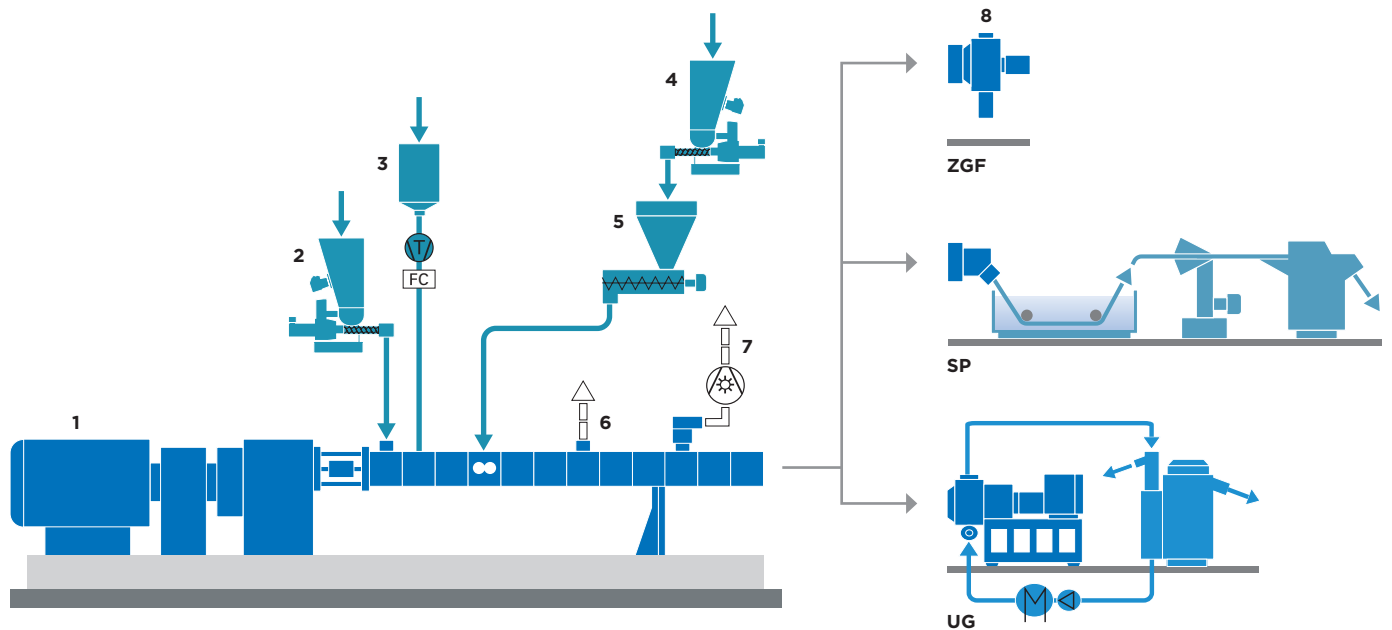
- › All parts in contact with products are made from stainless steel
- › 3.1 certification for parts that come into contact with products
- › Seals compliant with food industry standards (e.g. PTFE)
- › Designed with accessibility for ease of cleaning
- › Oils compliant with food industry standards/FDA-compliant/H1-certified lubricants
- › FDA 21 CFR

›› Processing biodegradable polymers.

Along with conventional engineering plastics such as PE, PP and PA, Coperion also specializes in developing compounding systems for biodegradable products. The production processes for biodegradable products were derived from processing technology for thermoplastic starch. Due to the variety of potential base polymers and the diversity of recipe mixtures, every process step in the ZSK processing system is individually tailored to the desired mechanical properties of the biomate-

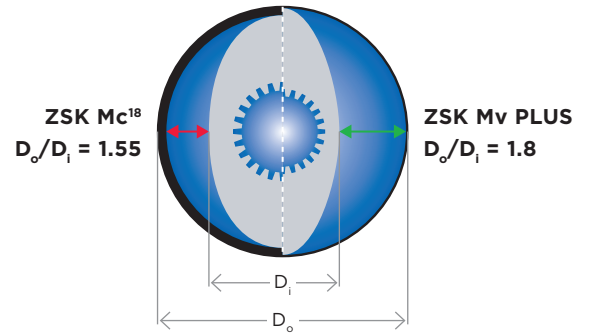
rial. Our many years of experience with cooking extrusion go hand in hand with our comprehensive expertise in designing our systems to meet the stringent requirements of the food industry (hygienic design). We are able to realize any specification right up to the pharmaceutically compliant, "full GMP design" ZSK extruder, and we assist you in weighing the cost-benefit ratio of such systems.

› TYPICAL SET-UP FOR PROCESSING BIODEGRADABLE POLYMERS



- | | | |
|--|--|--|
| <p>1 ZSK twin screw extruder</p> <p>2 Gravimetric feeder for starch/powder premix</p> <p>3 Gravimetric liquid feeder for softeners/liquid additives</p> | <p>4 Gravimetric feeder for polymer pellets (biodegradable, hydrophobic), polylactide (PLA), PVOH, synthetic copolyesters (PBAT), PBS, PHA, PCL, CA</p> <p>5 ZS-B twin screw side feeder</p> | <p>6 Atmospheric devolatilization</p> <p>7 Vacuum devolatilization</p> <p>8 Discharge parts, alternately ZGF centric pelletizer, SP strand pelletizer or UG underwater pelletizer</p> |
|--|--|--|

»» Technical data.



Technical data for the ZSK Mc¹⁸

ZSK	Max. torque per shaft [Nm]	Spec. torque Md/a ³ [Nm/cm ³]	Max. screw speed [rpm]	Max. motor output N [kW]	Screw diameter [mm]
18 MEGAlab*	38	11.3	1,200	10	18
26 Mc ¹⁸	140	15	1,200	37	25
32 Mc ¹⁸	315	18	1,200	83	32
45 Mc ¹⁸	930	18	1,200	245	45
58 Mc ¹⁸	2,000	18	1,200	528	58
70 Mc ¹⁸	3,500	18	1,200	924	70
82 Mc ¹⁸	5,700	18	1,200	1,504	83
92 Mc ¹⁸	7,500	17	1,000	1,649	92
119 Mc ¹⁸	15,300	17	1,000	3,364	118
133 Mc PLUS	20,000	15	1,000	4,398	133

Technical data for the ZSK Mv PLUS

ZSK	Max. torque per shaft [Nm]	Spec. torque Md/a ³ [Nm/cm ³]	Max. screw speed [rpm]	Max. motor output N [kW]	Screw diameter [mm]
18 MEGAlab*	38	11.3	1,200	10	18
27 Mv PLUS	100	10.6	1,800	40	27
34 Mv PLUS	205	11.3	1,800	81	34
43 Mv PLUS	420	11.3	1,800	166	43
54 Mv PLUS	815	11.3	1,800	323	54
62 Mv PLUS	1,250	11.3	1,800	495	62
76 Mv PLUS	2,275	11.3	1,800	900	76
98 Mv PLUS	5,000	11.3	1,500	1,649	98
125 Mv PLUS	10,300	11.3	1,500	3,397	125
248 Mv PLUS	44,000	6.0	300**	2,800	248

* Laboratory extruder with $D_o/D_i = 1.55$.

** Higher speeds upon request.

ZSK 32 to ZSK 76 available in a compact version.

Coperion GmbH

Theodorstrasse 10
70469 Stuttgart, Germany
Tel.: +49 711 897-0
Fax: +49 711 897-3999

Coperion GmbH

Niederbieger Strasse 9
88250 Weingarten, Germany
Tel.: +49 751 408-0
Fax: +49 751 408-200

info@coperion.com
www.coperion.com

> Europe

Belgium, Luxembourg, Netherlands
Coperion N.V.
Industrieweg 2, 2845 Niel, Belgium
Tel.: +32 3 870-5100
Fax: +32 3 877-0710

France

Coperion S.a.r.l.
56 boulevard de Courcerin
77183 Croissy-Beaubourg, France
Tel.: +33 164 801 600
Fax: +33 164 801 599

Germany

Coperion GmbH
Germany West Office
Industriestrasse 71a
50389 Wesseling, Germany
Tel.: +49 2232 20700-10
Fax: +49 2232 20700-11

Coperion Pelletizing Technology GmbH

Heinrich-Krumm-Strasse 6
63073 Offenbach, Germany
Tel.: +49 69 989 5238-0
Fax: +49 69 989 5238-25

Coperion K-Tron Deutschland GmbH

Heinrich-Krumm-Strasse 6
63073 Offenbach, Germany
Tel.: +49 69 8300 899-0
Fax: +49 69 8300 9498

Italy

Coperion S.r.l.
Via E. da Rotterdam, 25
44122 Ferrara, Italy
Tel.: +39 0532 7799-11
Fax: +39 0532 7799-80

Coperion S.r.l.
Milan Office

Via XXV Aprile, 49
20091 Bresso (MI), Italy
Tel.: +39 02 241 049-01
Fax: +39 02 241 049-22

Russian Federation, CIS

OOO Coperion
Proezd Serebryakova 14,
Bld. 15, Office 219
129343 Moscow, Russian Federation
Tel.: +7 499 258 4206
Fax: +7 499 258 4206

Spain, Portugal

Coperion, S.L.
Balmes, 73, pral.
08007 Barcelona, Spain
Tel.: +34 93 45173-37
Fax: +34 93 45175-32

Switzerland

Coperion K-Tron (Schweiz) GmbH
Lenzhardweg 43/45
5702 Niederlenz, Switzerland
Tel.: +41 62 8857-171
Fax: +41 62 8857-180

United Kingdom

Coperion Ltd.
Coperion K-Tron Great Britain Ltd.
Unit 4, Acorn Business Park
Heaton Lane
Stockport, SK4 1AS, United Kingdom
Tel.: +44 161 209 4810
Fax: +44 161 474 0292

> Asia

China

Coperion (Nanjing) Machinery Co. Ltd.
No. 1296 Jiyin Avenue
Jiangning District
Nanjing 211106, PR China
Tel.: +86 25 5278 6288
Fax: +86 25 5261 1188

Coperion International Trading (Shanghai) Co. Ltd.

Coperion Machinery & Systems (Shanghai) Co. Ltd.
Bldg. A2, 6000 Shenzhuan Road
Dongjing Town, Songjiang District
Shanghai 201619, PR China
Tel.: +86 21 6767 9505
Fax: +86 21 6767 9108

Coperion K-Tron (Shanghai) Co. Ltd.

Building A2-A3
No. 6000 Shen Zhuan Gong Road
Songjiang District
201619 Shanghai, PR China
Tel.: +86 21 6375 7925
Fax: +86 21 6375 7930

India

Coperion Ideal Pvt. Ltd.
Ideal House, A-35, Sector 64
201307 Noida (U.P.), India
Tel.: +91 120 4299 333
Fax: +91 120 4308 583

Japan

Coperion K.K.
4F, Leaf Square Shin-Yokohama Bldg.
3-7-3, Shin-Yokohama,
Kohoku-ku Yokohama,
Kanagawa 222-0033, Japan
Tel.: +81 45 595 9801
Fax: +81 45 595 9802

Saudi Arabia

Coperion Middle East Co. Ltd.
Street # 327, Sector G, Block 2, Lot # 31
Jubail 2 Industrial City,
Kingdom of Saudi Arabia
Tel.: +966 13 510 4420
Fax: +966 13 510 4421

Singapore

Coperion Pte. Ltd.
Coperion K-Tron Asia Pte. Ltd.
8 Jurong Town Hall Road
#28-01/02/03 The JTC Summit
Singapore 609434
Tel.: +65 641 88-200
Fax: +65 641 88-203

Taiwan

Coperion (Nanjing) Machinery Co. Ltd.
Taiwan Branch Office
5F, No. 43, Alley 115
Chung San North Road Sec. 2
Taipei, Taiwan
Tel.: +886 2 2521 3580
Fax: +886 2 2521 1604

> America

South America

Coperion Ltda.
R. Arinos, 1000
RBCA - Royal Business Center
Anhanguera, Módulo 4
Parque Industrial Anhanguera
06276-032 Osasco - SP, Brazil
Tel.: +55 11 3874-2740
Fax: +55 11 3874-2757

USA, Canada, Mexico, NAFTA
Coperion Corporation
590 Woodbury Glassboro Road
Sewell, NJ 08080, USA
Tel.: +1 201 327-6300
Fax: +1 201 825-6494

Coperion Corporation Wytheville Office

196 Appalachian Drive
Wytheville, VA 24382, USA
Tel.: +1 276 228-7717
Fax: +1 276-227-7044

Coperion Corporation Houston Office

7900 North Sam Houston Pkwy, West
Suite 202
Houston, TX 77064, USA
Tel.: +1 281 449-9944
Fax: +1 281 449-4599

Coperion K-Tron Pitman, Inc.

590 Woodbury Glassboro Road
Sewell, NJ 08080, USA
Tel.: +1 856 589-0500
Fax: +1 856 589-8113

Coperion K-Tron Salina, Inc.

606 North Front Street
Salina, KS 67401, USA
Tel.: +1 785 825-1611
Fax: +1 785 825-8759

For more information about
the worldwide Coperion network,
visit www.coperion.com