Complete lines for pipe extrusion & special pipe applications

Application: Pipes

Sustainable Solutions Worldwide.

battenfeld-cincinnati
a Davis-Standard Company

Process engineering for efficient plastics extrusion of tomorrow – From the raw material to the finished product

Based on our modular line concept, we are able to implement cost-optimized and customer-specific solutions. This goes beyond the product specification to the processing of the materials, the infrastructure specified in the general conditions up to the appearance of the plant and the control interface. Our company takes all of these conditions into account when designing your extrusion line. We combine our own products with components from long term partners in order to supply our customers the ideal solution from a single source.

battenfeld-cincinnati extrusion lines – One-stop solutions

1
- Customer expectation
- Plant specification
- Specifications
- Resource check

2
- Technical clarification
- Specification sheet
- Production of machines
- Selection of suppliers
- Supplier coordination

3
- Manufacturing
- In-house testing
- Pre-commissioning
- FAT on request

4
- Line commissioning
- Line handover
- Process consulting
- Staff training
- After Sales Service

Conservation of resources while maintaining profitability – Sustainability all along the line

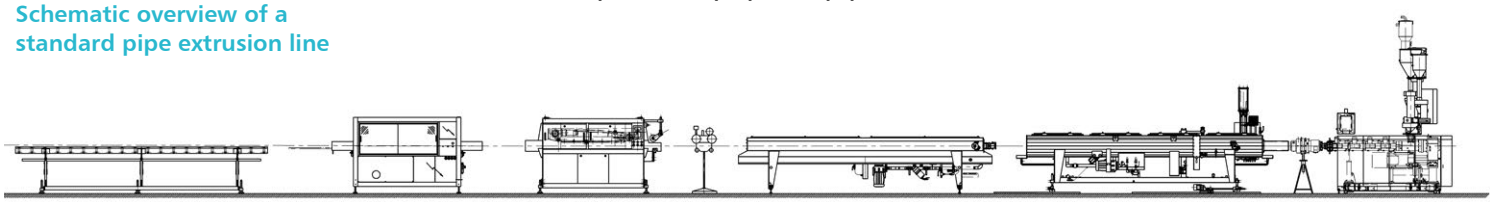
Our solutions offer a resource-saving and economical production of your products and our worldwide service network ensures the constant process availability. We focus on highest product quality with high output rates, functionality, machine availability as well as energy saving.

Complete lines for pipe extrusion – For stringent international quality standards

Depending on the application, plastic pipes consist of a variety of different plastics. The main raw materials used are PO and PVC offering a multitude of advantages such as easy laying, installation and maintenance, light weight, resistance to chemicals, incrustation and corrosion, long lifetime and recyclability.

battenfeld-cincinnati offers complete lines for a wide range of plastic pipes & tailored solutions for special pipe applications.

Schematic overview of a standard pipe extrusion line



rollStream / tiltStream:
Roller tables or tilt tables for pipe diameters up to 3,500 mm

pullStream:
Haul-offs for pipe diameters from 5-3,500 mm

cutStream:
Cutting tools for pipe diameters from 5-3,500 mm

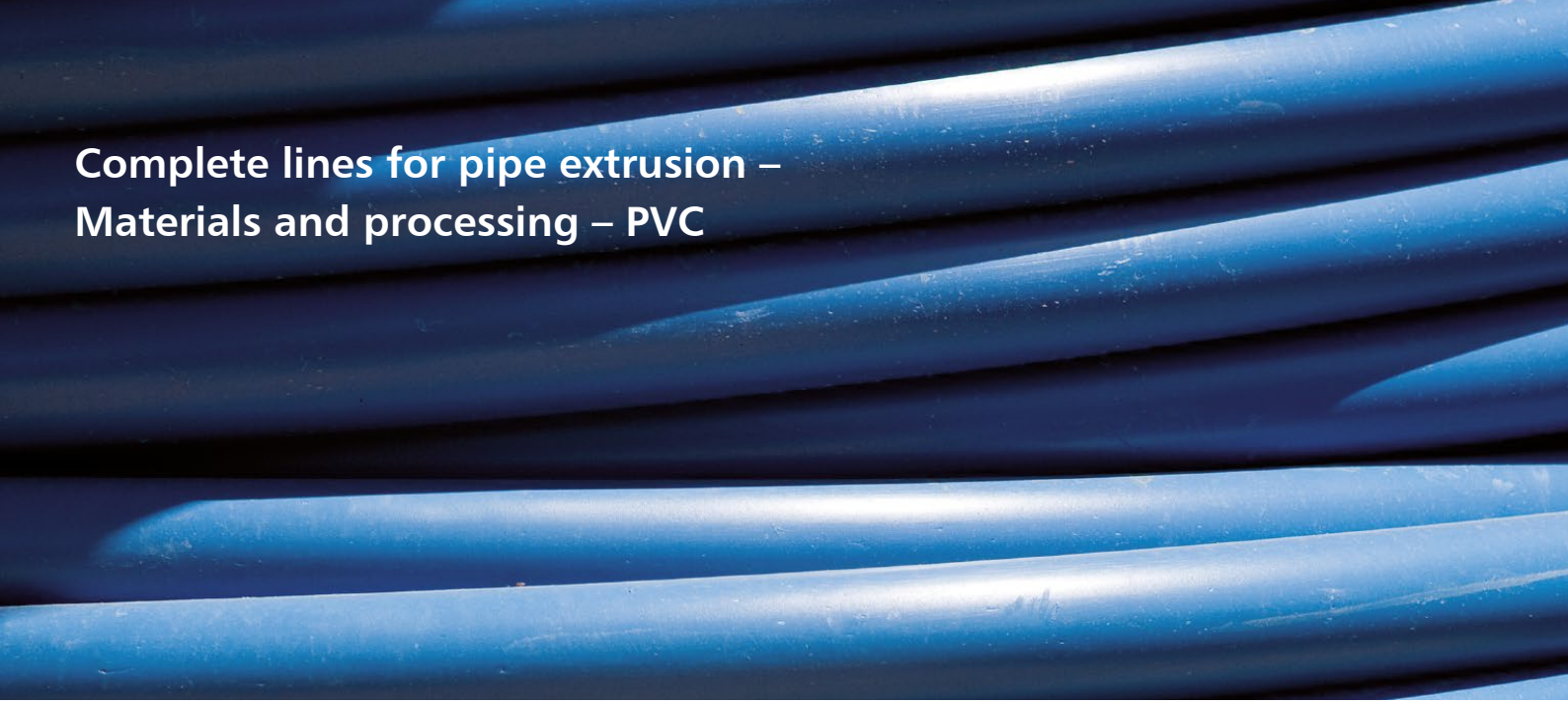
coolStream:
Cooling tanks for pipe diameters from 5-3,500 mm

vacStream:
Vaccum tanks for pipe diameters from 5-3,500 mm

Extruders and pipe heads:
1. Single screw extruder for PO
2. Twin screw extruder for PVC
3. Helix heads for PO
4. Spider heads for PVC

Content

Materials and Processing 4
Pipe Applications 6
Examples for special extrusion lines – PVC processing 13
3-layer pipe extrusion line 13
O-PVC pipe extrusion line 14
PVC large diameter pipe extrusion line 15
Quadruple strand extrusion line 16
Examples for special extrusion lines – PO and PP processing . . 17
PE-RT 3-layer and 5-layer pipe extrusion lines 17
Micro duct and Multi duct extrusion lines 18
PE-RT 4-layer pipe extrusion line 19
Pipe-in-pipe extrusion line 20
Aluminium composite pipe lines 21
battenfeld-cincinnati Services 22



Complete lines for pipe extrusion – Materials and processing – PVC

PVC processing

PVC is an extremely versatile material that is generally available as a dry (powder) blend. Prior to processing in the extruder, additives are blended into the virgin PVC in a heating/cooling mixing unit. PVC compounds are sensitive to shearing and high temperatures and are therefore gently processed on either parallel or conical twin screw extruders, depending on throughput requirements and pipe dimensions.

battenfeld-cincinnati twin screw extruders

- Longer, 34D processing unit
- Excellent product quality
- Enormous processing window
- Optimized for extremely high output levels

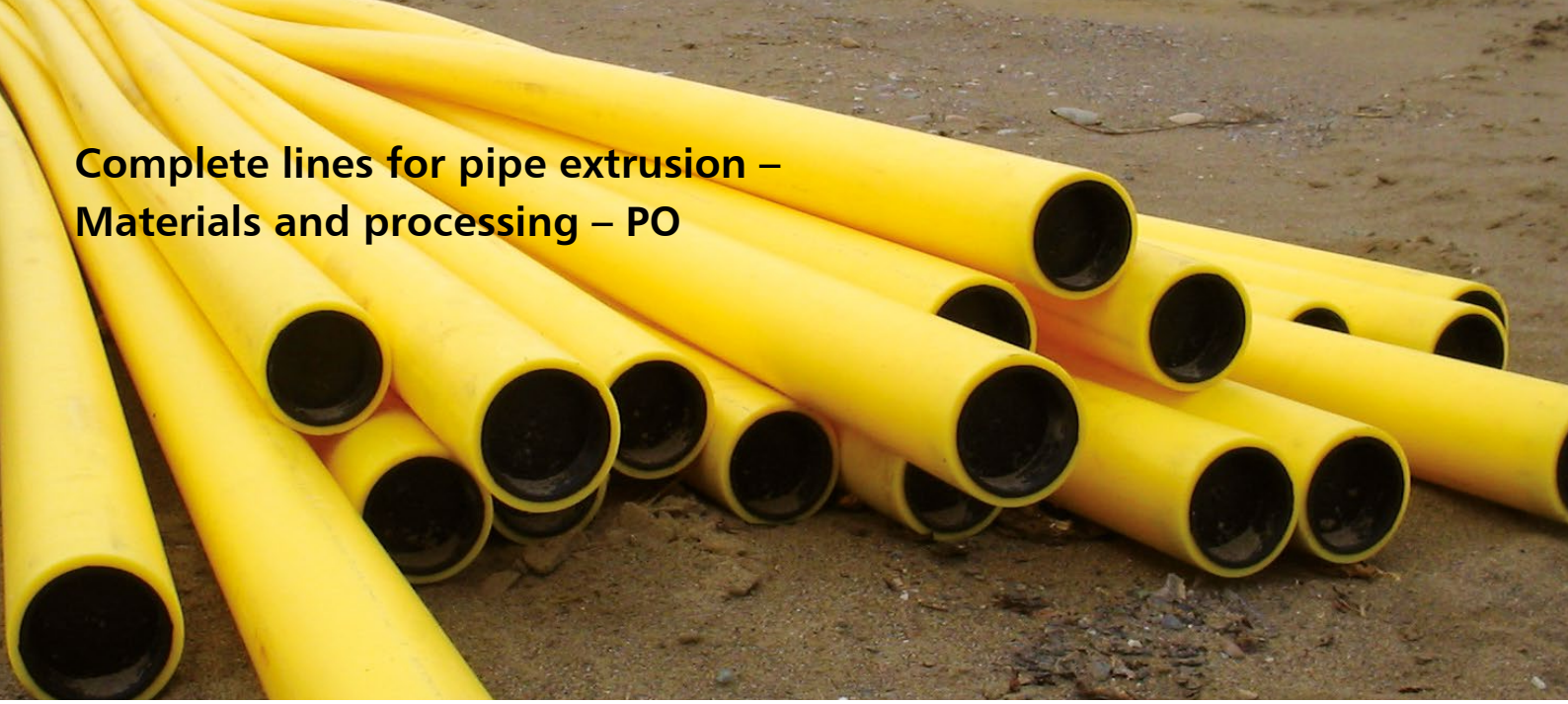
battenfeld-cincinnati PVC tooling

For processing sensitive PVC materials, flow-optimized spider-type mandrel dies are used which are suited for processing a great variety of material blends with high outputs.

Features

- Special geometry for even and accurate wall thickness distribution in the end product
- Low pressure level
- Minimum residence time

twinEX 114 extruder



Complete lines for pipe extrusion – Materials and processing – PO

PO processing

Polyolefin generally comes as a granulate. Since it is only moderately susceptible to shearing and thermal stress, it is particularly well suited for single screw extrusion.

battenfeld-cincinnati single screw extruders

- Modular extruder concept, with a choice of processing lengths (30 or 40 L/D), depending on the requirements and the application
- A grooved feed zone for optimal material feeding and a consistent, high output
- Processing units with optimized mixing screw and shearing elements for gentle melt processing at low temperatures
- Specially designed heating and cooling components for optimal material tempering and high extruder efficiency

battenfeld-cincinnati's PO tooling

battenfeld-cincinnati offers spiral mandrel distributors and VSI pipe heads (patented combination of spiral mandrel distributor and lattice basket dies). All designed and manufactured in-house, which are specially suited for polyolefin processing.

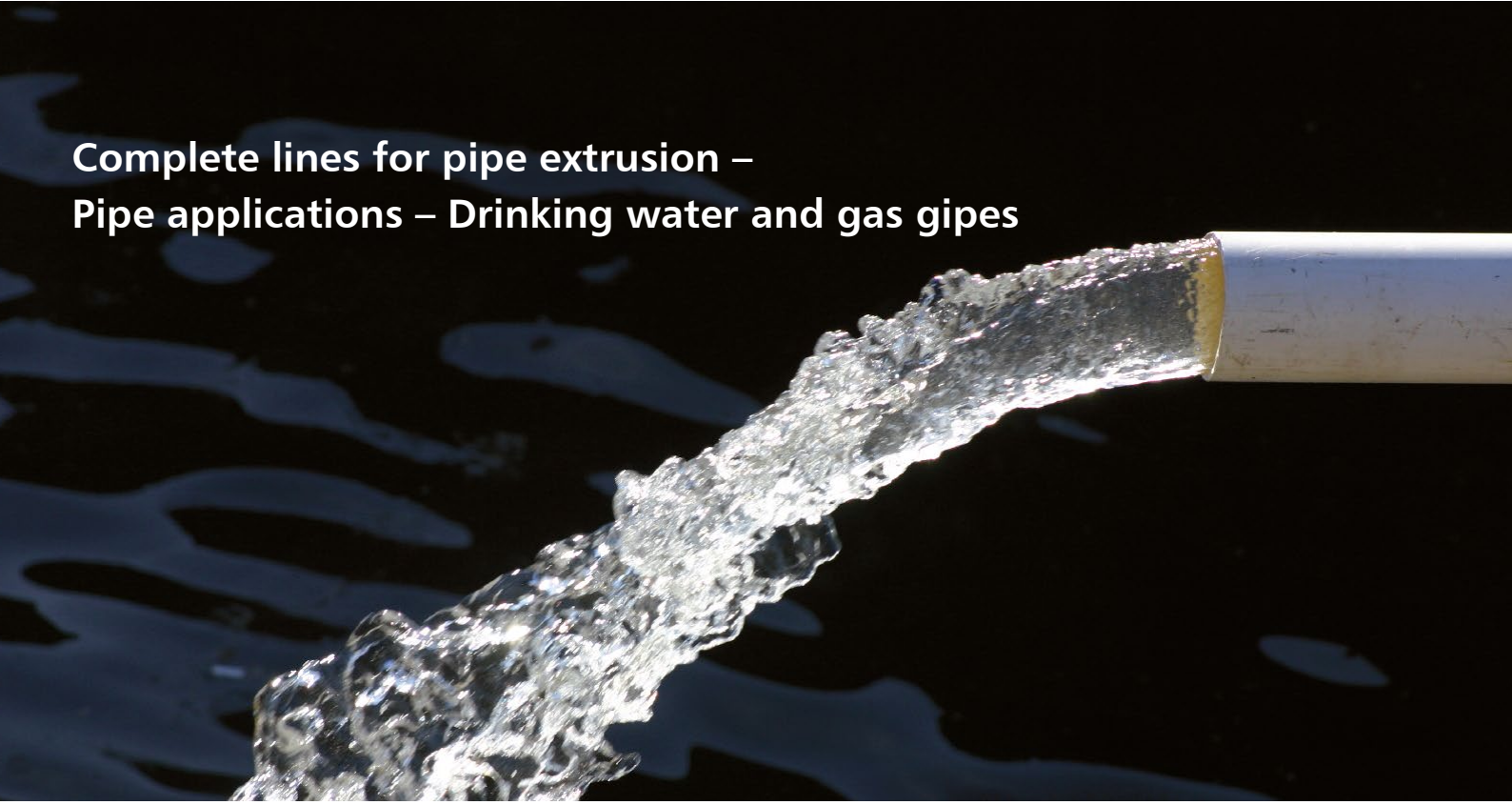
They feature

- Modular design
- Possibility of customized solutions
- Multi-layer pipe heads or co-extrusion
- Various retrofits

Our systems with melt cooling and internal pipe cooling offer enormous cost advantages through shortening of the cooling section and utilization of the resulting waste heat for granulate pre-heating.

solEX GL with uniEX GL piggyback for co-extrusion

Complete lines for pipe extrusion – Pipe applications – Drinking water and gas gipes



Drinking water pipes

Pipelines made of plastic are found in the entire drinking water supply network. They have pipe dimensions up to 3500 DN and are used as supply pipes connecting water catchment areas with water treatment plants and drinking water reservoirs. They also serve as main distribution pipelines within the supply network. Plastic pipes with smaller diameters connect the water mains with the domestic supply lines, carrying drinking water to the end consumers.

Gas pipes

Plastic pipes are also becoming increasingly common in gas supply networks. Pipes with dimensions of up to 250 DN are used as distribution mains in the supply network. Plastic pipes with smaller dimensions connect the mains with the house service connections and transport the gas to the end consumers.

Drinking water pipes

Gas pipes

Complete lines for pipe extrusion – Pipe applications – Multi-layer pipes and cable ducts

Multi-layer pipes for hot and cold water

The term “domestic installations” covers a wide range of individual applications in buildings. These include all types of panel and underfloor heating systems, hot and cold water installations as well as sound-insulated drainage in buildings. Heating and hot water pipes must be resistant to internal pressure and highly heat-resistant. Pipes in heating systems must also be gas-tight, to prevent corrosion of the heating system’s metal components through oxygen penetration and diffusion.

To align with these requirements, PE-X, PE-RT, PP-R, PB and C-PVC have been established as the most suitable materials. The oxygen barrier for pipes in heating systems is provided either by an EVOH layer or an aluminum barrier in composite pipes.

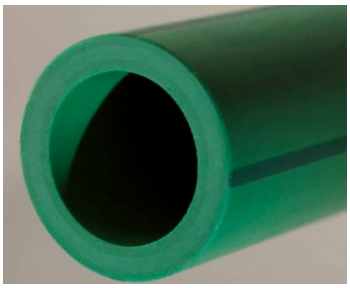
Cable ducts

The protection of power lines and cables for data transmission, control systems and telecommunication from outside impact is a segment almost completely taken over by plastics. Cable ducts account for about 10% of the total consumption of plastics for pipes in Europe. The most common materials for this purpose are polyethylene, polypropylene and PVC. To a lesser extent, PPO or ABS/PC blends are also used for halogen-free installations in buildings.

Cable ducts can be smooth or corrugated. In the automotive industry, corrugated cable ducts made of polyamide are in use as well. In all application fields, excellent pipe rigidity with minimal weight is very important and great variety of pipe wall structures and dimensions can be found.

Micro duct pipes for the protection of glass fiber cables (e.g. for telecommunication and fast internet connection) are another fast growing application. There are many different ways to bundle micro duct pipes into so called multi duct pipes.

Hot and cold 5-layer PE-RT pipe with EVOH oxygen barrier



3-layer PP-R hot water pipes with glass fiber in the middle

Micro duct pipe bundle

Complete lines for pipe extrusion – Pipe applications – District heating and unsulated pipes

District heating pipes

District heating is defined as thermal energy transport from generator to consumer by an insulated pipeline network normally laid underground – mainly for central heating, but also for hot water supply in buildings. District heating is environment-friendly, since less CO_2 and other exhaust gases harmful to the climate are released in producing energy. Plastic jacket pipes have a service life of more than 30 years and are resistant to chemicals and salts, physical impact and corrosion. They withstand operating pressures of up to 40 bar with water temperatures of up to 150° C.

District heating pipes

Insulated pipes

Their greatest benefit, however, is their extremely low effective heat loss, that is their optimal insulation performance, which is about 40% above that of conventional pipes.

Plastic jacket pipes are prefabricated pressure pipes with fittings. They consist of a metallic inner pipe (the medium pipe), a heat insulation layer (or layer for insulation against the cold) made of polyurethane (PUR) foam and a plastic jacket pipe made, for example, of polyethylene (PE). Due to the high pressure and heat-resistance requirements, the innermost medium pipe is produced mainly from PE-X, polybutylene or steel.

The PUR foam heat insulation layer has the additional task of creating an effective bond between the medium pipe, heat insulation and jacket, to bear the weight of the full medium pipe and to transmit the forces applied into the ground. Jacket pipes protect the heat insulation from outside. Normal medium pipe dimensions range from 15 to 1200 DN. Jacket pipes can have diameters of up to 2,000 mm.

Complete lines for pipe extrusion – Pipe applications – Sewage, drainage and mining pipes

Sewage pipes

In the past, cast iron or vitrified clay were used as raw material for sewage pipe systems. Now, depending on the application, plastics pressure and non-pressure solid wall, corrugated or multi-layer pipes are used. The preferred materials for public sewage systems (DN 200-800 and larger) are PE, PP or PVC pipes. Pipes used for domestic waste water disposal (DN 100-200) must be abrasion- and corrosion-resistant as well as resistant to domestic waste water and temperatures of up to 95°C. Due to its extreme stiffness, PP is an important material for waste water pipes, especially for larger diameters.

Pipes with heavy walls containing a high percentage of fillers are used for waste water transport, since, in addition to higher stiffness, these show excellent sound insulation, together with lower raw material consumption. For additional functions, such as a white interior pipe surface to facilitate camera inspection, or extremely UV-resistant outer layers, co-extrusion is used. For all types mentioned, an excellent price/performance ratio is achieved over the minimum 50-year service life.

Drainage pipes

Today, drainage system pipes collect rain water and snowmelts via gutters and downpipes to the main building site drainage. In road construction, the surface water is collected and drained. Polypropylene pipes are frequently used as drainage pipes in railroad track, airport and tunnel construction, where they are exposed to high static and dynamic loads. For bicycle lanes and footpaths, they are made of polyethylene. In high-load applications such as road construction, preference is given to PVC tunnel pipes. The smooth inner surface provides better drainage attributes than complete circular corrugated pipes.

Pipes for mining and oil production

The main focus for industrial mining applications is on crude oil, natural gas and metal ores. Steel pipes were used as transport systems in mines, but there are some drawbacks, such as the noise level generated by transporting slurry and the contamination of the slurry by the unavoidable abrasion of the steel. Thick-walled, large diameter pipes made of PE are preferred for these tasks today and only plastic pipes with diameters above 800 mm are used.

Sewage pipes

Mining pipes

Complete lines for pipe extrusion – Pipe applications – Drip irrigation

Due to climate change and world population growth, water consumption for the irrigation of arable land will rise dramatically. Consequently, there will be a rising demand for irrigation systems that enable targeted water supply to plants even in regions with little rainfall.

Drip irrigation

Agricultural irrigation has been practiced for thousands of years, but drip irrigation systems have existed only for the last few decades. These systems basically consist of plastic pipes made of PE and fitted with outlets at regular intervals. Polyolefin pipes can be produced in large quantities very easily and at low cost. They are resistant to weathering and UV radiation and lend themselves to flexible laying.

battenfeld-cincinnati offers systems for the production of irrigation pipe lines for agricultural use (e.g. greenhouses, field cultivation, viticulture, tobacco, tea growing), horticulture and landscaping, as well as the mining industry (leaching).

In a drip irrigation system the water is distributed directly to the plants' root areas by integrated (in-line) or inserted (on-line) drippers in pipe lines laid above ground or underground. Through targeted moistening of the area around the plant or rather its root area, no water can seep away into the surrounding soil or evaporate above ground. In drip irrigation, the degree of irrigation efficiency or water utilization efficiency is extremely high with more than 80 %.

This enables

- Yield increases and savings thanks to targeted use of fertilizers
- Prevention of soil salinization – this is particularly important in countries with arid climates

A distinction is made between thick-walled drip pipe lines with pressure compensation and thin-walled drip pipe lines without pressure compensation. In drip pipes with pressure compensation, the drippers are fitted with membranes that close at a certain pressure and thus prevent complete emptying of the drip pipe. To ensure constant water supply to every dripper, different types of drippers are used, for instance round or flat drippers or drip tapes.

Close-up on-line dripper
(Photo: istock)

Complete lines for pipe extrusion – PVC processing – 3-layer pipe extrusion line

Multi-layer co-extrusion systems adapted to each particular application, available either with 3-layer tooling or as feedblock system, optimally adjusted for process engineering.

3-layer pipe system

The most commonly used 3-layer pipe system is foam core pipe with a foamed middle layer. The foam layer enables a reduction of the total pipe weight by up to 25 %. Moreover, regrinds are very frequently used for the middle layer in both pipes with foam core and compact pipes.

Fields of application

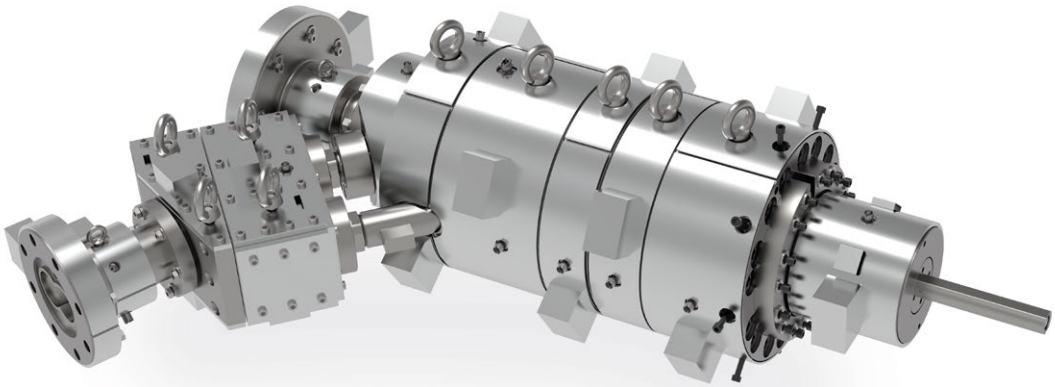
3-layer PVC pipes are now being used for all non-pressurized applications such as drainage pipes or cable conduits.

Extruder line configuration

Middle layer: twinEX series with foaming agent
Surface layer: conEX series or twinEX series
Pipe head: spider 200-3 or BC feedblock with spider feedblock
Cooling section: vacStream and coolStream
Haul-off: pullStream
Saw: cutStream

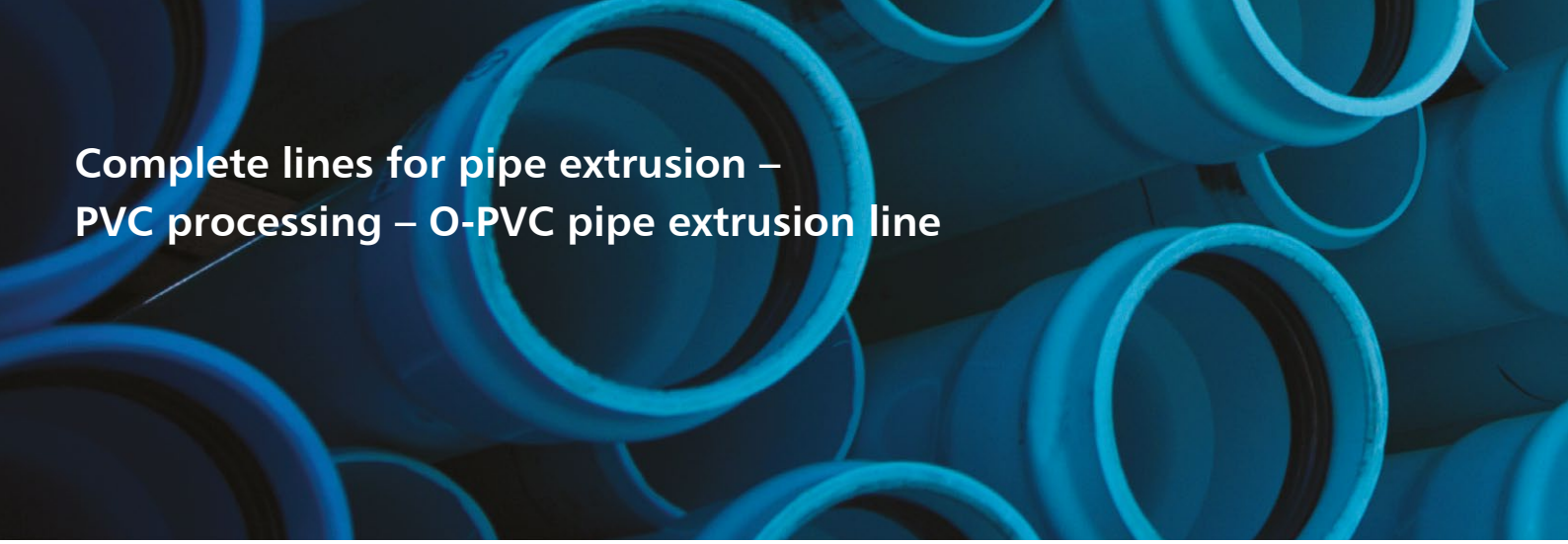
Technical data

Material: dry-blend on Pb, CaZn, OBS or Sn stabilization
Pipe dimensions: outer diameter 32-710 mm
Throughput: up to zu 1,600 kg/h



Spider pipe head for 3-layer PVC pipe

Enlarged view of the foam layer of a 3-layer PVC pipe



Complete lines for pipe extrusion – PVC processing – O-PVC pipe extrusion line

O-PVC pipes

Achieved through a stretching process during the production, O-PVC pipes stand out by outstanding mechanical properties. The stretching process enables a linear orientation of the amorphous molecular structure which improves the product properties. In comparison to normal U-PVC pipes, with this process it is possible to achieve up to 50 % thinner wall thicknesses or to produce O-PVC pipes with higher pressure classes than standard U-PVC pipes.

Fields of application

O-PVC pipes cover a wide range of applications in all areas of water management.

Our offer

- Optimized screw design for O-PVC formulations
- Pipe tooling adapted to the feedstock pipe production requirements by small wall thickness ratios
- For wall thicknesses from 35 mm, pipe heads with inner pipe cooling are used
- Comprehensive process expertise can be provided in co-operation with our partner Molecor
- Extruder line configuration

Extruder line configuration

Extruder: twinEX series extra for O-PVC processing
Pipe head: spider O-PVC series
Vacuum bath: vacStream, 6 or 9 m
Saw: cutStream
Orientation unit: Molecor M-OR-P (partner product)
Haul-off: pullStream

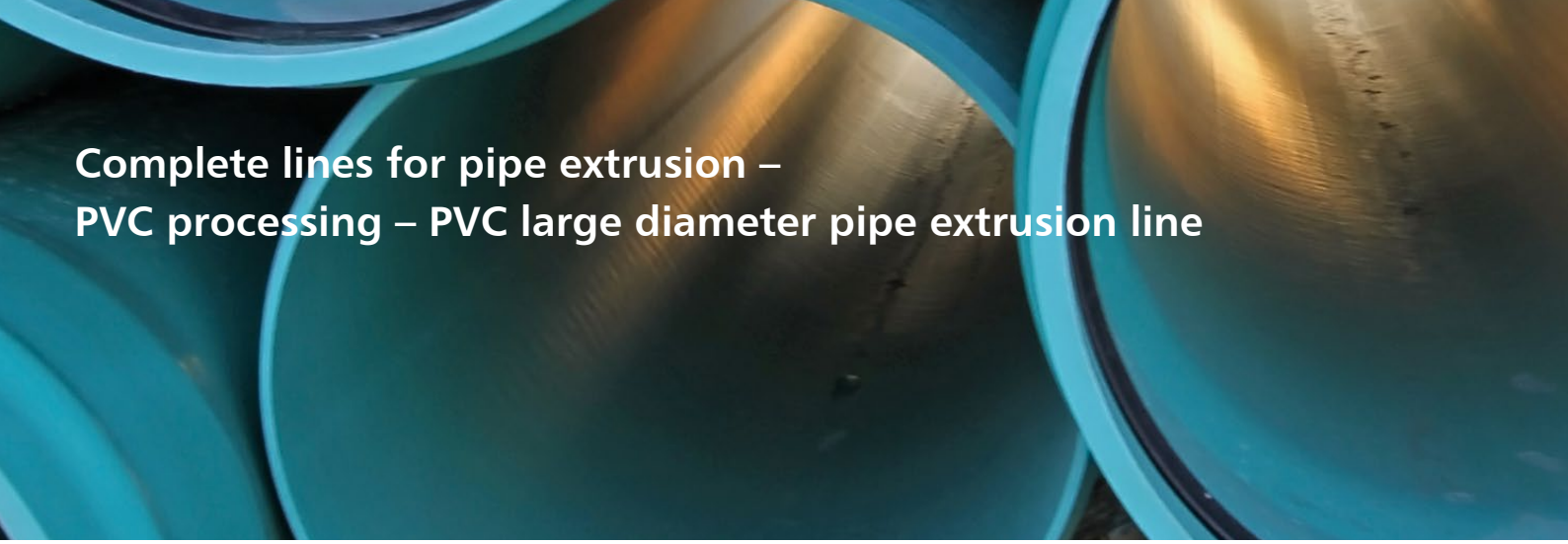
Technical data

Material: dry-blend with CaZn or OBS stabilization
Pipe dimensions: outer diameter 90 - 800 mm, PN 12.6 - PN 25
Throughput: up to 1,400 kg/h

Feedstock pipe

O-PVC pipe line (Photo: Molecor®)

Stretched pipe



Complete lines for pipe extrusion – PVC processing – PVC large diameter pipe extrusion line

PVC large diameter pipes

The demand for plastic pipes is globally increasing. The raw material costs are a key cost factor in pipe extrusion. PVC stands out as an ideally suited material with a stable and attractive price level. In addition, PVC pipes demonstrate very good mechanical properties, such as high stiffness due to the high E modulus, and excellent strength values.

Fields of application

Large diameter pipes are used in all areas of water management.

Our offer

- Complete, turnkey production lines
- Lines with highest possible throughputs
- Wide and double spider tooling system
- Double spider tooling is defined by its excellent rheological behavior ensuring low pipe overweight
- Extremely wide process know-how from large numbers of systems already installed worldwide

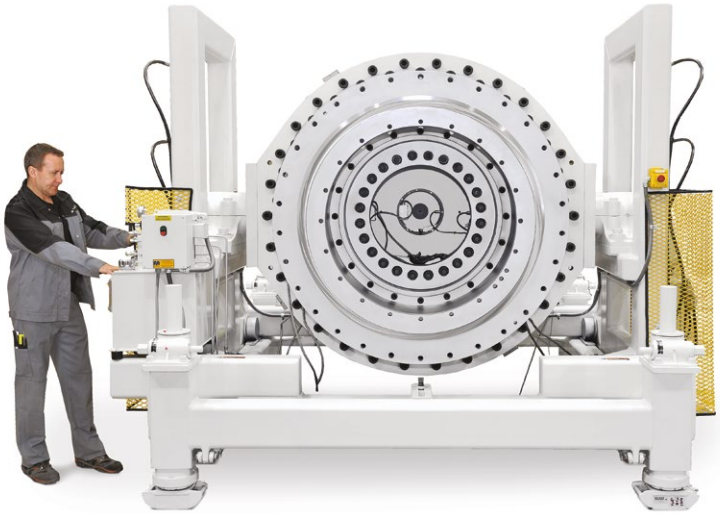
Extruder line configuration

Extruder: twinEX series, also as dual extruder setup
Pipe head: spider RD double spider tooling
Cooling section: vacStream and coolStream according to throughput
Haul-off: pullStream
Saw: cutStream
Start-up aid: startStream

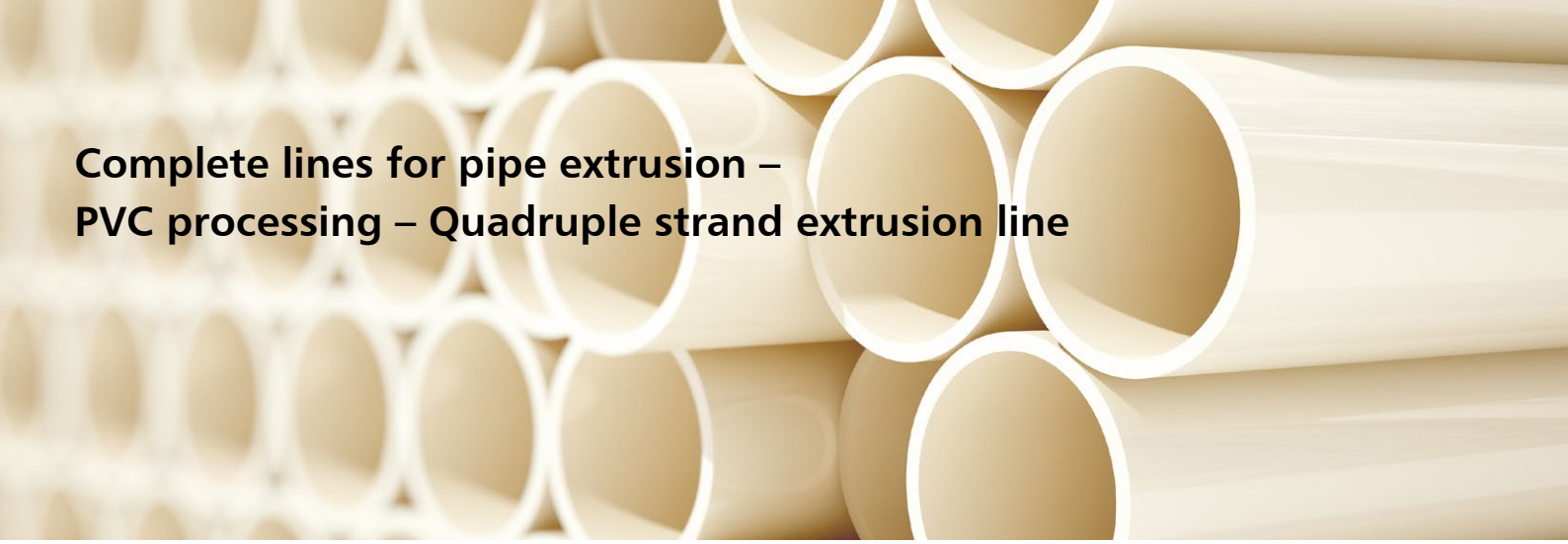
Technical data

Material: dry-blend with Pb, CaZn, OBS or Sn stabilization
Pipe dimensions: outer diameter up to 1,600 mm
Throughput: up to 4,000 kg/h

Double spider tooling



Spider double pipe head for 1,200 mm PVC pipe



Complete lines for pipe extrusion – PVC processing – Quadruple strand extrusion line

Quadruple strand pipes

For cable protection, PVC is – especially due to its high stiffness and its self-extinguishing property – the most widely used pipe protection material. To reduce space requirements, twin strand lines have already become a standard. As a further development step, quadruple strand lines have now been designed.

Fields of application

Small PVC pipes are mainly used as cable protection pipes, but also for cold water supply systems.

Our offer

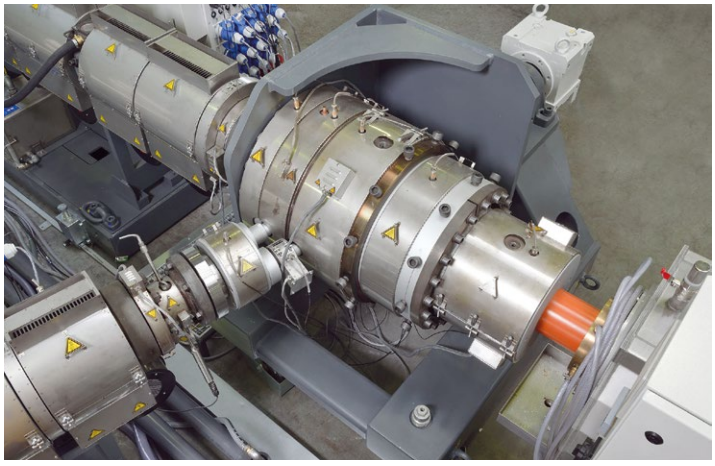
- Complete, turnkey production lines
- Line speeds to 30 m/min (dep. on dimension)
- Two separately controllable vacuum baths
- Separately controllable haul-offs for each strand
- Each saw on its own slide

Extruder line configuration

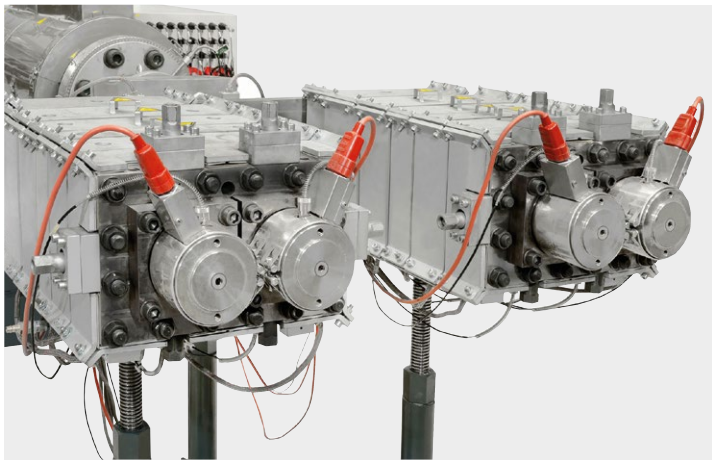
Extruder: twinEX 114-34
Pipe head: spider 50/4
Vacuum bath: vacStream 250-6 twin
Cooling section: coolStream 250-6 twin
Haul-off/saw combination: Belling machine

Technical data

Material: PVC dry-blend
Pipe dimensions: outer diameters from 6 - 50 mm
Throughput: up to 1,200 kg/h



Spider 400-3 die head



Spider 50-4 pipe die for quadruple strand extrusion of U-PVC pipes

Complete lines for pipe extrusion – PO and PP processing – PE-RT 3-layer and 5-layer pipe extrusion lines

3- and 5-layer pipes

These 3- and 5-layer pipes consist of an inner layer made of PE-RT, an adhesive layer and an EVOH oxygen barrier layer (3-layer pipe), and an additional adhesive layer and an outer layer made of PE-RT (5-layer pipe).

Fields of application

3- and 5-layer pipes are mainly used for floor heating and hot water transport.

Our offer

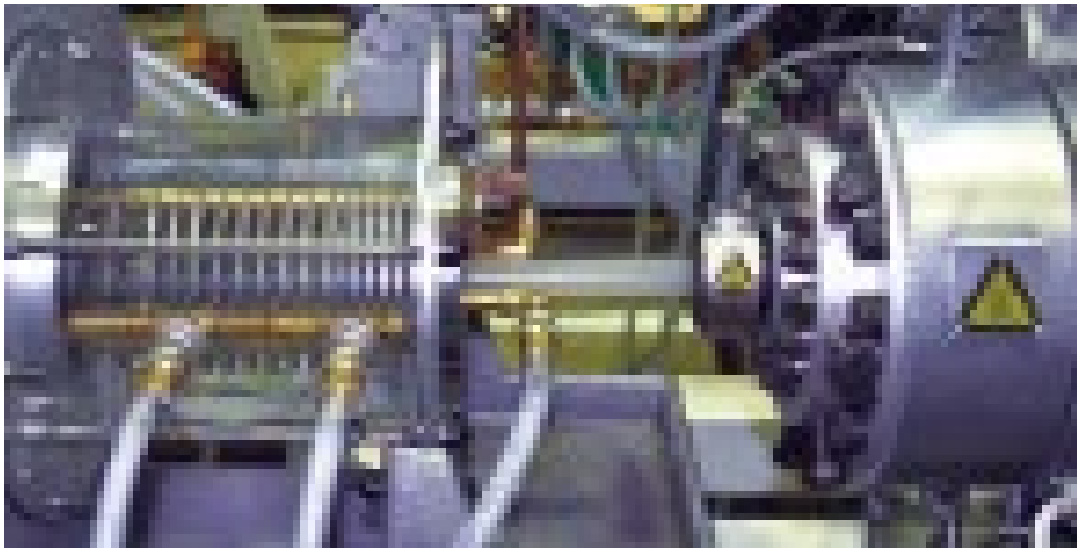
- High line speeds for small pipe dimensions
- Wide range of pipe dimensions
- Production of 3- and 5-layer pipes with a single die
- Excellent layer thickness distribution of each layer

Example of extrusion line configuration

Main extruder PE-RT inner layer: uniEX 60-30
Co-extruder adhesive: coEX II 30-25
Co-extruder EVOH: coEX II 30-25
Co-extruder adhesive: coEX II 30-25
Co-extruder PE-RT outer layer: uniEX 45-30
Pipe head 1: helix II 32-5 VSI
Pipe head 2: helix II 63-5 VSI
Vacuum tank: vacStream WT 63-9/2C
Cooling section: coolStream K 63-6F1 (2x)
Haul-off: pullStream B63-1000 WS
Cutting unit: cutStream RTA 63

Technical data

Material: PE-RT type II
Pipe dimensions: 12 x 2.0 mm up to 63 x 5.8 mm
Speed: up to 50 m/min



Multiple layer extrusion line

Complete lines for pipe extrusion – PO and PP processing – Micro duct and Multi duct extrusion lines

Multi duct pipes

Bundling of micro duct pipes in many different versions and sheathings of these pipes, with or without vacuum treatment (multi duct).

Fields of application

Micro duct pipes are mainly used for fiber-optic cables.

Our offer

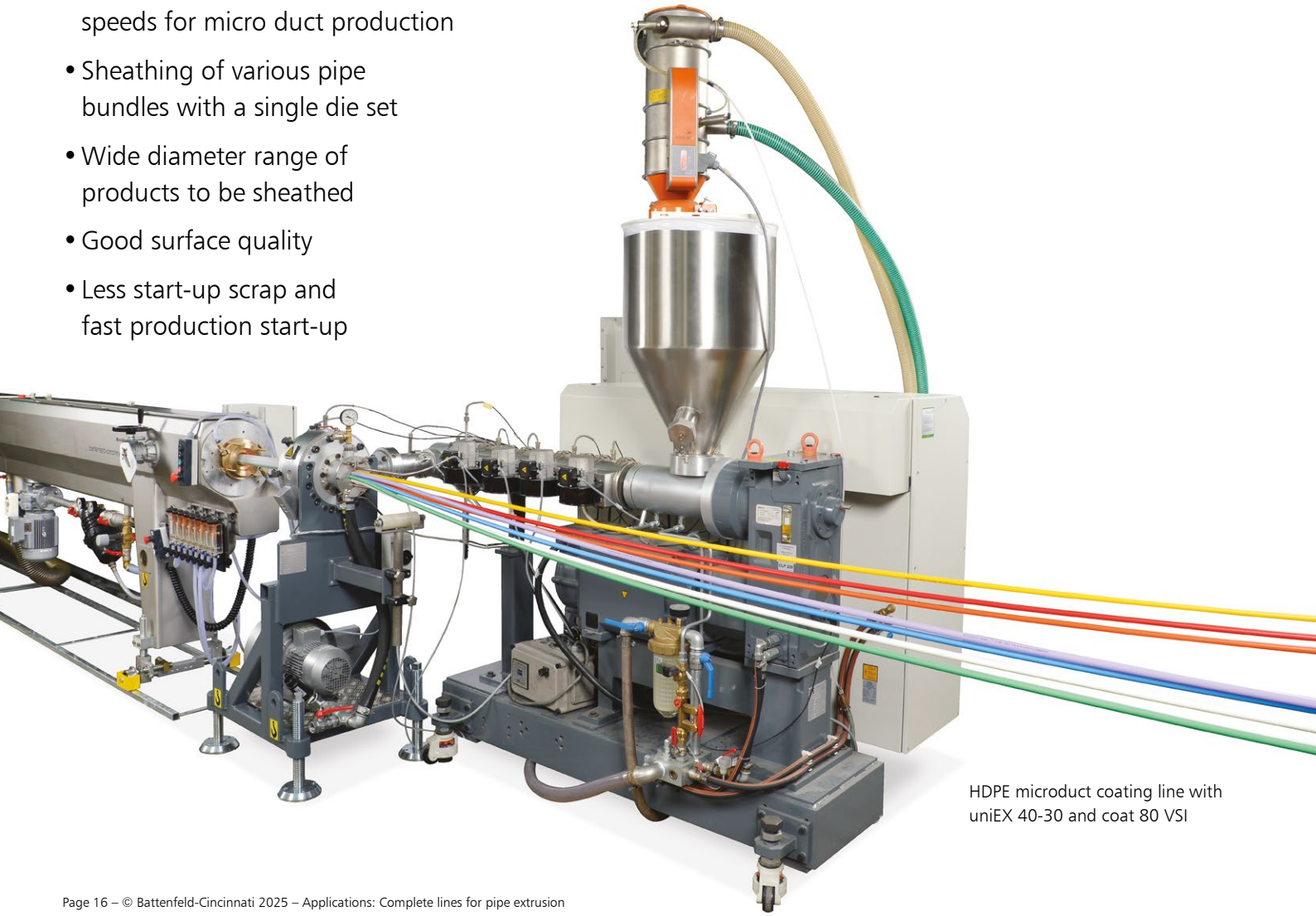
- Precise layer distribution at high line speeds for micro duct production
- Sheathing of various pipe bundles with a single die set
- Wide diameter range of products to be sheathed
- Good surface quality
- Less start-up scrap and fast production start-up

Example of extrusion line configuration

Extruder: uniEX 45-30
Coating die: coat 160
VSI Cooling section: coolStream 160-6
Haul-off: pullStream B 125/1200

Technical data

Material: PE-HD
Bundle dimensions: up to 110 mm cross section
Speed: up to 50 m



HDPE microduct coating line with uniEX 40-30 and coat 80 VSI

Complete lines for pipe extrusion – PO and PP processing – PP-RCT 4-layer pipe extrusion line

4-layer pipes

This 4-layer pipe consists of an inner layer of PPRCT, a middle layer of glass fiber reinforced PPRCT, an additional layer of PP-RCT, and a fourth (outer) layer of coloured PP-R.

Fields of application

4-layer pipes are used for hot and cold water transport.

Our offer

- Largest pipe dimensions for PP-RCT; diameter and wall thickness up to 500 x 36.8 mm
- Good layer distribution even for large diameters
- Use of pipe inner cooling and melt cooling to reduce the sagging effect
- High synchronization constancy of the haul-off at very low speed range (1/50)
- Swarfless cutting of large wall thicknesses with processed materials of PP-RCT with glass fiber
- Excellent pipe surface quality even at low haul-off speed

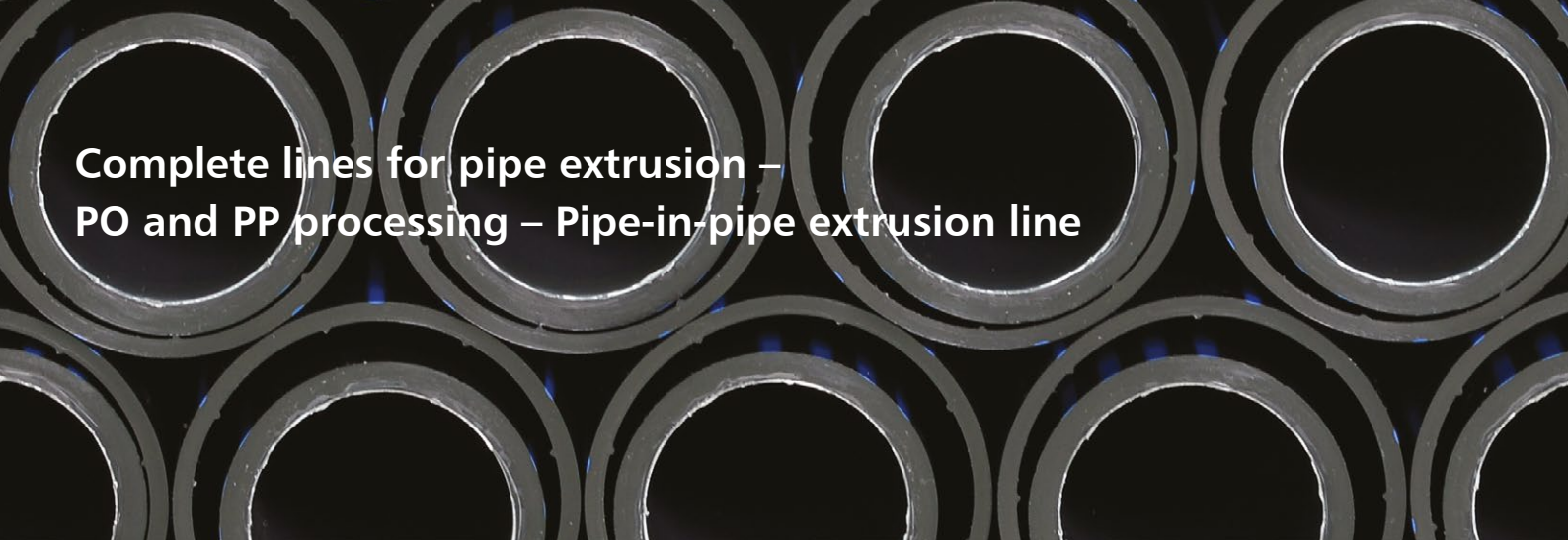
Example of extrusion line configuration

Main extruder PP-RCT inner/outer layer: solEX 60-40
Co-extruder PP-RCT glass fiber inner layer: uniEX 60-30
Co-extruder PP-R top layer: uniEX 35-30
Co-extruder color stripes: coEX II 30-25
Pipe head: helix 630-4 VSI-T+
Vacuum tank: vacStream 630-6 (2x)
Cooling section: coolStream 630-6 (2x)
Haul-off: pullStream R 630-6 EZ
Cutting unit: cutStream PTA 800

Technical data

Material: PP-RCT / PP-RCT with glass fiber / PP-R
Pipe dimensions inside: up to 500 x 36.8 mm
Throughput: 450 kg/h
Speed: 0,15 m/min

pullStream R630-6EZ and cutStream PTA 630 E



Complete lines for pipe extrusion – PO and PP processing – Pipe-in-pipe extrusion line

Pipe-in-pipe solutions

For safety reasons, fuel pipes are laid inside a second pipe. To keep the production of these pipe systems as cost-effective as possible, pipe-in-pipe extrusion is applied.

Key challenges for pipe-in-pipe production are:

- Inner pipe with EVOH inner layer
- Outer pipe with inner contour as spacer
- Calibration of outer pipe with inner pipe
- No contact or bonding of the two pipes
- No damage to inside contours of outer pipe
- Synchronization of both line sections
- Simultaneous cutting of two pipes

Our offer

- Complete line with inline extrusion of both inner and outer pipe
- Comprehensive process know-how for the manufacture of these lines

Example of extrusion line configuration

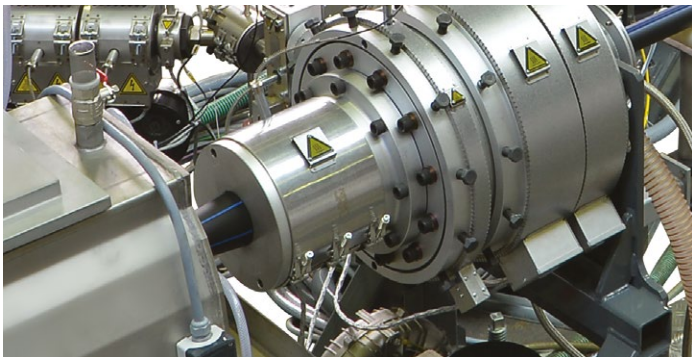
Main extruder: uniEX 45-30
Co-extruder adhesive: CoEX II 30-25
Co-extruder EVOH: CoEX II 35-25
Co-extruder color stripes: CoEX II 30-25
Pipe head: helix II 160 VSI
Vacuum tank: vacStream WT 160 WS
Cooling section: coolStream 160-6 WS
Haul-off: pullStream R160-4E

Line configuration of jacket pipe

Main extruder: uniEX 45-30
Co-extruder color stripes: CoEX II 30-25
Pipe head: coat 125 VSI
Vacuum tank: vacStream 160-9 WS
Cooling section: coolStream 160-6 WS
Haul-off: pullStream R160-4E
Cutting unit: cutStream DTA 160 WS
Tipping table: tiltStream KR 160

Technical data

Material: PE-HD / adhesive / EVOH
Pipe dimension inner pipe:
32 x 3.0 mm / 50 x 4.6 mm / 63 x 4.7 mm
Pipe dimension outer pipe:
40 x 2.5 mm / 63 x 2.5 mm / 75 x 2.9 mm
Speeds: 3 m/min to 7 m/min



Pipe head for pipe-in-pipe extrusion

Complete lines for pipe extrusion – PO and PP processing – Aluminum composite pipe lines

Aluminium composite pipes

These 5-layer pipes with a diameter range from 12 - 63 mm are frequently used in heating engineering, especially for floor heating applications. The middle aluminum layer is surrounded by two adhesive layers, then inner and outer layers consisting of PE-X/ PB /PP-R or PE-RT. Thanks to their metal core, these pipes are absolutely impervious to oxygen and other gases, and where PE-X is used, they are also resistant to UV radiation on the outside and to chlorine on the inside. At the same time, the aluminum layer en-sures high dimensional stability with simultaneous flexibility. Small bending radii to adapt the pipes can be formed simply by hand or can also be joined by cold pressing or clamping processes without great assembly expense.

A special form of composite pipe is the so called "stabi pipe", an aluminum-coated PP-R pipe with an extruded outer finishing layer to improve its rigidity.

Our offer

- Speeds up to 60 m/min
- Laser or TIG welding

Example of extrusion line configuration

Main extruder: uniEX 60-30
Pipe head: helix II 32 VSI
Vacuum tank: vacStream 63-9/2C WS
Cooling section 1: coolStream K63-6F
Pipe drying station: dryStream (high performance)

Aluminium forming & welding station

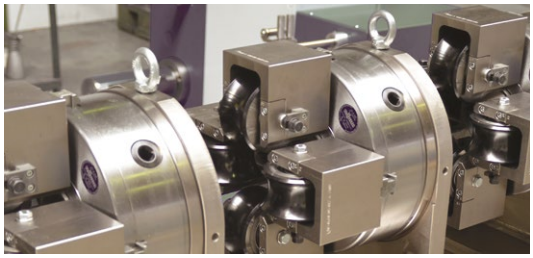
Haul-off 1: pullStream B 63/1000 WS
Co-extruder adhesive: CoEX II 30-25
Sheathing die 1: coat 40 P

Haul-off 2: pullStream B 63/1000 WS
Co-extruder adhesive: CoEX II 30-25
Co-extruder outer layer: uniEX 45-30
Sheathing die 2: coat 40 P-2
Cooling section 2: coolStream K 63-21F

Haul-off 3: pullStream B 63/1000 WS
Cutting unit: cutStream RTA 63
Pipe drying station: dryStream (high performance)

Technical data

Material: PE-RT type II
Pipe dimension: 50 mm
Speeds: 50 m/min



Detail of compacting unit

Pipe head for aluminium pipe extrusion

battenfeld-cincinnati Services –
Worldwide active for you

We have an extensive service network at our disposal to support our customers professionally and promptly with technical know-how and spare parts. Our locally available service technicians are regularly trained on the current state of the art and informed about new developments.

Spare Parts
1. Tailor-made spare parts packages
2. Innovative screw design

Technical Service
1. Commissioning, maintenance, inspection
2. Repair-in-the-field-Hotline
3. Remote diagnosis system

Wear Analysis
1. Regular wear measurement
2. Wear protection consulting

Extruserve
1. Completely overhauled extruders
2. Screws repair for many external extruders
3. Screws & barrels for other brands

Support & Training
1. Consulting & training
2. Inspection & service contracts
3. Energy-saving advice
4. Forecasting required key parts
5. Material analyses & pilot plant

Repairs & Upgrades
1. Control retrofits
2. New drives for extruders & successions
3. Repairs of screws, gears, controls & drives

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