Application: pipe

Complete lines for a wide range of plastic pipes & tailored solutions for special pipe applications
Part 1: General processing of plastics

Complete, state-of-the-art pipe extrusion systems from a single source

battenfeld-cincinnati is the leading manufacturer of customized, energy-efficient pipe extrusion systems. Every line is designed by us from start to finish, with all individual components matching perfectly. As partners for our customers, we provide comprehensive counseling in application-related process technology and offer optimal solutions for every application - with high performance equipment, shortest possible line lengths and savings in energy, material and water consumption.

Plastic pipes may be subject to stringent international quality standards and, depending on the application, consist of a variety of different plastics. The main raw materials used are polyolefine and PVC. Plastic pipes offer a multitude of advantages:

- Easy laying, installation and maintenance
- Light weight
- Resistance to chemicals, incrustation and corrosion
- Long lifetime
- Recyclability

Schematic overview of a standard pipe extrusion line:

- Extruders:
  - Single screw extruders for PO
  - Twin screw extruders for PVC
- Vacuum tanks for pipe diameters from 5 to 2,600 mm
- Cooling tanks for pipe diameters from 5 to 2,600 mm
- Cutting tools for pipe diameters from 5 to 2,600 mm
- Haul-offs for pipe diameters from 5 to 2,600 mm
- Roller tables or tilt tables for pipe diameters up to 2,600 mm
Part 2: Materials and processing

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.

Advantages of battenfeld-cincinnati twin screw extruders

- Longer, 34D processing unit for:
  - Better product quality
  - Enormous processing window
  - Optimized screw concepts for extremely high output levels

Advantages of battenfeld-cincinnati’s 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. They feature:

- Special geometry for even and accurate wall thickness distribution in the end product
- Low pressure build-up that minimizes residence time

battenfeld-cincinnati also offers co-extrusion solutions and pipe dies for multi-layer applications, such as foam core pipes which reduce material requirements.

PE-Xa processing

PE-Xa pipes have an extremely high crosslink density and consequently outstanding thermal resistance. Manufacturing PE-Xa pipes requires a highly specialized process:

- A blend of PE powder, liquid peroxide and stabilizers is melted and homogenized in a twin screw extruder. To prevent premature cross-linking, a low processing temperature of 160°C is necessary.
- Then, the melt is formed into a pipe strand in flow-optimized pipe dies with extremely small volumes and a special coating.
- Next, the melt strand is guided through an IR oven and cross-linked.
- The following downstream is similar to a standard pipe extrusion line.
Part 3: Production lines for PVC processing

3-layer pipe extrusion line

1. Pipe description:
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.

2. Line configuration:
- Extruder for middle layer: twinEX series with foaming agent
- Extruder for main 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

3. Technical data:
- Raw material: PVC dry-blend based on Pb, CaZn, OBS or Sn stabilization
- Pipe dimension range: outer diameter 32 - 710 mm
- Throughput: up to zu 1,600 kg/h

4. Our offer:
- Complete, turnkey production lines
- Multi-layer co-extrusion systems adapted to each particular application, available either with 3-layer tooling or as feedblock system
- Optimally adjusted process engineering
O-PVC pipe extrusion line

1. Pipe description:
O-PVC pipes are characterized by their outstanding mechanical properties. They are achieved through a stretching process during the production of the pipe. The stretching process enables a linear orientation of the amorphous molecular structure which substantially 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.
Application: O-PVC pipes cover a wide range of applications in all areas of water management

2. Line configuration:
- Extruder: twinEX series specially designed for O-PVC processing
- Pipe head: spider O-PVC series with inner pipe cooling
- Vacuum bath: vacStream, 6 or 9 m
- Haul-off: pullStream
- Saw: cutStream
- Orientation unit: Molecor M-OR-P (from our partner Molecor)

3. Technical data:
- Raw material: PVC dry-blend with CaZn or OBS stabilization
- Pipe diameter range: outer diameter 90 - 800 mm, PN 12.6 – PN25
- Throughput: up to 1,400 kg/h

4. Our offer:
- Optimized screw design for O-PVC formulations
- Pipe tooling adapted to the special requirements of the feedstock pipe production with 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
PVC large diameter pipe line

1. Pipe description:
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.
Application: in all areas of water management

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

3. Technical data:
   - Raw material: based on PVC dry-blend with Pb, CaZn, OBS or Sn stabilization
   - Pipe dimension range: outer diameters up to 1,600 mm
   - Throughput: up to 4,000 kg/h

4. Our offer:
   - Complete, turnkey production lines
   - Lines with highest possible throughputs
   - Wide and fully developed double spider tooling system
   - battenfeld-cincinnati double spider tooling is characterized by its excellent rheological behavior which ensures low pipe overweight
   - Extremely wide process know-how from large numbers of systems already installed worldwide
Quadruple strand extrusion line

1. Pipe description:
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.
Application: small PVC pipes are mainly used as cable protection pipes, but also as cold water supply systems.

2. 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

3. Technical data:
- Raw material: PVC dry-blend
- Pipe dimension range: outer diameters from 6 to 50 mm
- Throughput: up to 1,200 kg/h

4. Our offer:
- Complete, turnkey production lines
- Depending on the dimension line speeds up to 30 m/min
- Two separately controllable vacuum baths
- Separately controllable haul-offs for each strand
- Each saw on its own slide
Polyolefin 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.

Advantages of battenfeld-cincinnati single screw extruders

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

Advantages of 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
- Retrofitting is possible
- Multi-layer pipe heads or co-extrusion solutions

battenfeld-cincinnati 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 pre-heating the granulate.

Multi-layer extrusion line for 4-layer PP-RCT pipes up to 630 mm outer diameter and 4-layer PP-RCT pipes with glass fiber reinforced middle layer
Part 4: applications

Drinking water pipes and gas pipes

Pipelines made of plastic are found in the entire drinking water supply network. They have pipe dimensions up to 2600 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 the drinking water to the end consumers.

Drinking water 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.

Gas pipes
**Pipes for domestic installations**

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 (find more information about sewage pipes on page 12).

Three characteristics of plastic pipes are significant for all of these applications, the relevance of which depends on the specific field of application in each case. Both 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 ensure compliance with these requirements for plastic pipes, 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 fields of application, special attention is paid to combining excellent pipe rigidity with minimal pipe weight. Therefore a great variety of pipe wall structures and dimensions can be found to suit every application.

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 (for more information, see page 19 under “Micro duct pipe sheathing extrusion line”).

Smooth cable ducts  Corrugated cable ducts  Micro duct 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 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 of waste water pipes mentioned, an excellent price/performance ratio is achieved over the minimum 50-year service life.

Pipes for mining / oil production

The main focus for industrial mining applications is on crude oil, natural gas and metal ores. Iron ore for steel production and copper ore for the electrical and communication industries are of special interest. Formerly, steel pipes were used as transport systems in mines. These have a longer service life than plastic pipes, but there are also definite drawbacks, such as the noise level generated by transporting slurry, a mixture of crushed ore and water, and the contamination of the slurry by the unavoidable abrasion (up to 20% of their wall thickness) of the steel. Therefore, thick-walled, large diameter pipes made of PE 100 are preferred for these tasks today.

For mining applications, only plastic pipes with diameters above 800 mm are used.

Plastic pipes are also used in oil production and more frequently in fracking for natural gas exploitation as well.
Irrigation pipes

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 polyolefin and fitted with outlets at regular intervals. In practice, 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.

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. 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 preset 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 drippers, flat drippers or drip tapes.

Irrigation with plastic pipes enables yield increases and savings thanks to targeted use of fertilizers. Moreover, soil salinization is prevented which is particularly important in countries with arid climates.

Drainage pipes

Today, drainage pipes are required to meet more and more stringent demands imposed for underground drainage. Building drainage systems take care of draining rain water and snowmelts via gutters and downpipes to the main building site drainage. In road construction, the surface water from rain or snowfall is collected and absorbed by drainage systems, to prevent danger to traffic and structural damage. More than 30% of plastics consumption for pipes in Europe is for waste water disposal and drainage. Pipes with smooth inner surfaces and circular profiles on the outside are in use especially in road and tunnel construction, but also in building site drainage.

Polypropylene pipes are frequently used as seepage 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 and underground structures, preference is given to PVC tunnel pipes because of their high ring stiffness. The smooth surface at the bottom of the pipes provides substantially better drainage attributes than circular corrugated pipes.

Drainage pipes in a corn field (Photo: istock)
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 CO₂ and other exhaust gases harmful to the climate are released in producing energy. Plastic jacket pipes have a long service life of more than 30 years and are resistant to chemicals and salts, physical impact and corrosion. They are required to withstand operating pressures of 40 bar with water temperatures of up to 150° C, depending on the application requirements. 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.

Design of plastic jacket 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-Xa, 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.

The jacket pipe protects the heat insulation from outside impact. Normal medium pipe dimensions range from 15 to 1200 DN. The jacket pipes can have diameters of up to 2,000 mm.
Part 5: Lines for special applications

Aluminum composite pipe lines

1. Description of pipe:
These 5-layer pipes with diameters from 16 to 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 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 ensures 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.

2. Line configuration:
- Main extruder: uniEX 60-30
- Pipe head: spider 32 PE-X
- Vacuum tank: vacStream 63-9/2C
- Cooling section 1: K63
- Haul-off 1: pullStream B 63 / 800
- Co-extruder adhesive: E 25.3 x 25D
- Sheathing die 1: coat 40 P
- Aluminium forming & welding station
- Haul-off 2: pullStream B 63 / 1200
- Co-extruder adhesive: E 25.3 x 25D
- Co-extruder outer layer: uniEX 45-30
- Sheathing die 2: coat 40 P-2
- Cooling section 2: K 63
- Haul-off 3: pullStream B 63 / 800
- Pipe drying unit
- Cutting unit: cutStream RTA 63

3. Technical data:
- Processed material: PE-RT type II
- Pipe dimension: 16 x 2.0 mm
- Line speeds: 40 m/min

4. Our offer:
- Speeds up to 50 m/min,
laser or TIG welding
Pipe-in-pipe extrusion line

1. Pipe description:
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. The key challenges for pipe-in-pipe production are as follows:
- Inner pipe with EVOH inner layer
- Outer pipe with inside contour as spacer
- Calibration of outer pipe with inner pipe
- No contact or bonding of the two pipes
- No damage to the inside contours of the outer pipe
- Synchronization of both line sections
- Simultaneous cutting of two pipes

2.1 Line configuration of inner pipe
- Main extruder: uniEX 45-30
- Co-extruder adhesive: E 25.0 x 25 D
- Co-extruder EVOH: E 30.6 x 25 D
- Co-extruder color stripes: E 20.0 x 25 D
- Pipe head: helix 125-3 VSI
- Vacuum tank: vacStream 125-9
- Cooling section: coolStream 125-6
- Haul-off: pullStream R 125/4E

2.2 Line configuration of jacket pipe
- Main extruder: uniEX 45-30
- Co-extruder color stripes: E 20.0 x 25 D
- Pipe head: coat 125 VSI
- Vacuum tank: vacStream 125-9
- Cooling section: coolStream 125-6
- Haul-off: pullStream R 125/4E

- Cutting unit: cutStream RTA 125 E
- Tipping table: tiltStream KR 160

3. Technical data:
- Raw material: PE-HD / adhesive / EVOH
- Pipe dimension for inner pipe: 32 x 3,0 mm / 50 x 4,6 mm / 63 x 4,7 mm
- Pipe dimension for 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

4. Our offer:
- Complete line with inline extrusion of both inner and outer pipe
- Comprehensive process know-how for the manufacture of these lines
1. Pipe description:
This 4-layer pipe consists of an inner layer of PP-RCT, a middle layer of PP-RCT and glass fiber, an additional layer of PP-RCT, and a fourth (outer) layer of PP-R with a color.
Application: Hot and cold water transport

2. Line configuration:
- Main extruder PP-RCT inner and 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: co-EX 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:
- Processed materials: PP-RCT / PP-RCT with glass fiber / PP-R
- Pipe dimension inner pipe: 500 x 36.8 mm SDR 13.6
- Total throughput: 450 kg/h
- Haul-off speed: 0.15 m/min

Our offer:
- Largest pipe dimensions for PP-RCT so far; diameter and wall thickness (500 x 36.8 mm)
- Good layer distribution even for large diameters
- Use of pipe inner cooling and T+ melt cooling to reduce the sagging effect
- Good pipe surface quality at extremely low haul-off speed
- 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
PE-RT 3-layer and 5-layer pipe extrusion lines

1. Pipe description:
These 3- and 5-layer pipes consist of an inner layer made of PE-RT, an adhesive layer and an EVOH layer (3-layer pipe), and an additional adhesive layer and an outer layer made of PE-RT (5-layer pipe).
Application: mainly floor heating pipes and pipes for hot water transport

2. Line configuration:
- Main extruder PE-RT inner layer: uniEX 60-30
- Co-extruder adhesive: E 25 x 25D
- Co-extruder EVOH: E 30 x 25D
- Co-extruder adhesive: E 25 x 25D
- Co-extruder PE-RT outer layer: uniEX 45-30
- Pipe head 1: helix 32-5 VSI-P
- Pipe head 2: helix 125-5 VSI-P
- Vacuum tank: vacStream 125-9
- Cooling section: coolStream 125-6 (2x)
- Haul-off: pullStream B 125 / 1200
- Cutting unit: cutStream TRK 125

3. Technical data:
- Material: PE-RT type II
- Pipe dimension: 20 x 1.9 mm up to 110 x 15.2 mm
- Speeds: 1.0 m/min up to 20 m/min

4. Our offer:
- High line speeds for small pipe dimensions
- Wide range of pipe dimensions
- Production of 3-layer pipes and 5-layer pipes each with a single die
- Good layer thickness distribution of the individual layers
Micro duct pipe sheathing extrusion line

1. **Pipe description:**
Bundling of micro duct pipes in many different versions and sheathings of these pipes, with or without vacuum treatment (multi duct).
Application: fiber-optic cables

2. **Line configuration:**
- Main extruder: uniEX 45-30
- Coating die: coat 80 VSI
- Cooling section: coolStream 63-6
- Haul-off: pullStream B 63/800

3. **Technical data:**
- Processed material: PE-HD
- Pipe dimensions: 14/10 7-way & 14/10 3-way
- Line speeds: 16 m/min and 21 m/min

4. **Our offer:**
- Uncoiling and feeding of various pipe bundles
- Sheathing of various pipe bundles with only one die set
- Wide diameter range of products to be sheathed
- Good surface quality for sheathing
- Minimal start-up scrap and fast production start-up

3-way multi duct pipe
7-way multi duct pipe
Diverse extruders can be used in lines for the production of PO and PVC pipe. Here you see a schematic line layout with uniEX and coEX extruders in green.

In the list below you will find all of our equipment for PO and PVC pipe production:

- Single screw extruders
- Twin screw extruders
- PO pipe heads
- PVC pipe heads
- FDC - fast inline pipe dimension change for pipe extrusion
- Pipe downstream equipment

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