

Extrusion of blown film

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TERMOPLASTI – PLAMA d.o.o.



- Production of PO flexible packaging films and bags
- Private company
- Annual turnover: 24.300.000 €
- Produced in 2013: 9.300 tons
- N. of employees: 115
- Certified according int.standard ISO 9001 / 14001
- www.ter-plama.si

LOCATION



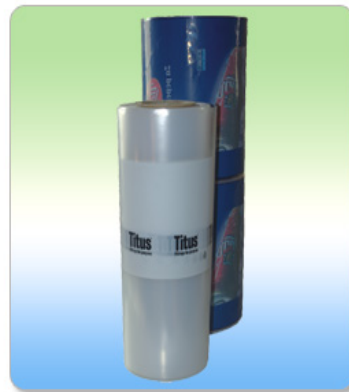
MANUFACTURING PROGRAM

- **Production steps: extrusion, printing, embossing, welding, recycling**
- **Products: films and bag**

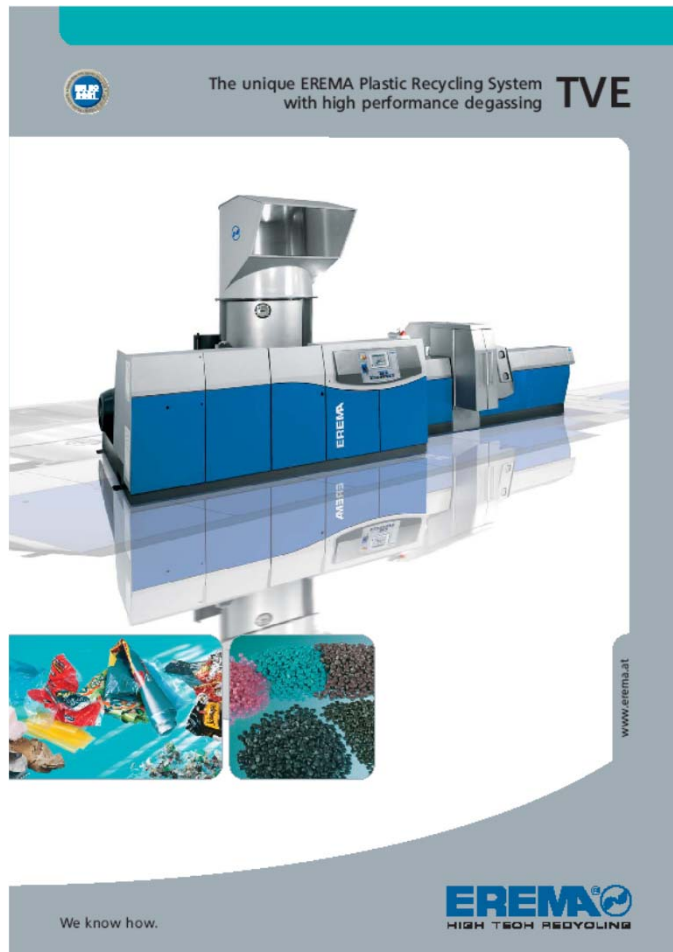
- film for industrial packaging
- thermoshrinkable film
- cover and protective film
- embossed film
- film for lamination



- shopper bags: patch handle, flexi loop handle, T shirt bag
- safety bags
- bags for industrial packaging
- bio degradable bags: oxo and compostable
- recycled plastic materials in pellets form

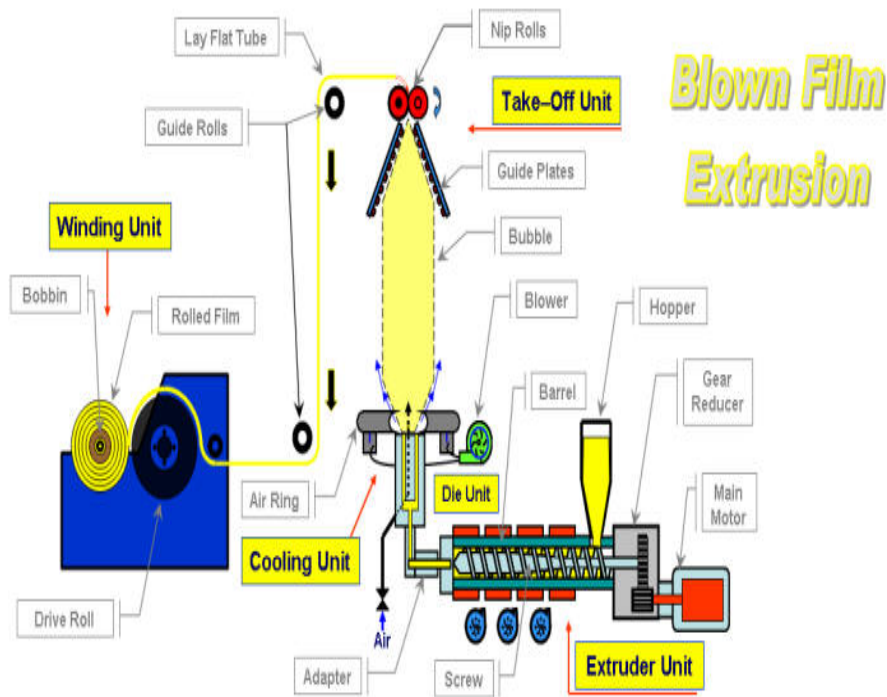


RECYCLING



- Technological film waste
- Lumps
- Packaging waste from our clients
- Used solvent distillation

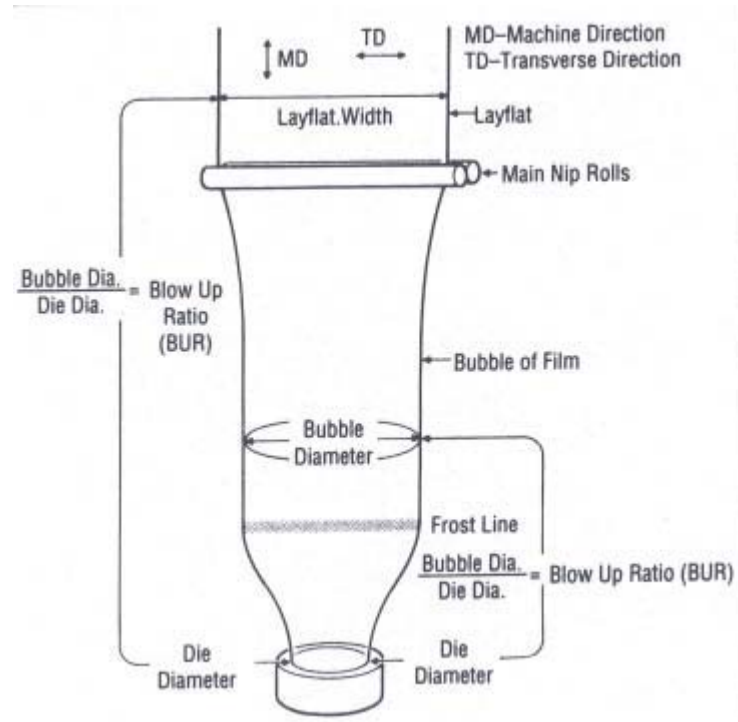
Extrusion process



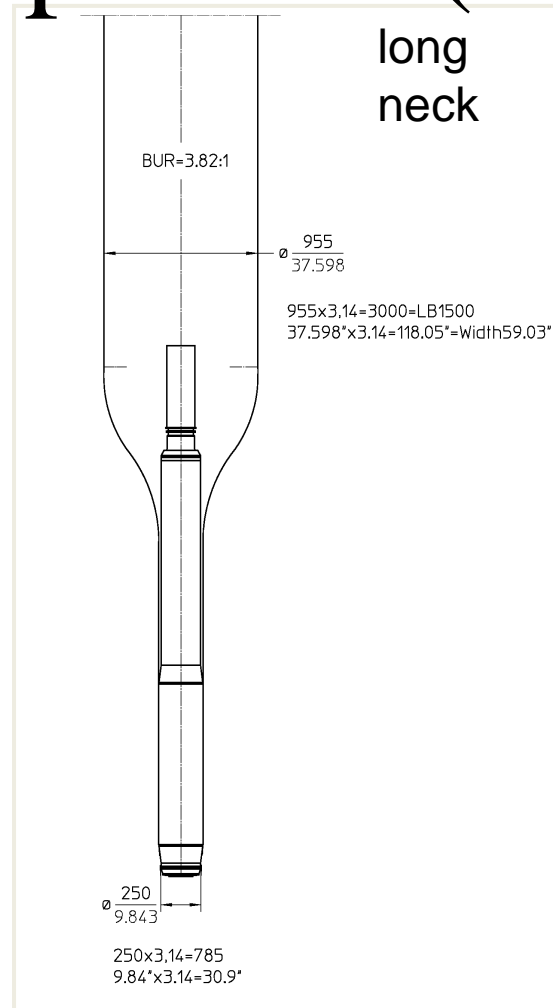
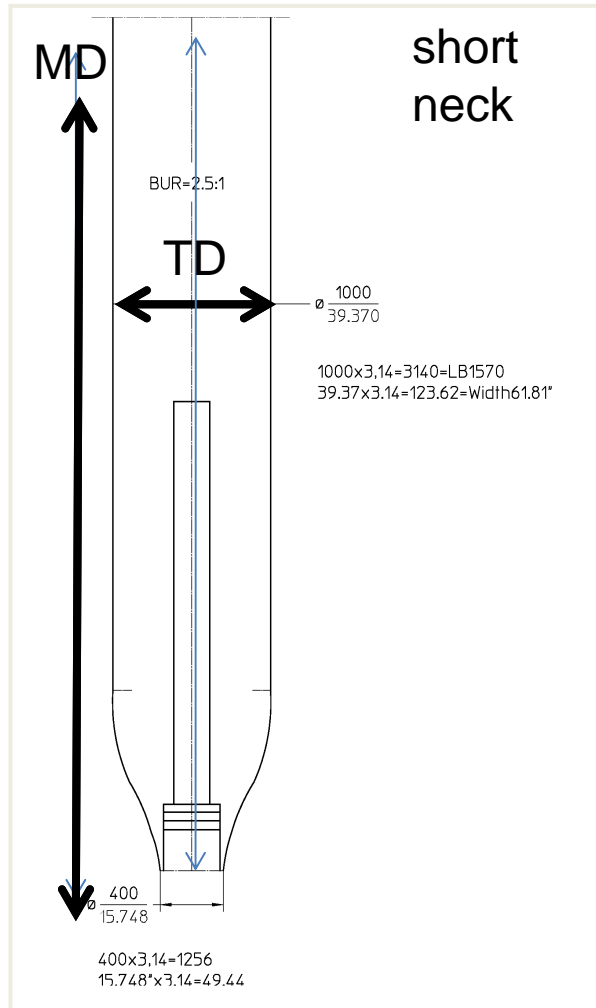
- Plastic melt is extruded through an annular slit die, vertically to form thin walled tube
- Air is introduced in the centre of the die to blow up the tube like a balloon (IBC)
- Air ring blows onto the hot film to cool it (outside and inside the tube)
- The tube passes through nip rolls where it is flattened
- Collapsed tube is taken back down the extrusion tower via more idler rollers
- On winder the tube or film is wound into rolls

Elements of blown film

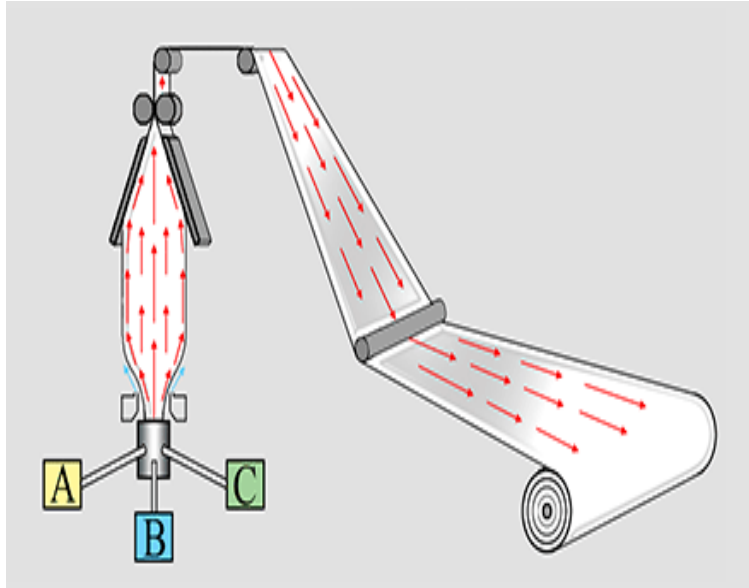
- Film thickness: 6 – 250 microns
- Layflat width: 600 – 4000mm
- Die diameter: 100 – 600mm
- Die gap: 0.8 – 2.8 mm
- Bubble diameter
- BUR (blow up ratio): 2 – 4.5
- DDR (draw down ratio) = gap width/thickness x BuR
- MD (machine direction)
- TD (transverse direction)
- L/D ratio of screw: 24, 30, 32



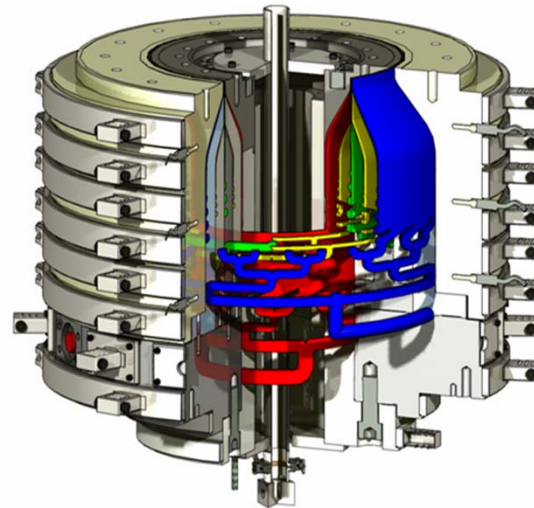
Blow-up Ratio (BUR)



Coextrusion of blown film



Coextrusion is the extrusion of multiple layers of material simultaneously. This type of extrusion utilizes two or more extruders to melt and deliver a steady volumetric throughput of different viscous plastics to a single extrusion head (die) which extrude the materials in the desired form. The layer thicknesses are controlled by the relative speeds and sizes of the individual extruders delivering the materials



Raw materials for blown film

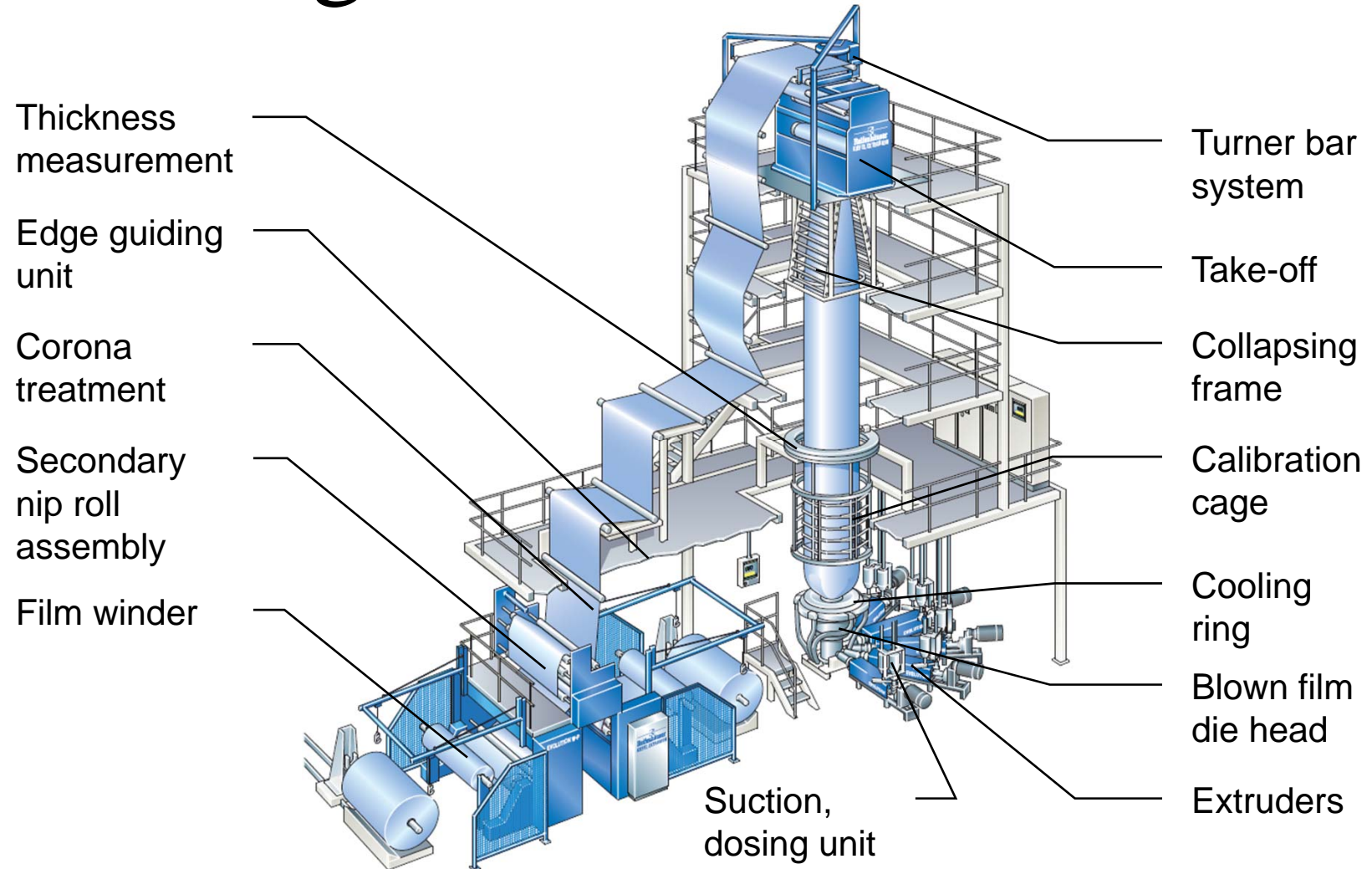
POLYOLEFINS, BARRIER MATERIALS, PLASTOMERS , IONOMERS, BIO MATERIALS

- LDPE
- LLDPE
- MDPE
- HDPE
- mLLDPE
- EVA
- COC
- HIPS
- Ionomer
- PP Copolymer
- PA6, CoPA
- EVOH
- PETG
- BIO materials (PLA, PHA...)

Additives for blown film

- Antioxidant
- Slip agent
- Antiblock
- UV stabilizer
- IR absorber
- Antistatic agent
- Processing aids
- Flame retardant
- Cleaning compound
- Antislip agent
- Blowing agent
- Oxo – degradable additive
- Colour masterbatches

Design of blown film line





**Suction and
conveying unit**

**Gravimetric
dosing unit**



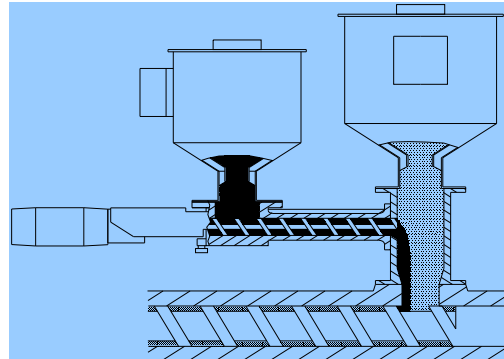
Dosing system Octagon GDS



Combining the well-proven throughput measurement and screw feeder units, the GDS system offers highest performance in gravimetric dosing and extruder control

Continuous dosing of additives directly at the material intake of the extruder ensuring:

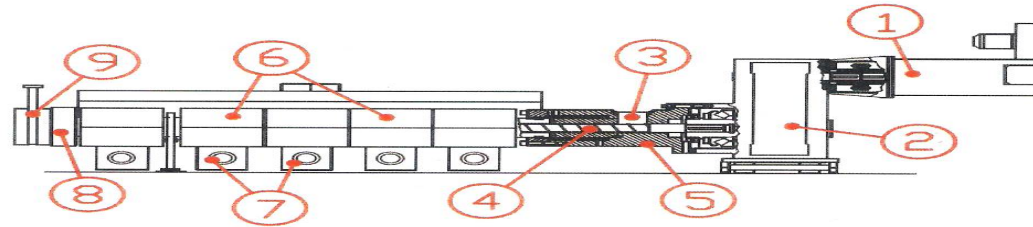
- **no loss of blend of components**
- **evenly distributed coloring**
- **highest blending accuracy**



Dosing page example

		MC	Ad1					
Prop.	Act. Set		0,0	0,0	0,0	0,0	%	Dosing Exterior on
			0,0	0,0	0,0	0,0	%	
Density		0,945	0,935	0,000	0,000	0,000	g/ccm	
Throughput		31,7	0,0	0,0	0,0	0,0	kg/h	
Tolerance	Act. Set		0,0	0,0	0,0	0,0	kg/h	
			0,5	0,0	0,0	0,0	kg/h	
Prop.	Act. Set		15,2	0,0	0,0	0,0	%	Centre on
			15,0	0,0	0,0	0,0	%	
Density		0,945	1,300	0,000	0,000	0,000	g/ccm	
Throughput		35,5	6,4	0,0	0,0	0,0	kg/h	
Tolerance	Act. Set		0,1	0,0	0,0	0,0	kg/h	
			0,0	0,0	0,0	0,0	kg/h	
Prop.	Act. Set		24,8	0,0	0,0	0,0	%	Inside on
			25,0	0,0	0,0	0,0	%	
Density		0,945	0,935	0,000	0,000	0,000	g/ccm	
Throughput		16,8	5,4	0,0	0,0	0,0	kg/h	
Tolerance	Act. Set		0,1	0,0	0,0	0,0	kg/h	
			0,5	0,0	0,0	0,0	kg/h	

Components of the extruder



Ref.	Component
1	Screw drive motor
2	Screw drive gear reducer
3	Granule feed throat
4	Extrusion screw
5	Extrusion barrel
6	Thermoregulation insulating zones
7	Cooling fans
8	Connection flange to the screen changer
9	Screen changer assembly

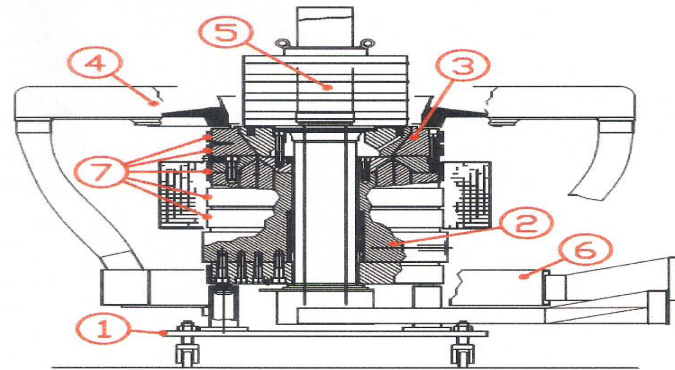


**Frequency controlled AC
motors as standard
extruder drive**

**Extruders, head and operator
panel on 3-layer coex line**

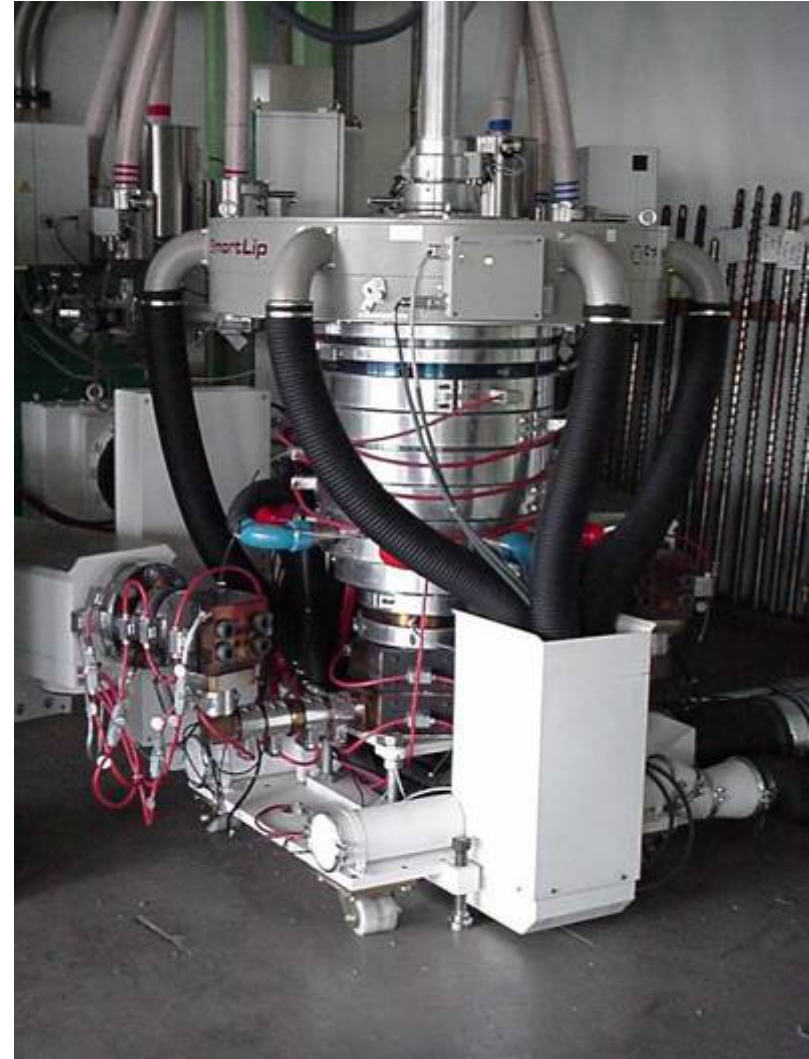
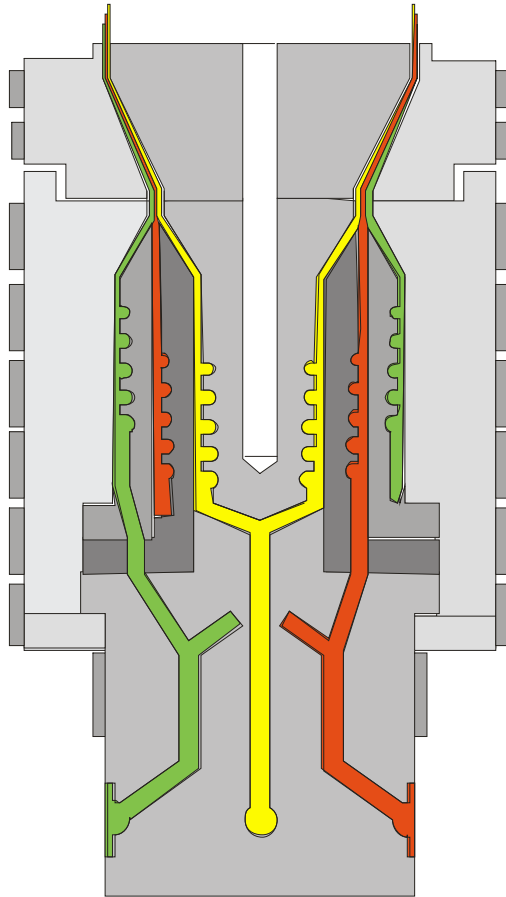


Components of blowing head

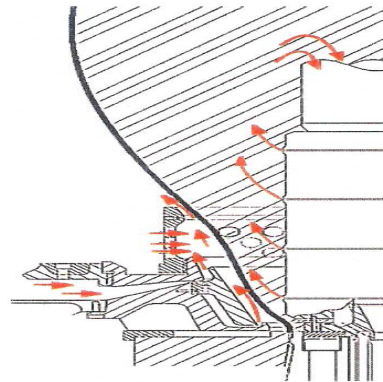


Ref.	Component
1	Trolley with wheels
2	Die body (head)
3	Die
4	Cooling ring
5	IBC system
6	Plenum
7	Circular heating elements

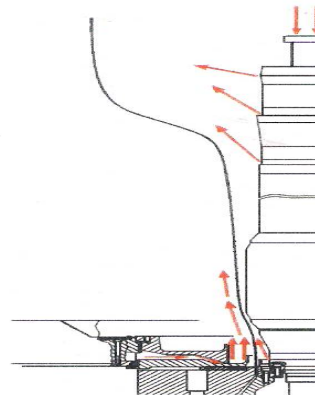
3-layer coextrusion head with cooling ring



Film bubble cooling

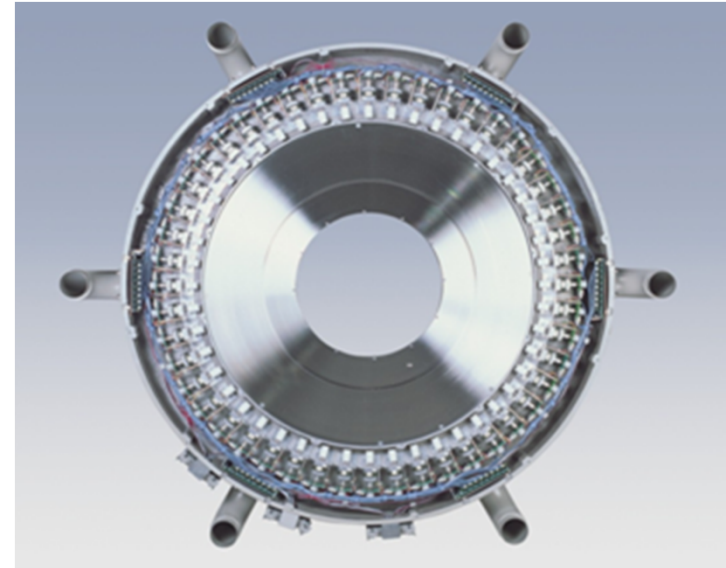


Film bubble cooling and inflating air flows

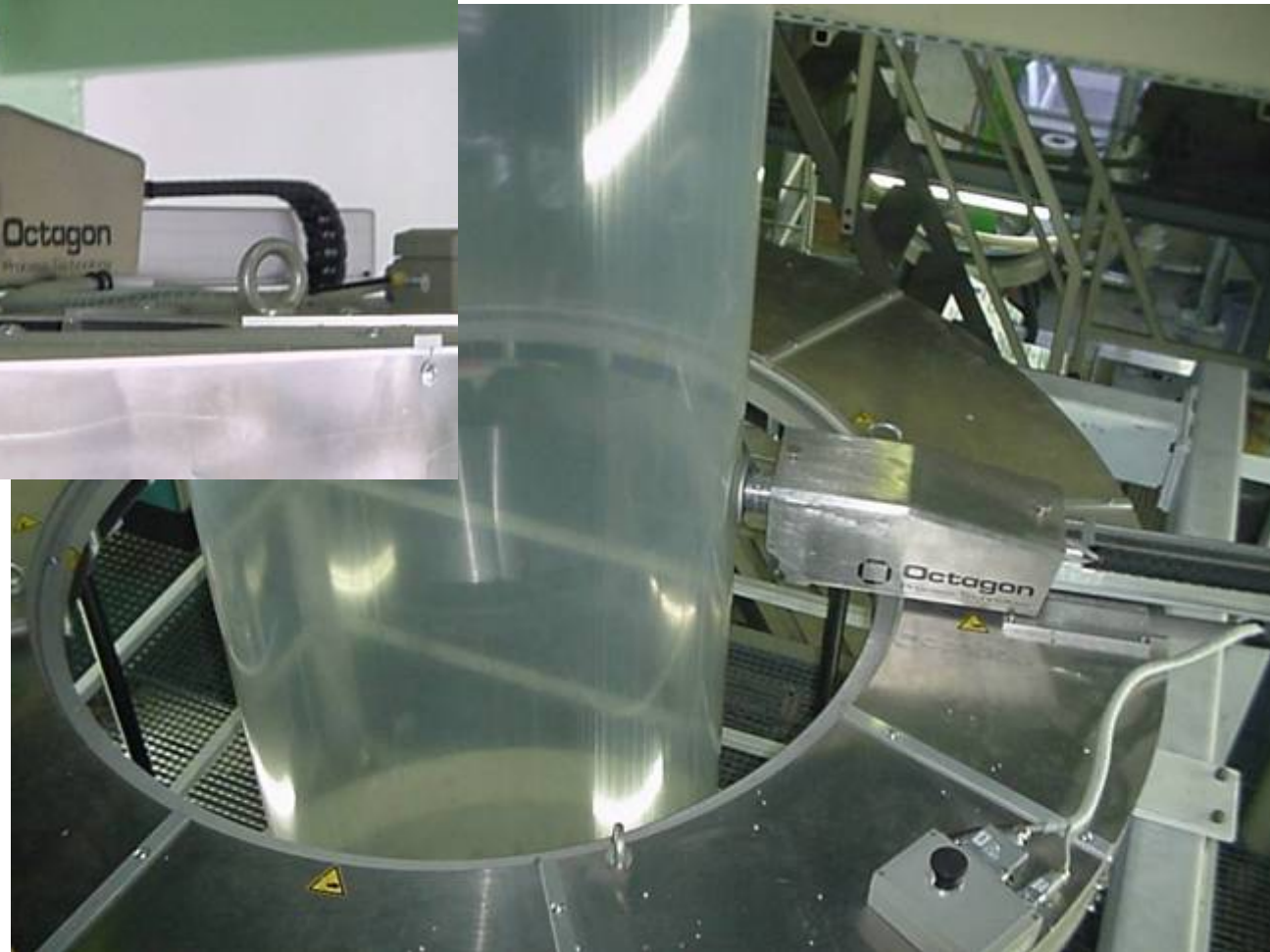


Film bubble cooling and inflating single air flows

Double lip cooling ring including thickness control



Film thickness measurement unit - capacitive sensor reversing around the bubble



IBC equipment

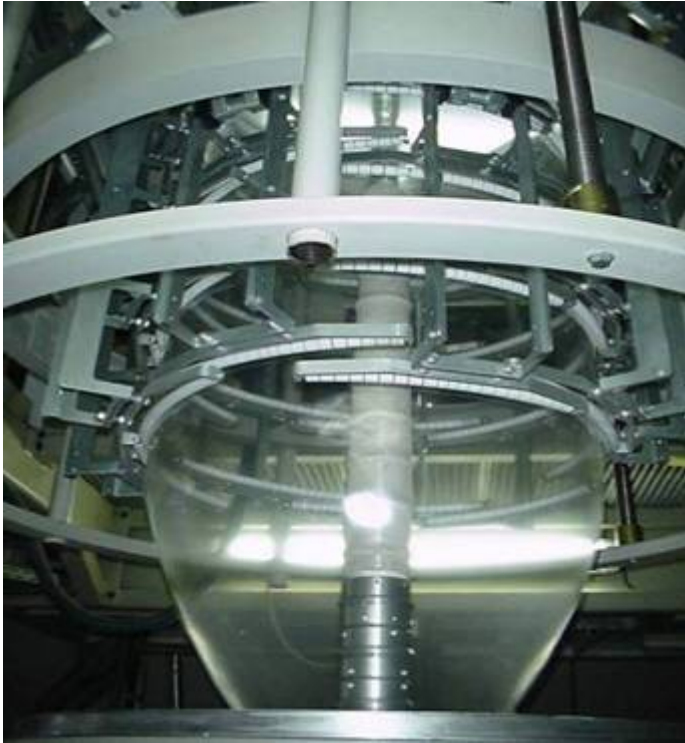


Heat exchangers for air cooling



IBC fans controlled via frequency converters

Calibration cage



- Ultrasonic sensor for IBC control

Combined layflat device with CFK (and felt) + wooden slats and side gusseting tools up to the centre, all movements are motorized



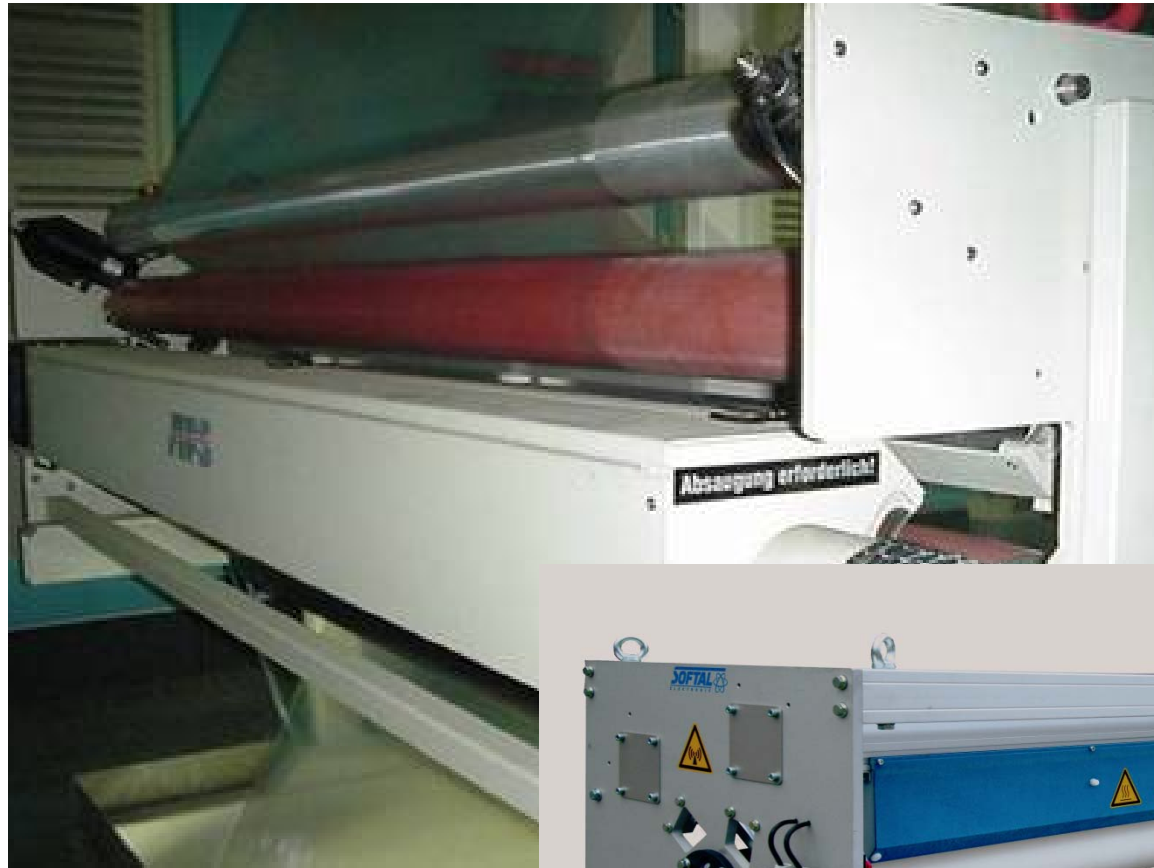
Reversing haul off system



Horizontal
take off system



Turner Bar



Corona treatment device

Film edge guiding device



Operator panel



Processing data

11:33 18.06.04

Line on

Haul-off 10,2 m/min
W/m 154,6 g/m

Gauge
Total 149,7 µm
Exterior 50,1 µm
Centre 64,1 µm
Inside 35,5 µm

Tol. profile 6,0 (2-S)%

Width 535 mm
Gussets 0 mm
Edge left 0,0 mm
right 0,0 mm
max 0,0 mm

Blow up ratio 1,9
Length stretching 8,1

Pressure -99 mbar
Temperature -99 °C
Die 175 mm
Gap 2,3 mm

Throughput 95,0 kg/h

Order: 1 Formula: 1 **Octagon**

Section	1	2	3	4	%	kg/h	rpm
Exterior	0,0	0,0	0,0	0,0	0,0 %	0,0	0,0
	0,0	0,0	31,2	0,0	0,0	31,2	55,3
	0,0	0,0	0,0	0,0	0,0	0,0	0,565
Centre	15,4	0,0	0,0	0,0	0,0 %	0,0	0,0
	6,4	0,0	35,2	0,0	0,0	41,6	96,4
	185,6	0,0	0,0	0,0	0,0	0,431	0,431
Inside	24,9	0,0	0,0	0,0	0,0 %	0,0	0,0
	5,4	0,0	16,6	0,0	0,0	22,0	46,2
	134,1	0,0	0,0	0,0	0,0	0,477	0,477

Measure

Profile on

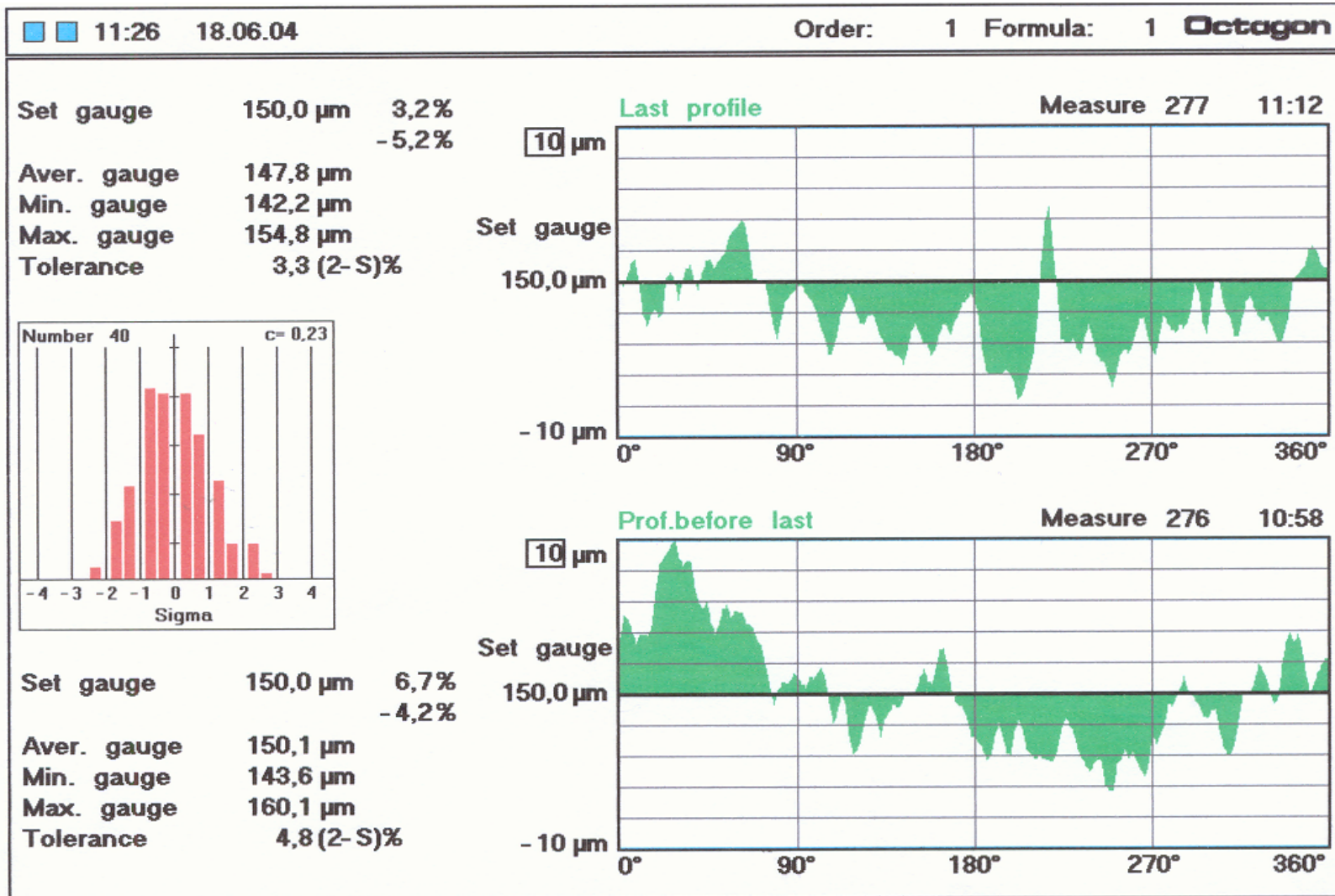
Width off

Edge off

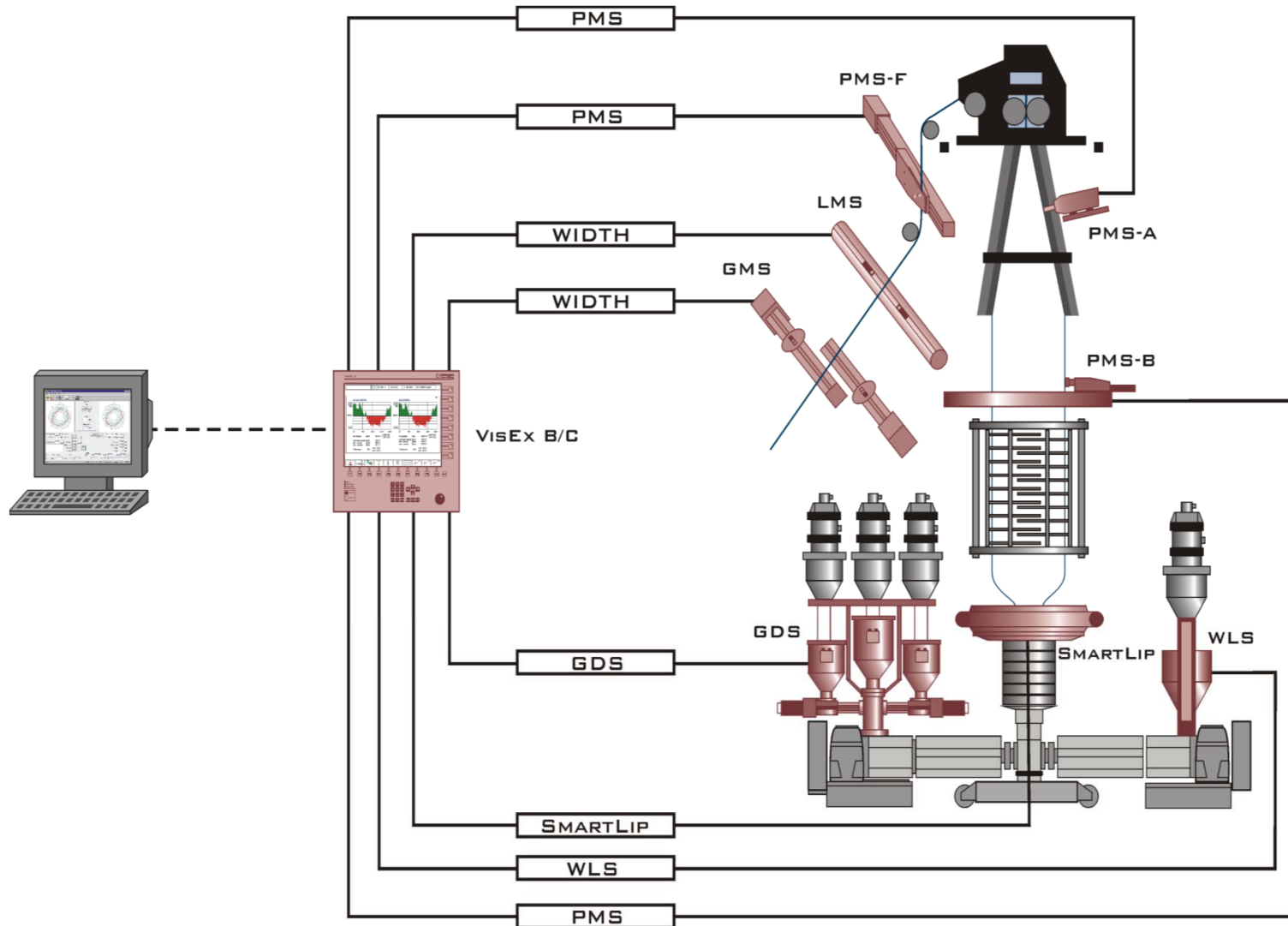
SmartLip off

Reset off

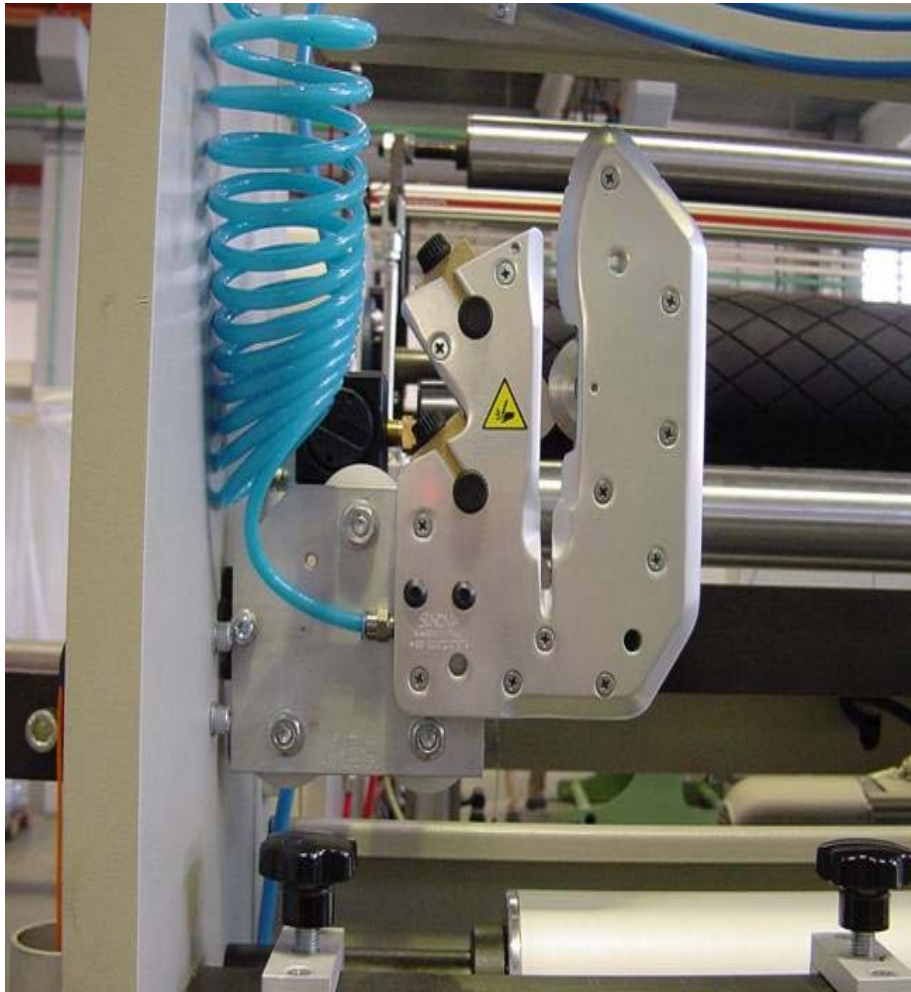
Profile page example



Blowing film control concept



Film cutting

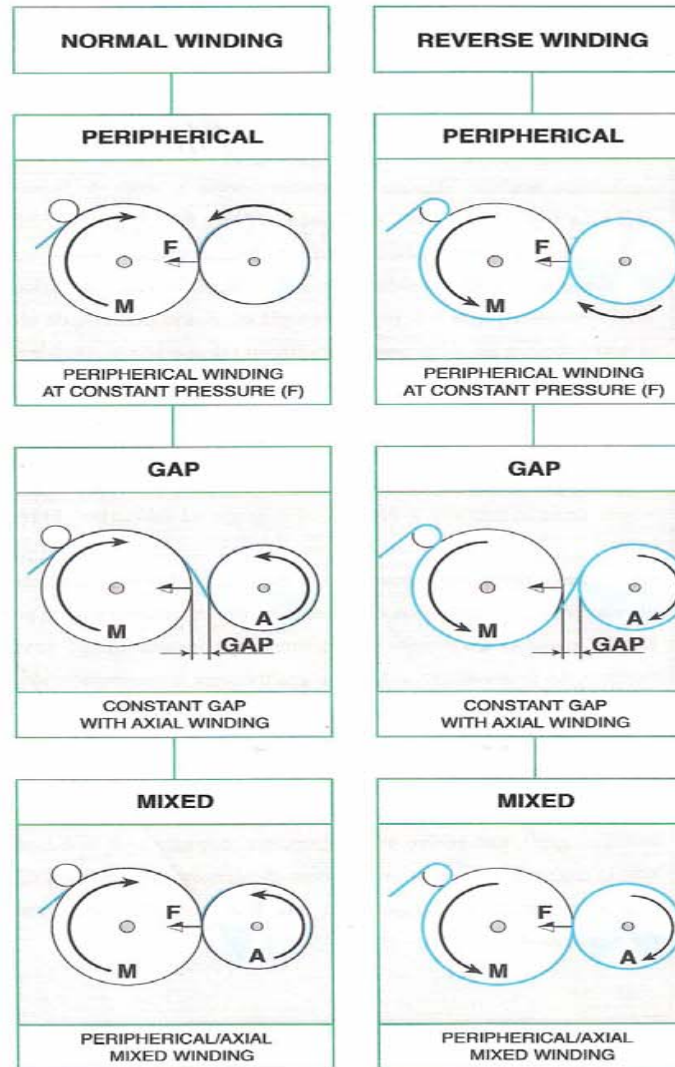


Lateral cutter

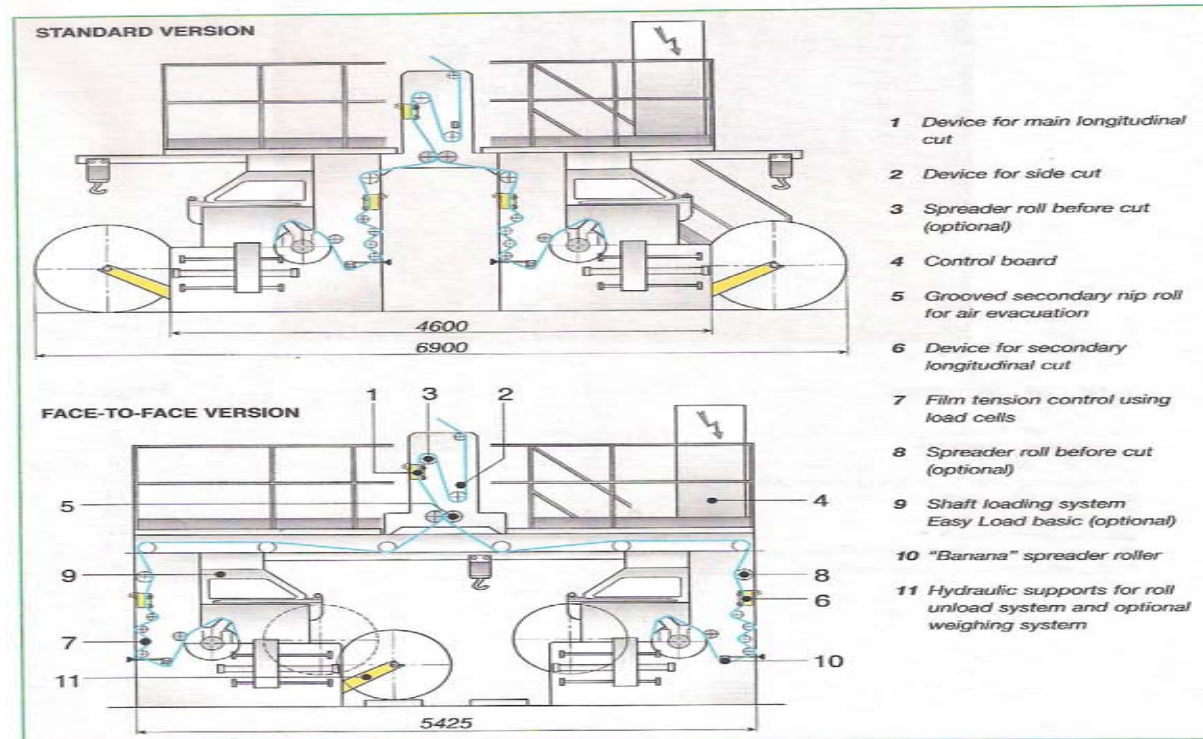


Central knives

Principles of film winding



Versions of winders

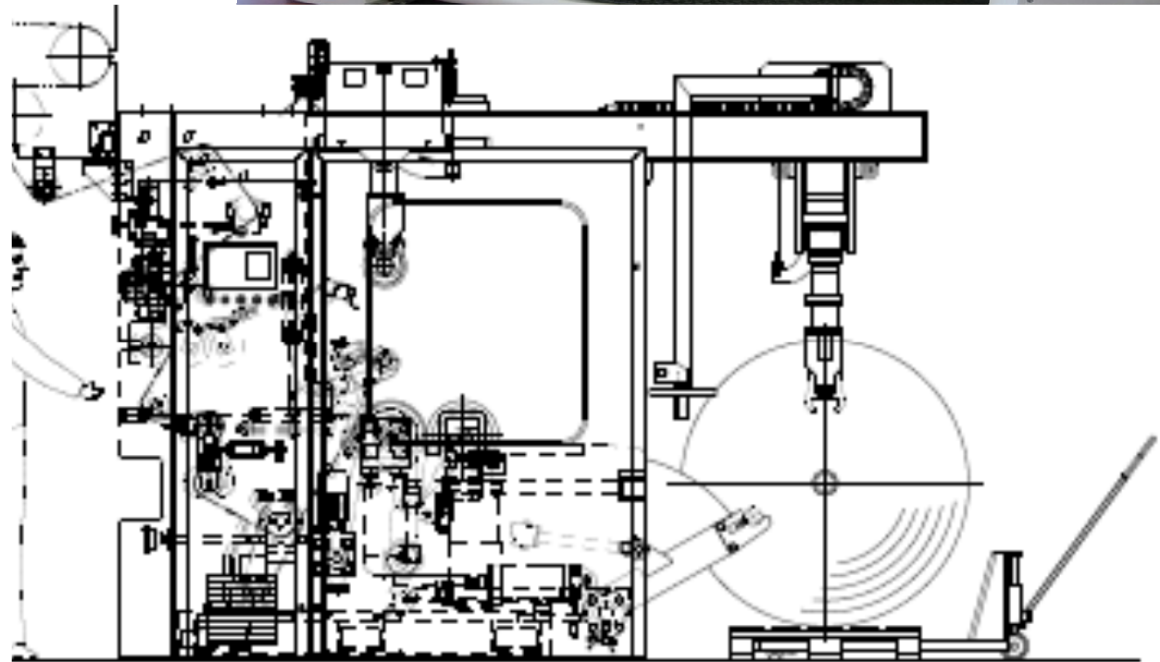


Automatic contact surface winder



Central – contact winder

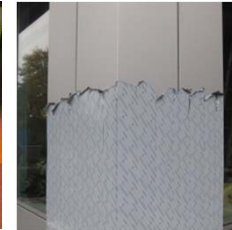
- Nip roller in the winder with dancer
- Lay on roller STS spiral grooved
- 5 knives with oscillation
- Driven cord spreader roller
- WWH winding shaft handling / gripper
- Winding shaft pre-acceleration



Blown Film Applications

Focused key application areas:

- General Packaging films
- Lamination films
- Surface Protection films
- Barrier films for food packaging
- Agricultural films
 - Greenhouse films
 - Mulch
 - Silage sheeting
 - Silage stretch
- FFS – Heavy Duty Shipping Sacks



Blown film requirements

- **Thickness tolerances**
→ influenced by temperature profile during production process
- **Width tolerances**
→ influenced by air volume stability
- **Mechanical properties**
→ influenced by orientation of molecular structure during production process (blow-up ratio of film bubble) and raw material type / material combination
- **Optical properties**
→ influenced by raw material type and melt quality in extruder
- **Film planarity / free of wrinkles**
→ influenced by collapsing process → change from round to flat shape

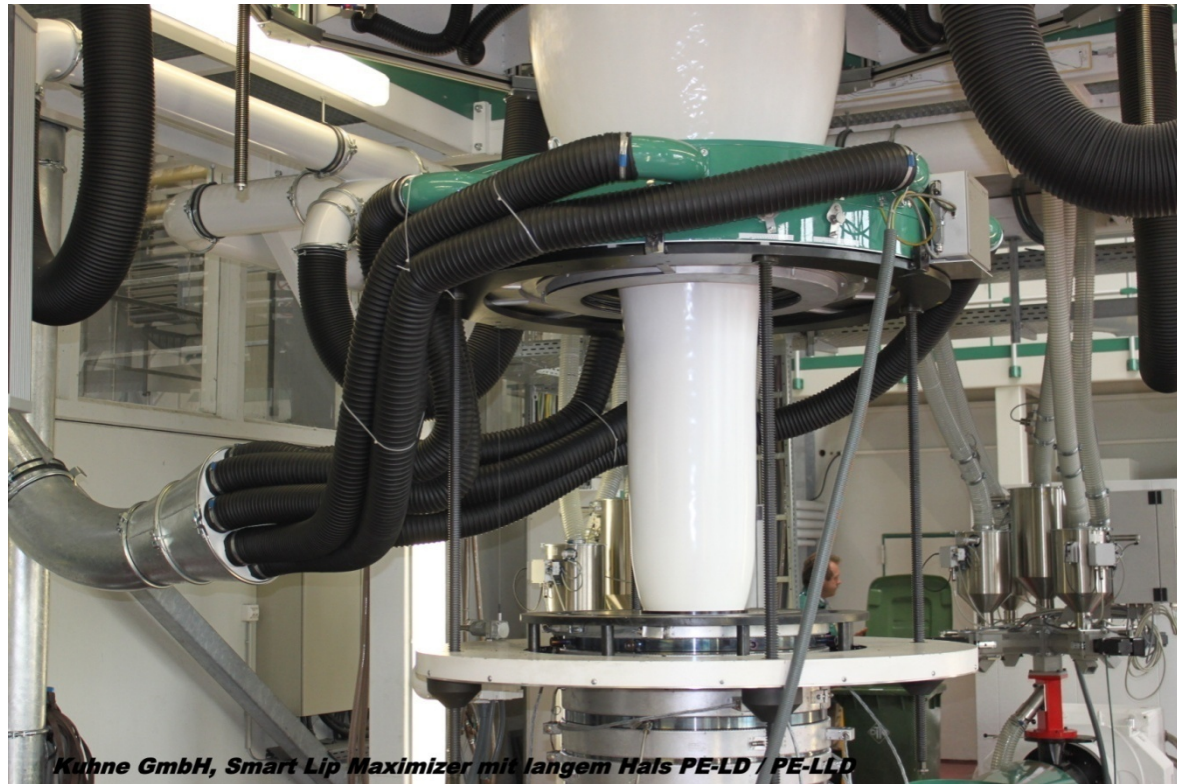


How to achieve film requirements?

- **Thickness tolerances**
 - profile control system
- **Width tolerances**
 - precise and fast ultra sonic bubble control system (USB)
- **Mechanical properties**
 - smart recipe design
 - selection of blow-up ratio
- **Optical properties**
 - smart recipe design
 - homogeneous melt quality trough optimized screw design
- **Film planarity / free of wrinkles**
 - smooth collapsing process trough film haul-off
 - constant winding tension/pressure

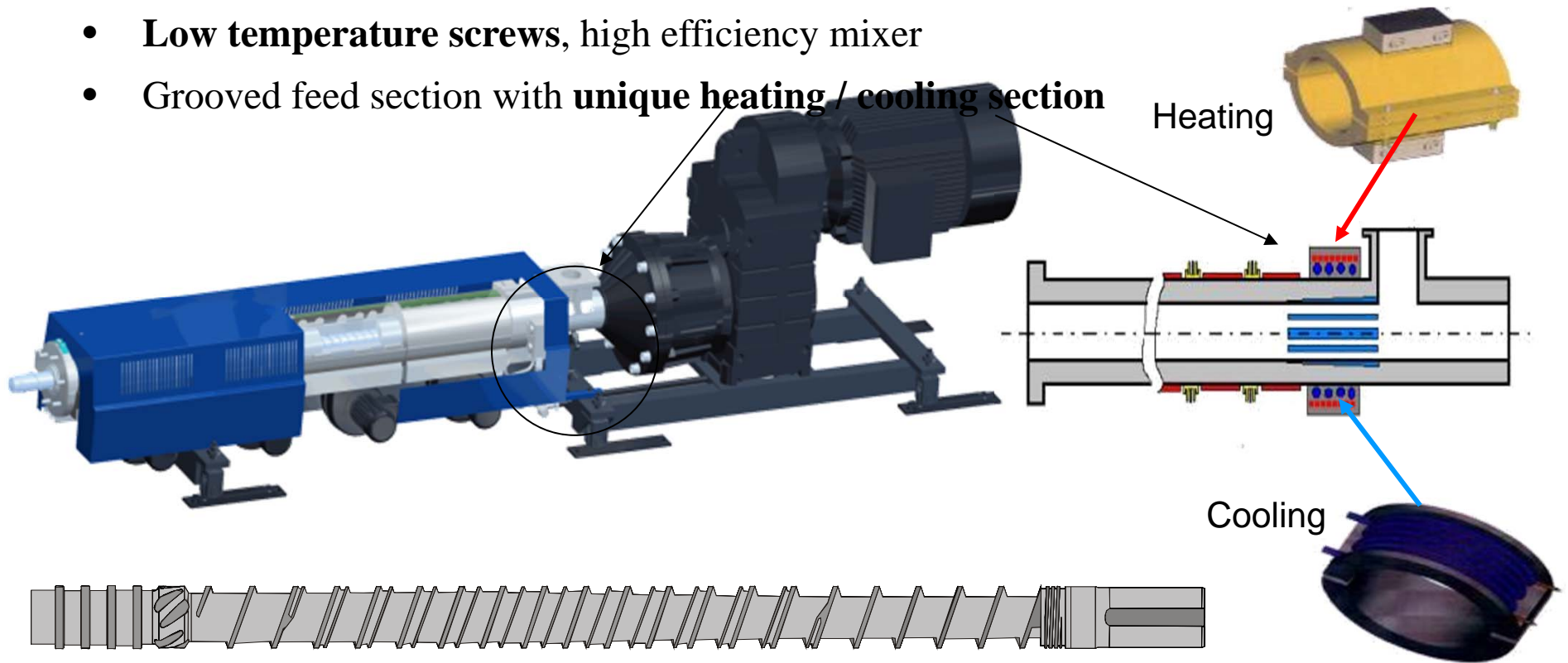


Smart lip maximizer long neck for enhanced mechanical properties = down gauging



Screw and cylinder design

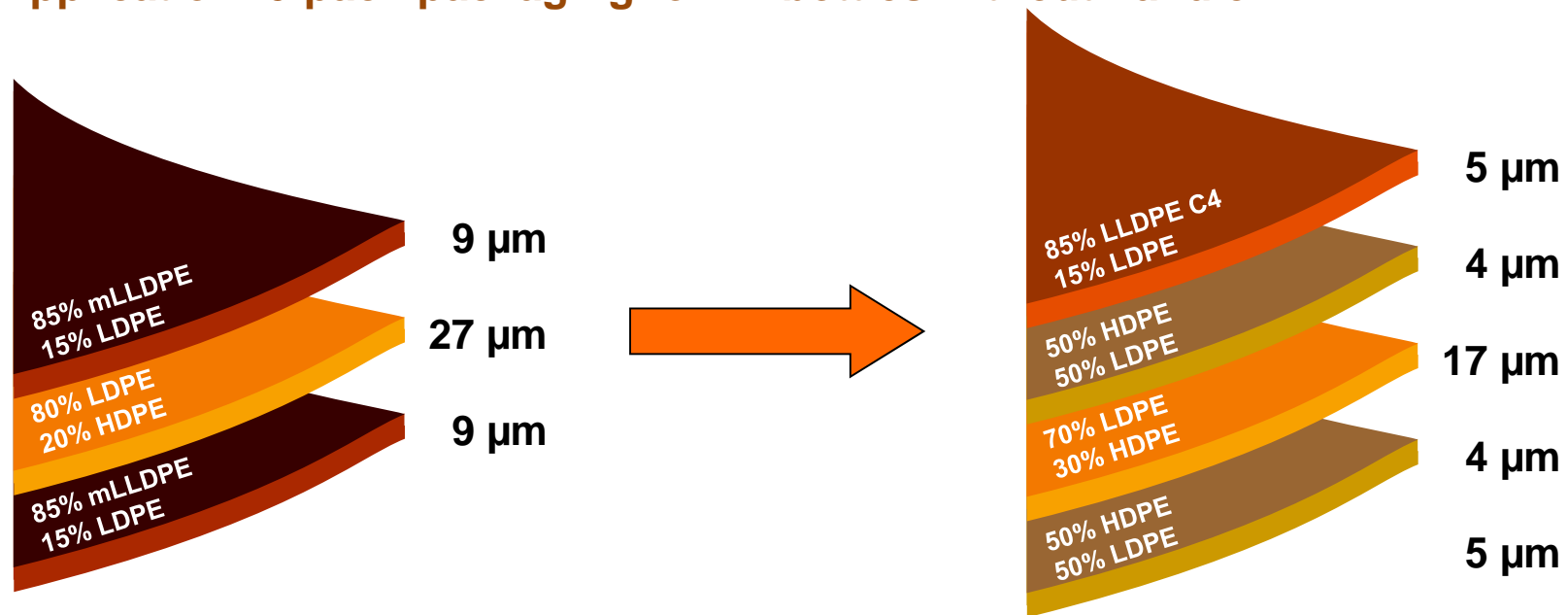
- L/D ratio (24, 30, 32)
- Screw design for processing all PE types, PP, mLLDPE, **and** PA, EVOH, K-resin, PETG without screw-change
- **Low temperature screws**, high efficiency mixer
- Grooved feed section with **unique heating / cooling section**



Collation shrink film structure

Development target: down gauging from 45 μm to 35 μm with same properties

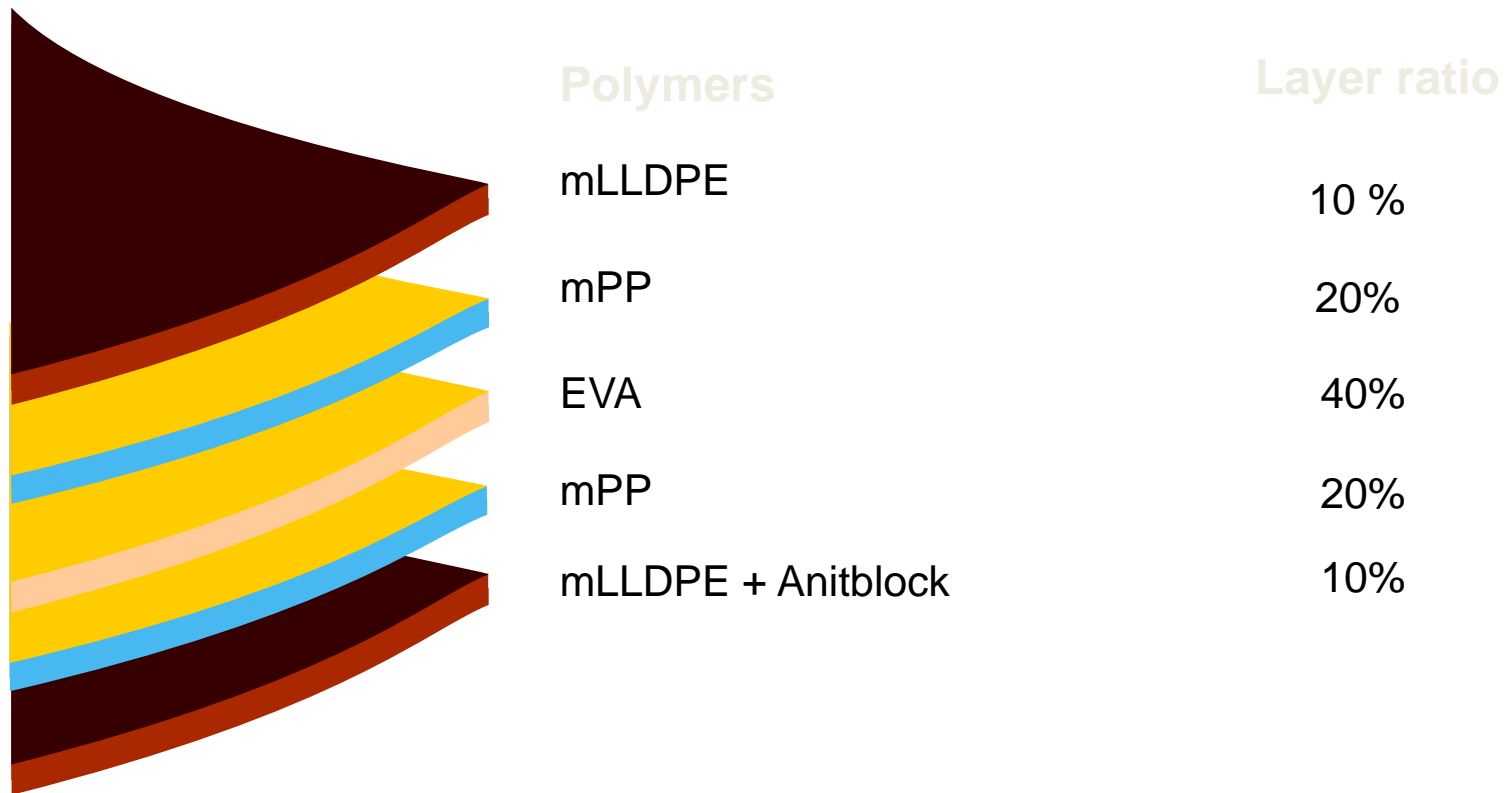
Application: 6-pack packaging for 2L bottles without handle



Stretch hood film structure

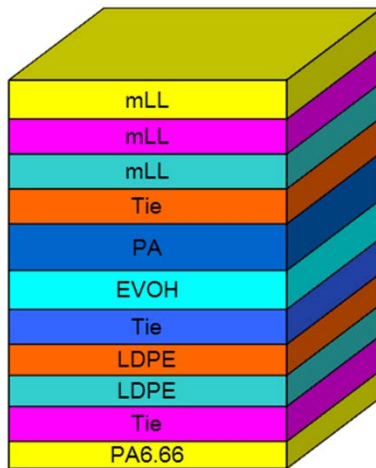
Development target: reduction of EVA content with same properties

Application: stretch hood for Euro-Pallets

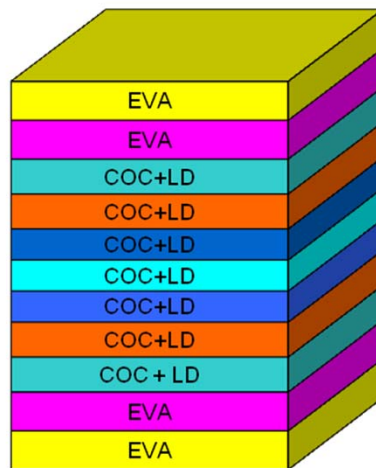
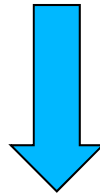


New products and new possibilities

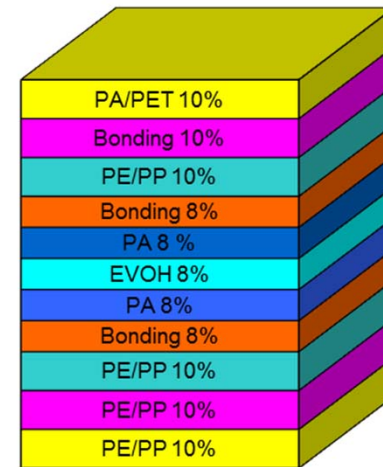
Asymetric structures



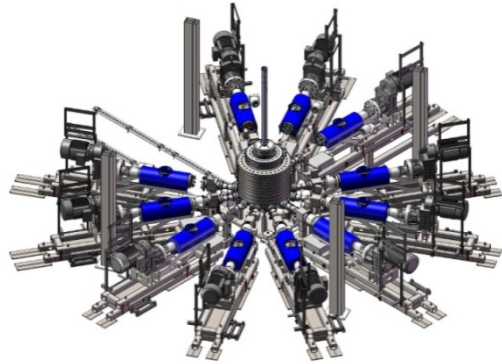
COC rich structures



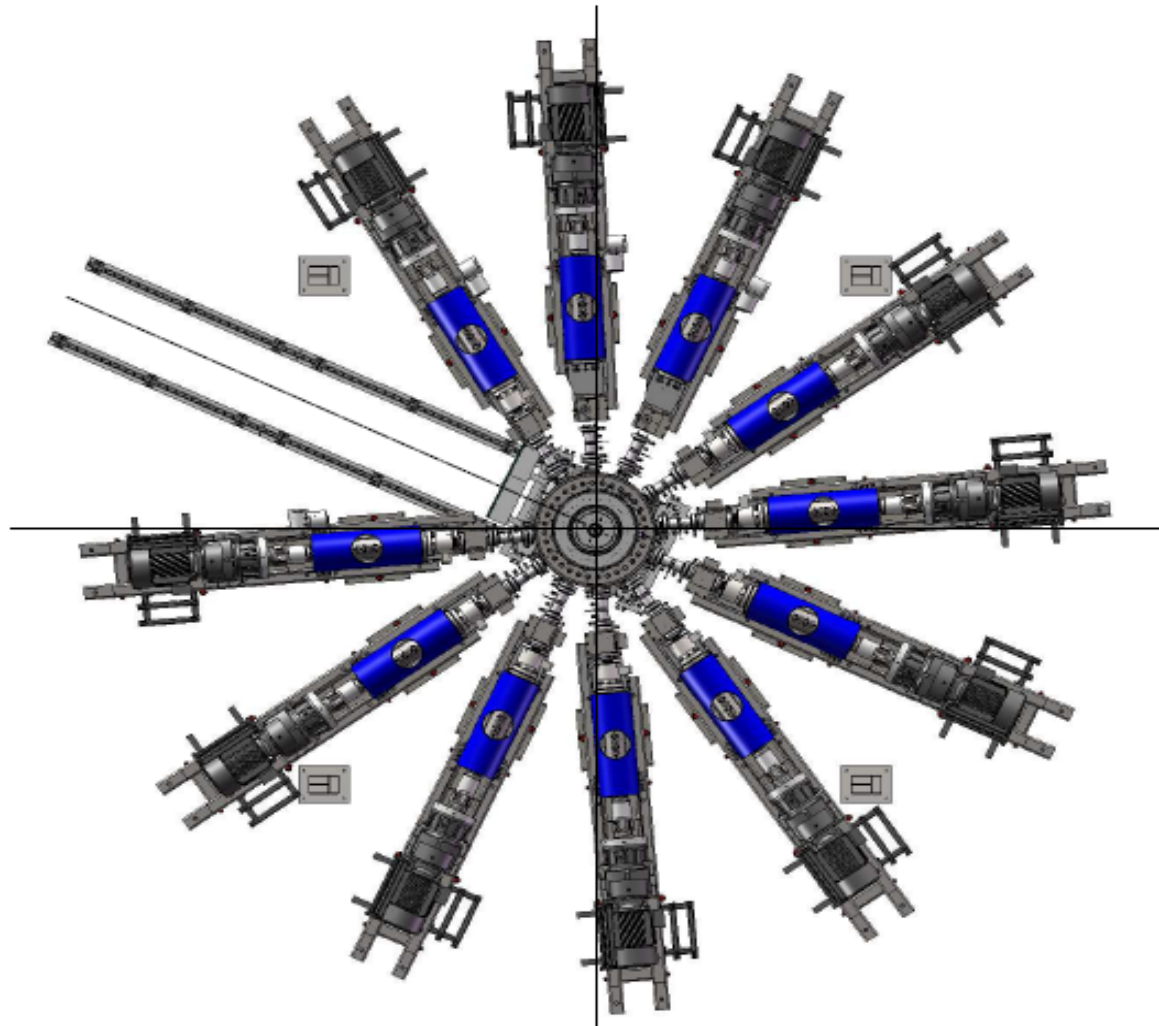
PET outer layer



Extruders configuration – 11 layers



Extruder K 60-24D with melt pumps for a perfect melt quality and no pressure variation!



Blown film line - Recent Trends

- Increasing number of multi-layer lines
→ 5-, 7-, 9- and 11-layers
- Transfer of traditional
3-layer films to
5-layer structures
- Increasing number of films
with **barrier** properties
- Increasing number of high
quality / technical films



THANK YOU FOR
YOUR ATTENTION !