KUHNE | NORTH AMERICA

Extrusion Beyond Your Imagination

In-Line-Extrusion today

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In-Line-Extrusion

The world has changed!

- 70% of extrusion lines manufactured by Kuhne are used for in-line extrusion!
- A lot of converters dont get huge „long term contracts“ anymore.
  - Smaller quantities of different products have to be manufactured.
  - „Just in Time“ supply with smaller but dedicated lines.
  - A lot of companies try to step back from roll stock warehousing due to uncertain buying behaviours.
- Shipping became more expensive and prices volutile. De-centalized manufacturing is growing!
- It is difficult to find good skilled operators in most regions. Smaller machinery has less barriers and risks.
- Process controllability became more important to have repeatable processes and a consistant product quality.
- Sustainable processing is key to success!
  - Energy consumption | Energy recovery
  - Less raw material consumption | High amounts of PCR
  - Quick changeovers

In-Line-Extrusion

What is important to keep in mind?:

- Advatages:
  - Faster cycle times due to sheet temperatures above usuall temperatures.
  - Thermoforming above cristalization point provides better quality control on some raw materials.
  - The line footprint is small and highest yield rates can be achieved with smart set-ups.
  - Better quality control on final products due to elimination of roll warehousing.
  - Higher energy efficiency compare to off-line extrusion.
  - Thermoformer is the MASTER! The extrusion line follows using loop control mechanisms.
  - No edge cut = Less waste/regrind

- Raw Material:
  - PP & PS is standard
  - Lots of requests nowadays for PET & PE (different roll stacks & other motor concepts)

In-Line-Extrusion

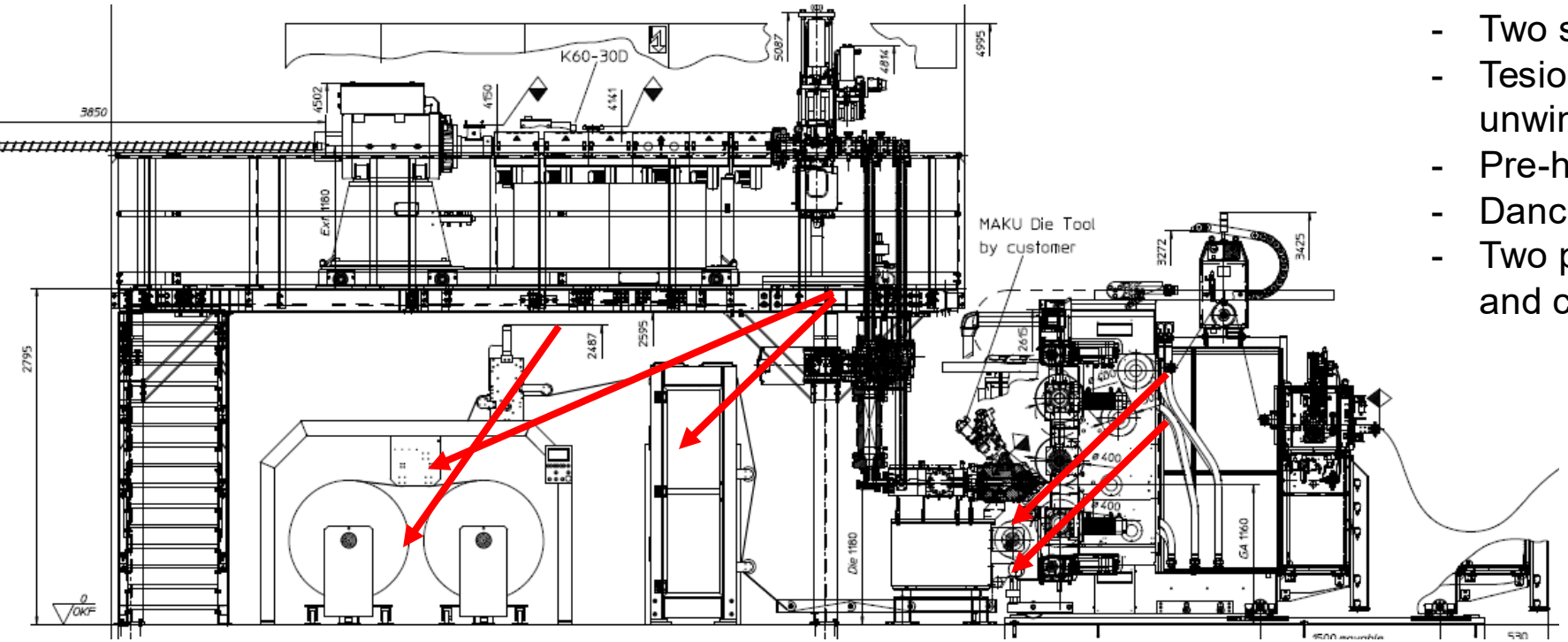
Technical framework:

- Sheet Width → Usually around 700 to 840 mm, wider usually only for the US
- Sheet Thickness → 200 µm to 3,5 mm
- Set-up today:
  - Small roll diameters | US grades often need bigger roll diameters
  - Haul-Off-Unit as close to the roll stack as possible
  - Sheet thicker 1,5 mm needs post cooling rolls
  - Optional heat tunnel between roll stack and thermoformer improves temperature variation on sheet
  - Line speeds of up to 1.600 Kg/h → Much higher than 10 years ago!

Set-Ups

A/B/A PP Extrusion line with In-Line-Concept with in-line lamination of COEX7 film.

All adjustable from HMI and linked to recipe storage!

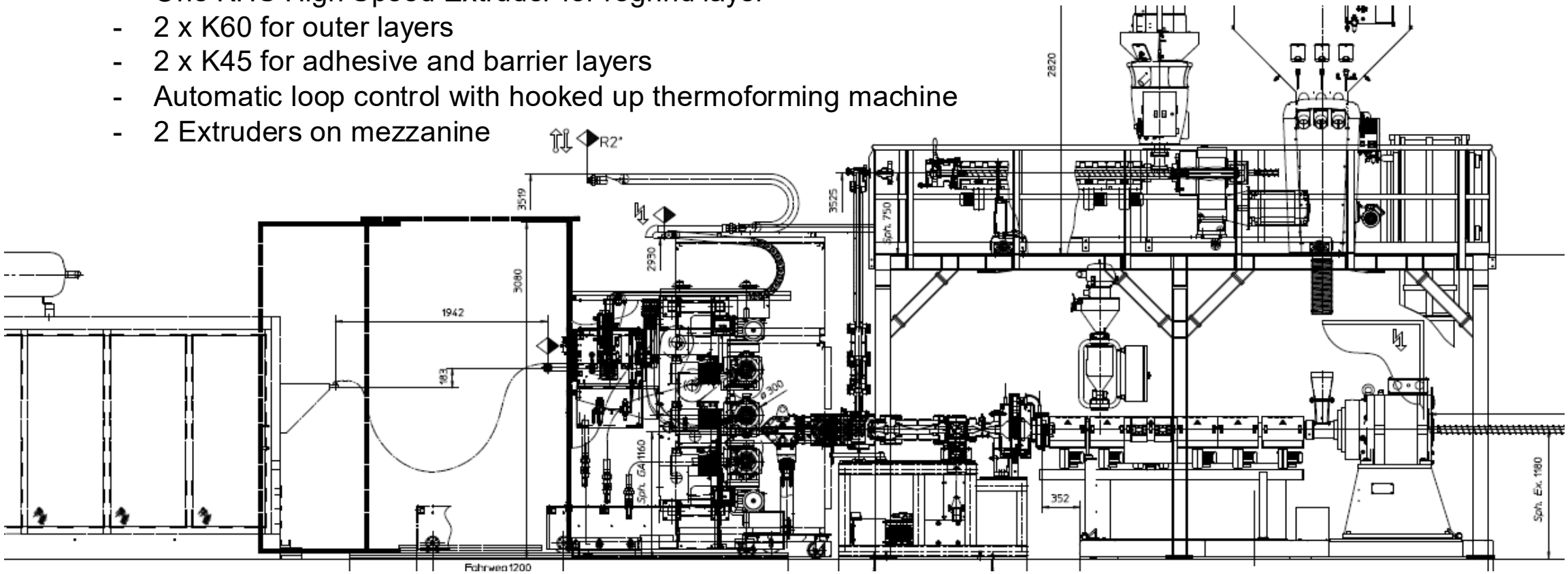


- Two KHS High Speed Extruders on mezzanine
- Two station unwinder below mezzanine
- Tesion control loop for barrier film from unwinder
- Pre-heating roll for barrier film
- Dancer and automatic splicing
- Two post cooling rolls, individually driven and cooled

Set-Ups

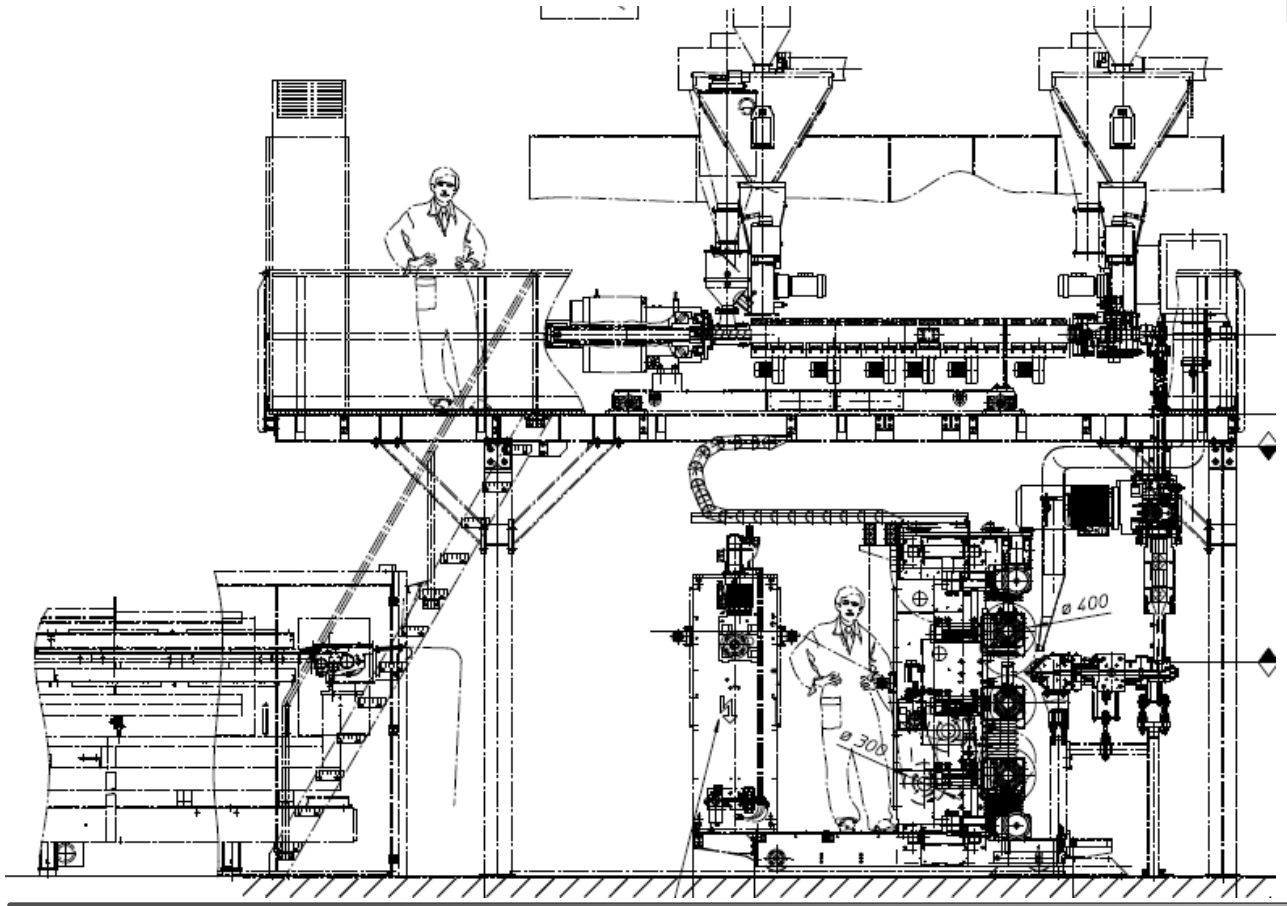
COEX7 PP Extrusion line with In-Line-Concept for better layer distribution during thermoforming

- One KHS High Speed Extruder for regrind layer
- 2 x K60 for outer layers
- 2 x K45 for adhesive and barrier layers
- Automatic loop control with hooked up thermoforming machine
- 2 Extruders on mezzanine



In-Line-Extrusion today

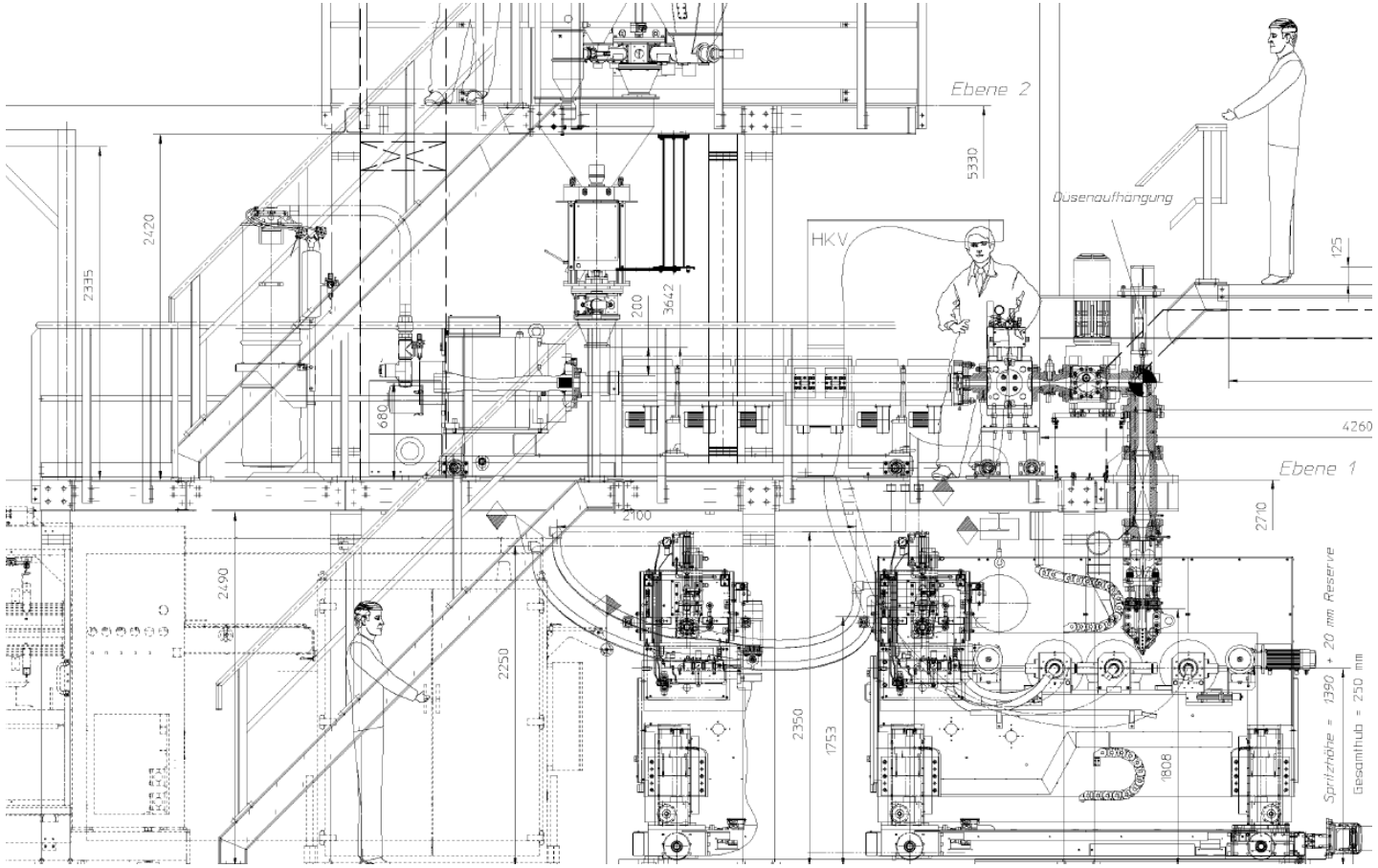
Set-Ups



COEX7 PP Extrusion line with In-Line-Concept for better layer distribution during thermoforming

- Platform above thermoformin machine for smaller machine footprint
- One KHS High Speed Extruder for regrind layer
- 2 x K60 for outer layers
- 2 x K45 for adhesive and barrier layers
- Automatic loop control with hooked up thermoforming machine

Set-Ups

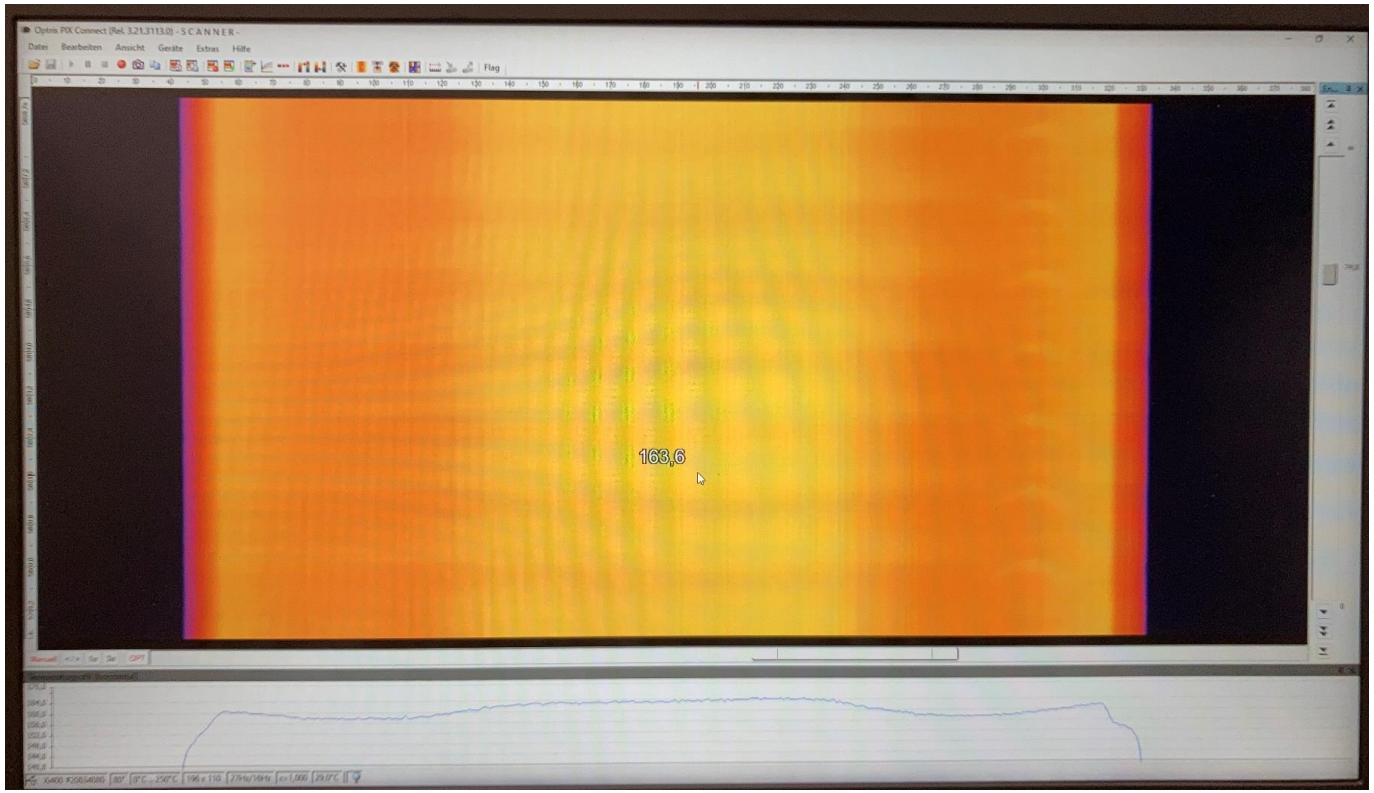


A/B/A PET Extrusion line with In-Line-Concept

- Platform above thermoformin machine for vertical extrusion
- 1 x K70 for outer layers
- 1 x K90 for main layer
- Automatic loop control with hooked up thermoforming machine
- Infra-Red Dryer from Kreyenborg
- Double venting on each extruder with Edwards Vacuum Pump
- Nordson Back-Flush Screen Changers

Heat Inspection

Temperature profile gives a good indication on thickness and melt bank adjustment.



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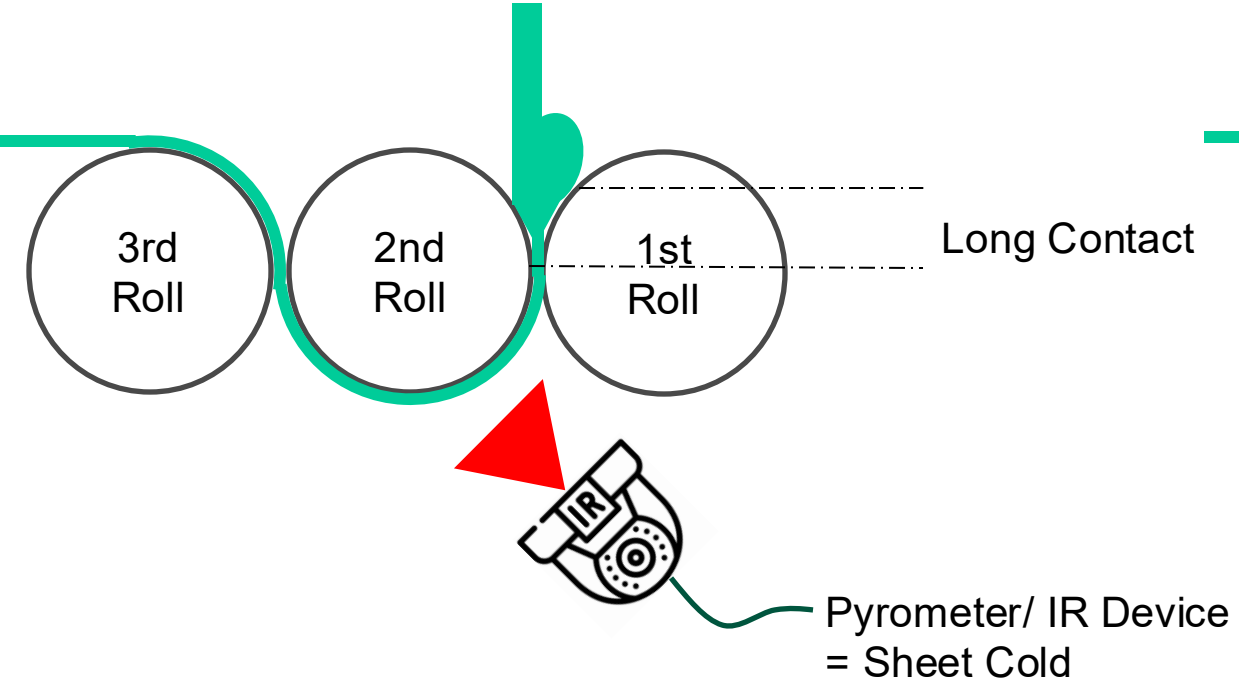
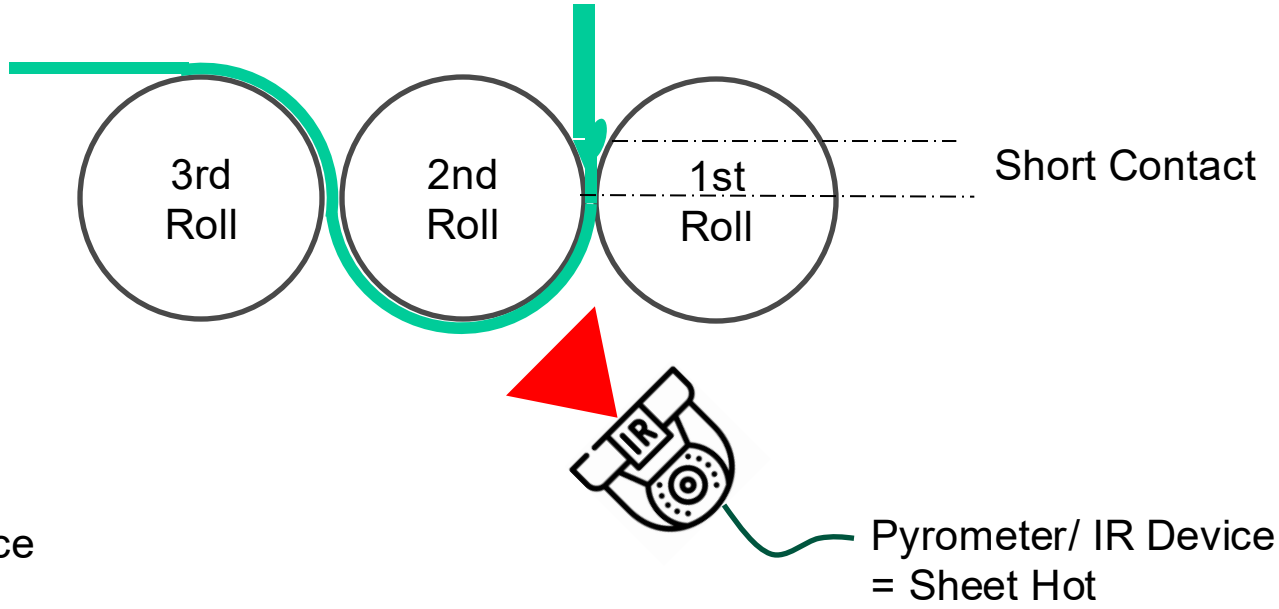
Heat Inspection

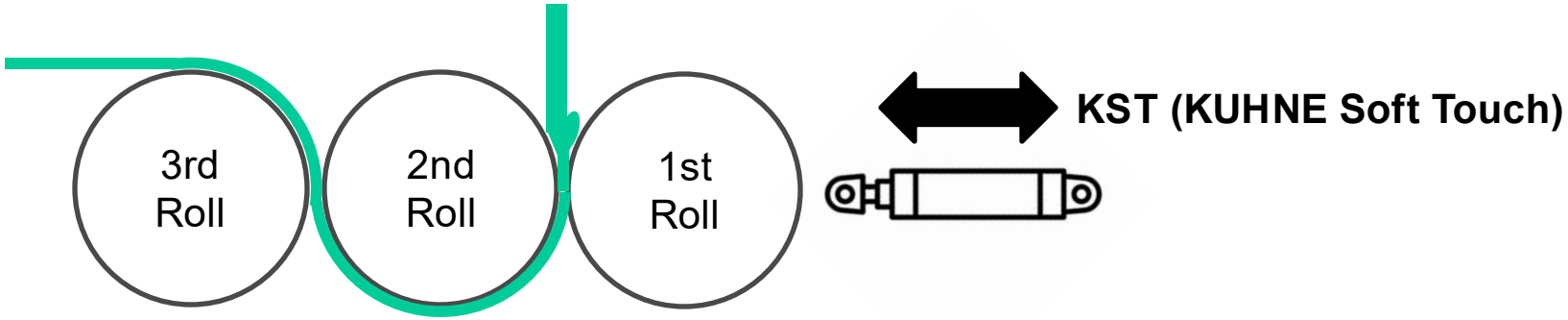
The horizontal roll stack set up is a game changer as we can control the melt bank more precise!





Soft Touch

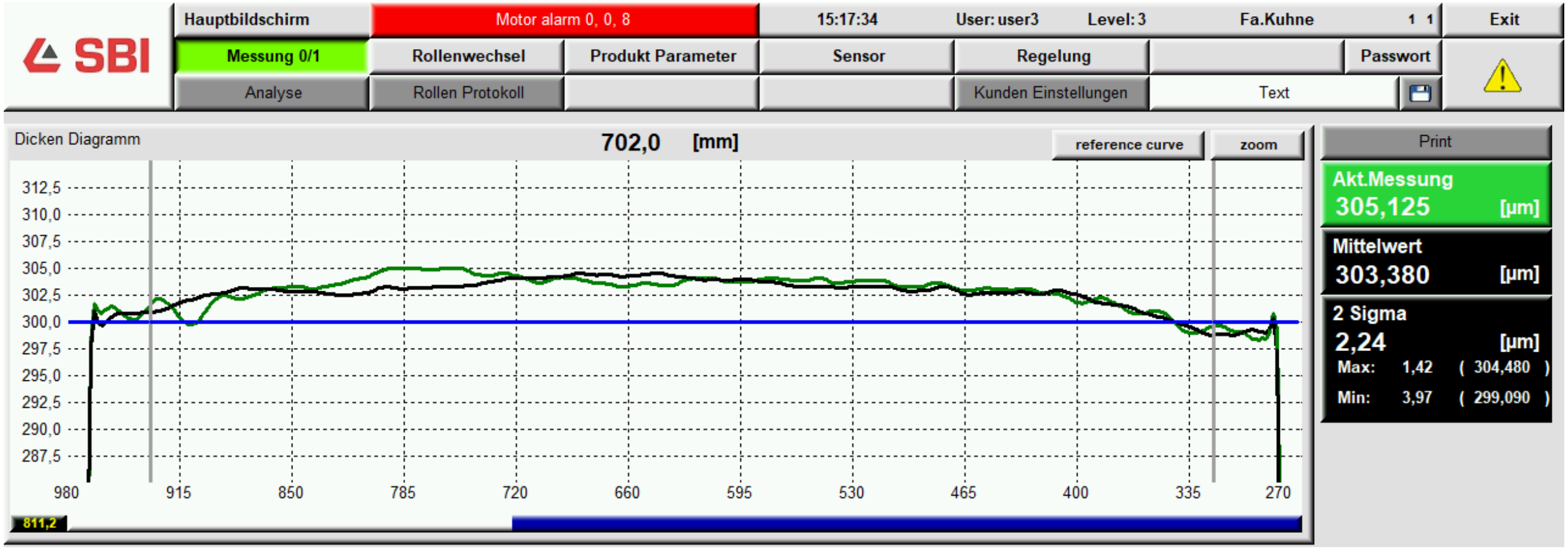
We adjust the slight difference over the time → the gap is not fix the gap is able to breathe



- We pair each extruder with a melt pump to reduce flow rate variation down to approx. +/- 0.5%.
- Hydraulic cylinder with integrated distance measuring sensor → We measure right where the counter forces occur!
- Servo Hydraulic with adjustable pressure → We can keep any pressure at the adjusted position!
- We adust a pressure that opens for melt to pass if pressure increases due to high melt bank!
- We keep operators away from adjusting melt banks all shift long and keep a better sheet thickness variation.

- Considering the above enables us to extrude sheet – also lid film – that is almost „stress free“.

Soft Touch



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Die Concepts

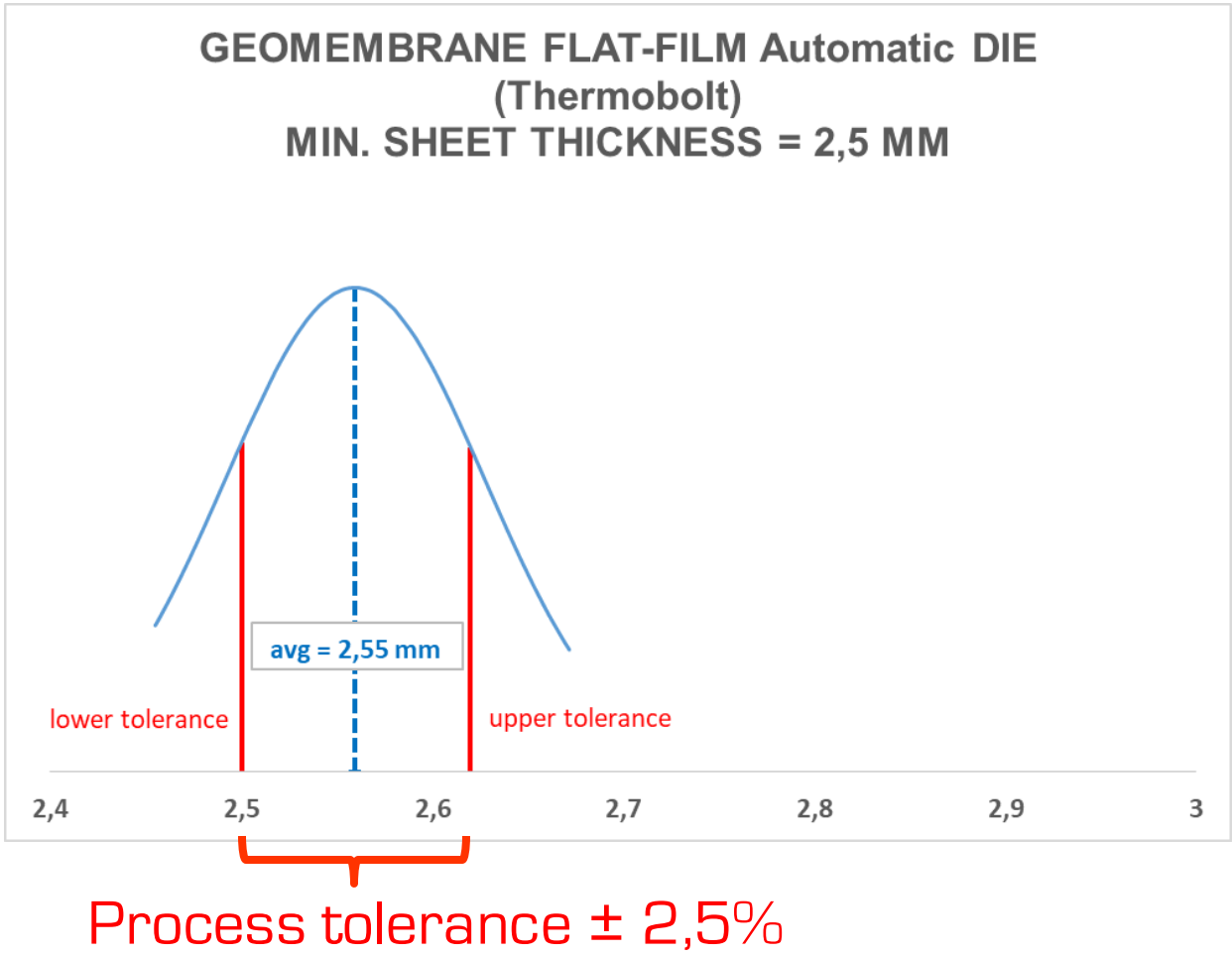
Production Quality and Cost Comparison

Flat Film Sheet Process with Thermo Bolts:

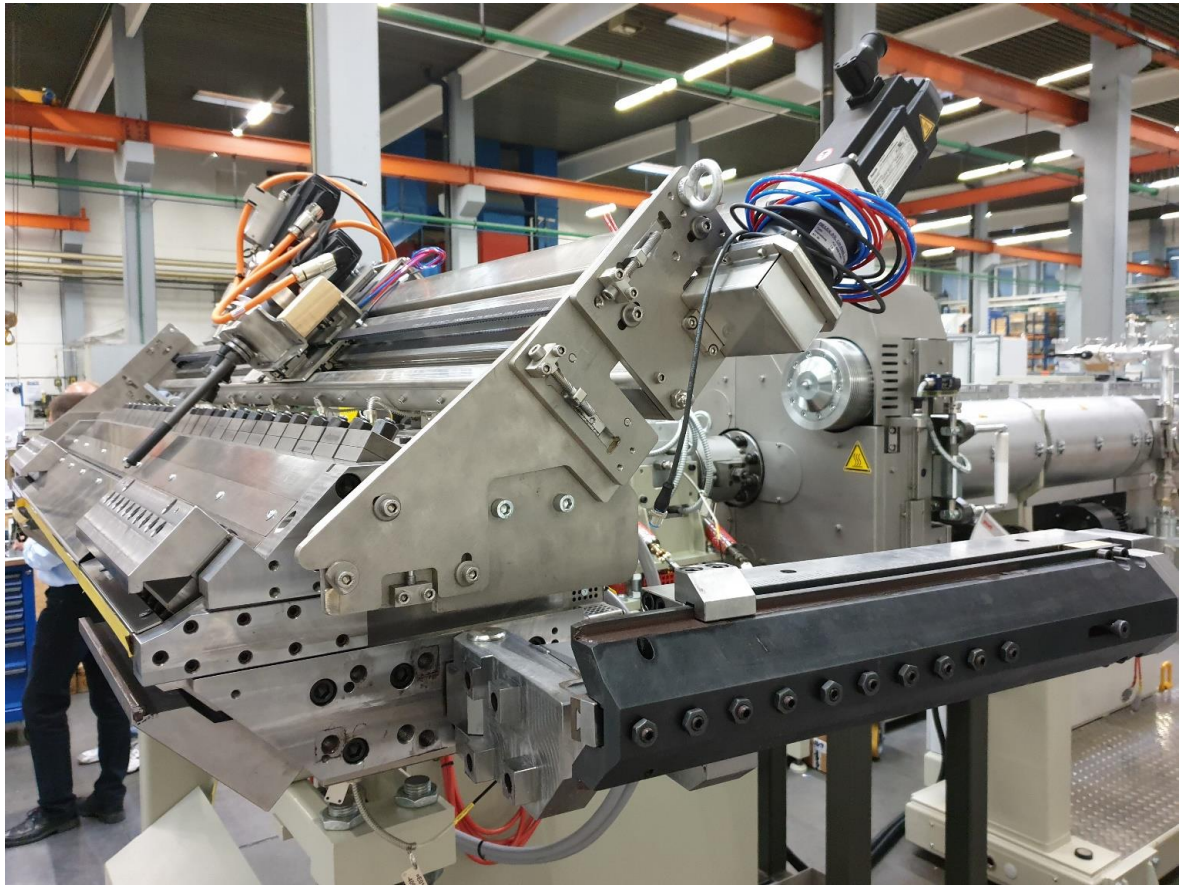
- Thermo Bolts can bring the accuracy down to +/- 2.5%
- Reaction time is not fast. Expansion is quick but cool down process takes a while.
- Auto Gap Control only for about 150 µm, rough adjustment still manually.
- 1.100 mm die has 36 thermos bolts.
- 0,075 kW/h consumption each (Ø).

→ 240 bolts x 0,075 kW/h each x 8.000 h/a

= 21.600 kW/a



Die Concepts



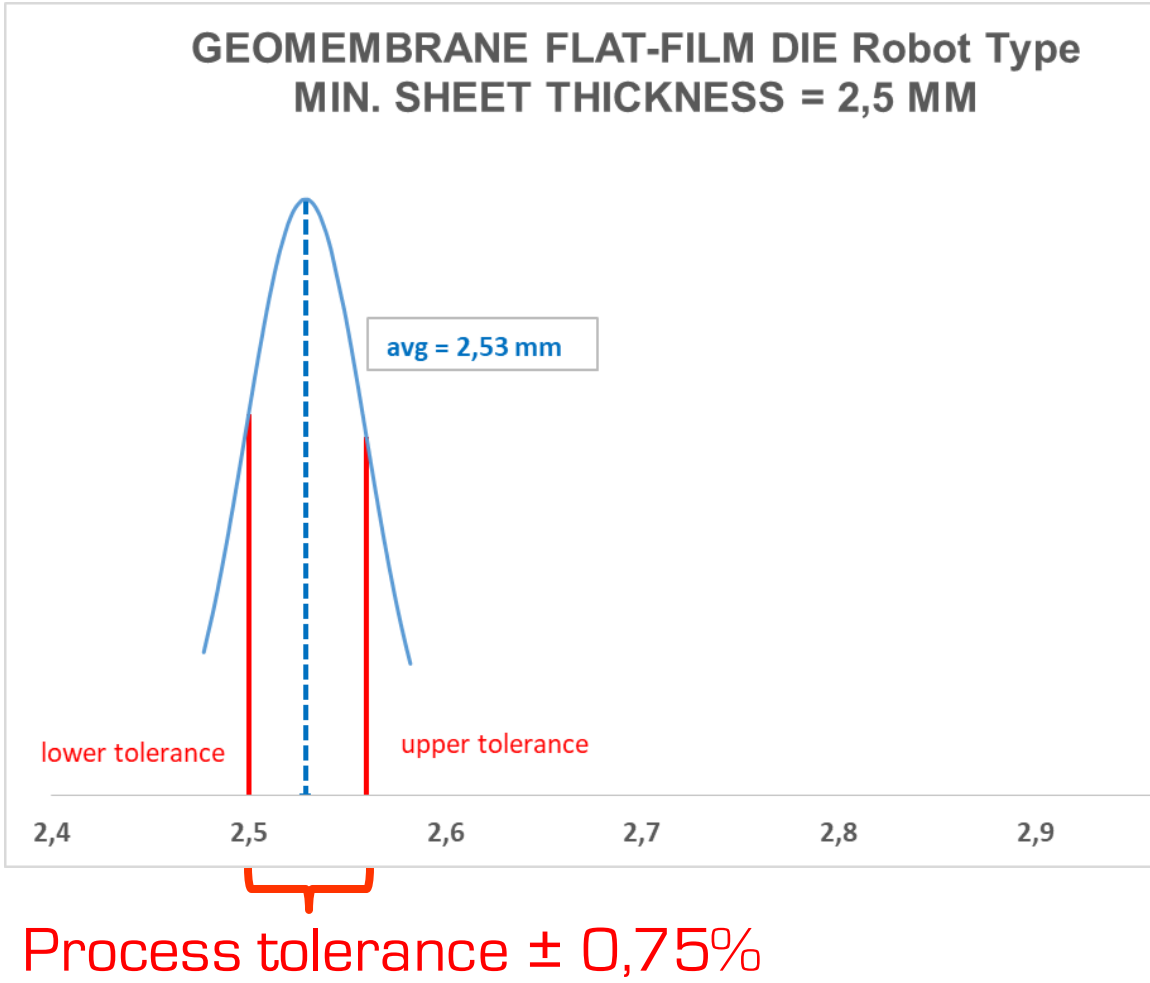
In-Line-Extrusion today

Die Concepts

Production Quality and Cost Comparison

Flat Film Sheet Process:

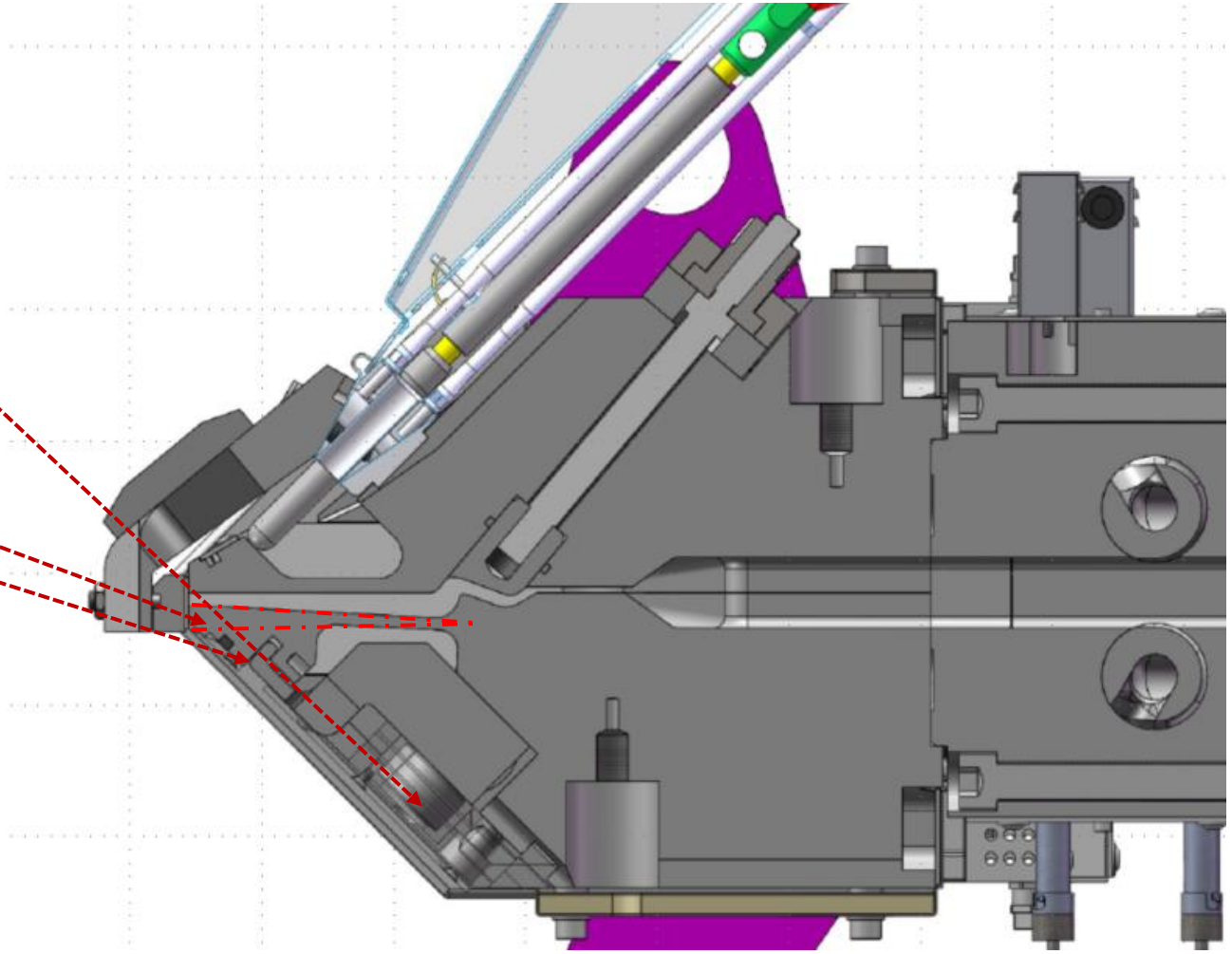
- Linear Robot or Stepper Motor Adaptor
- Adjustment of Flex Lip and Linear Lip as well as Restrictor Bar possible.
- Faster reaction time for custom sheet manufacturing!
- Higher precision with thickness variations of +/- 0.75%
- Energy consumption only if unit operates.
- Also for recipe changes and main adjustments.



Die Concepts

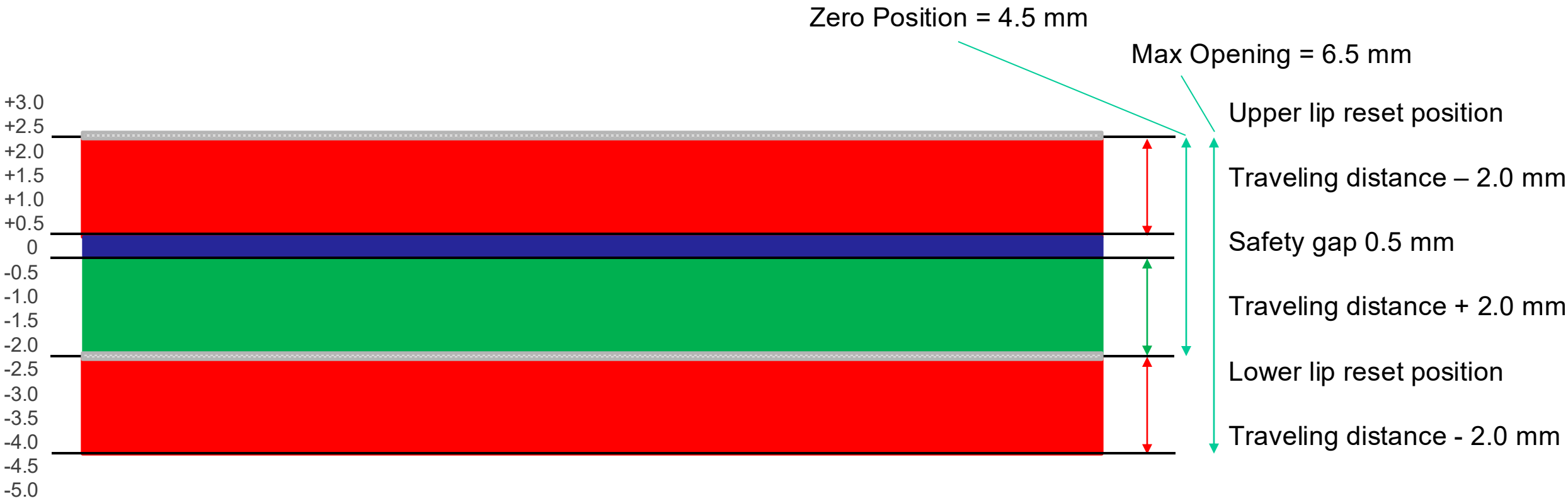
Flat Film Die Type BD84F with Fast Gap

- Moveable lip
- Push & pull rod connected towards threaded bar
- Connection of push/pull rod and lip
- Lower flex lip movement: +/- 2.0 mm
- Upper flex lip movement: - 2.0 mm
- Total range: e.g. 0.5 – 6.5 mm



Die Concepts

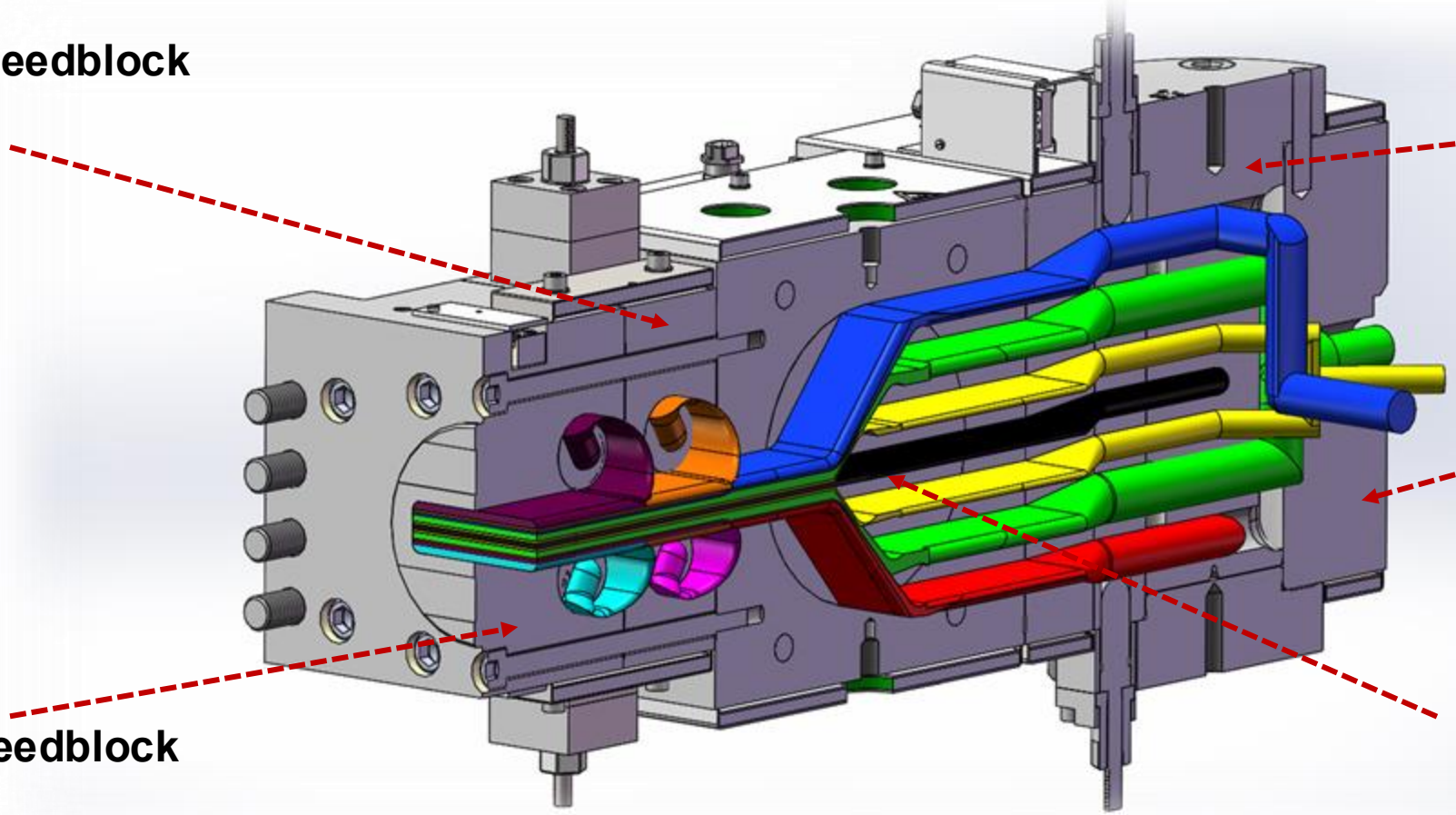
Flat Film Die Type BD84F with Fast Gap



Feedblocks

Optional Bolt Feedblock

for Layer 8 & 9



Manifold

Guides Melt into specific positions

Main Body

Lamella Insert

Provides different profiles depending on layer viscosity

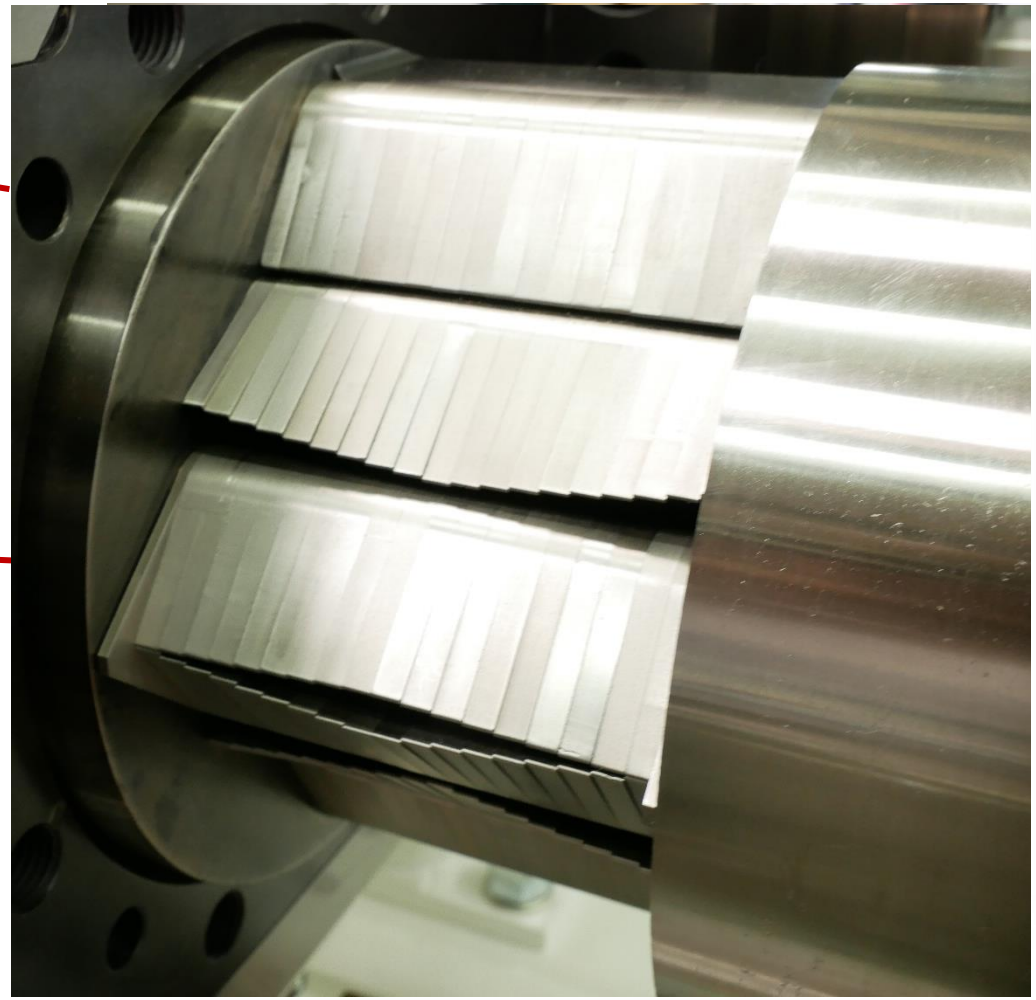
Optional Bolt Feedblock

for Layer 10 & 11

In-Line-Extrusion today

Feedblocks

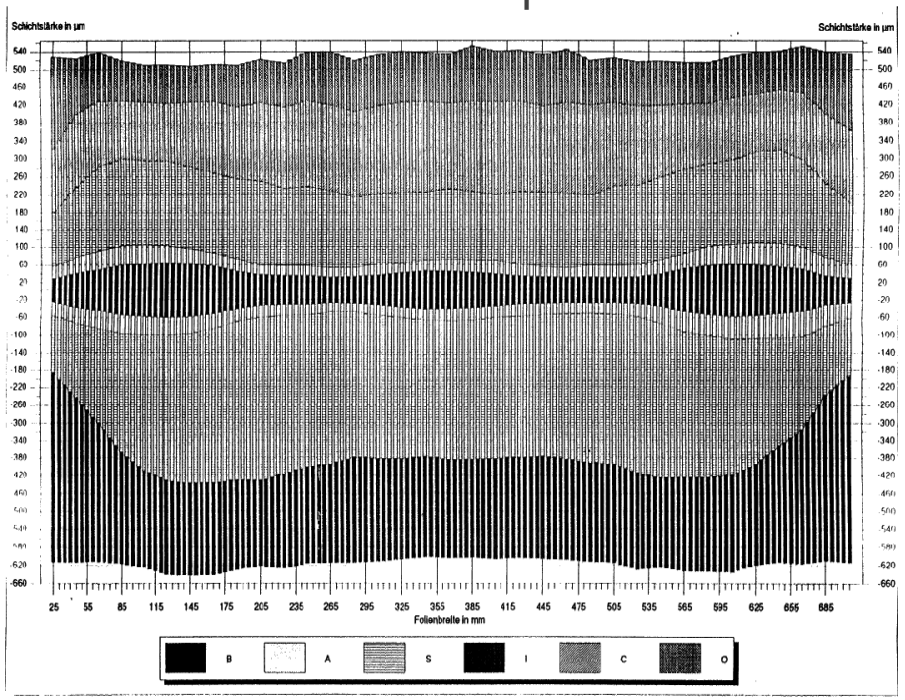
- Flow Channel individually adjustable for each layer
- Can be integrated with A/B/A configuration providing connections for the future (A|B|B|B|B|A)
- All Layers come together at the same spot
  No issues with flow turbulences and counter pressures



Feedblocks

Precise layer distribution reduces material and energy consumption and increases profitability!

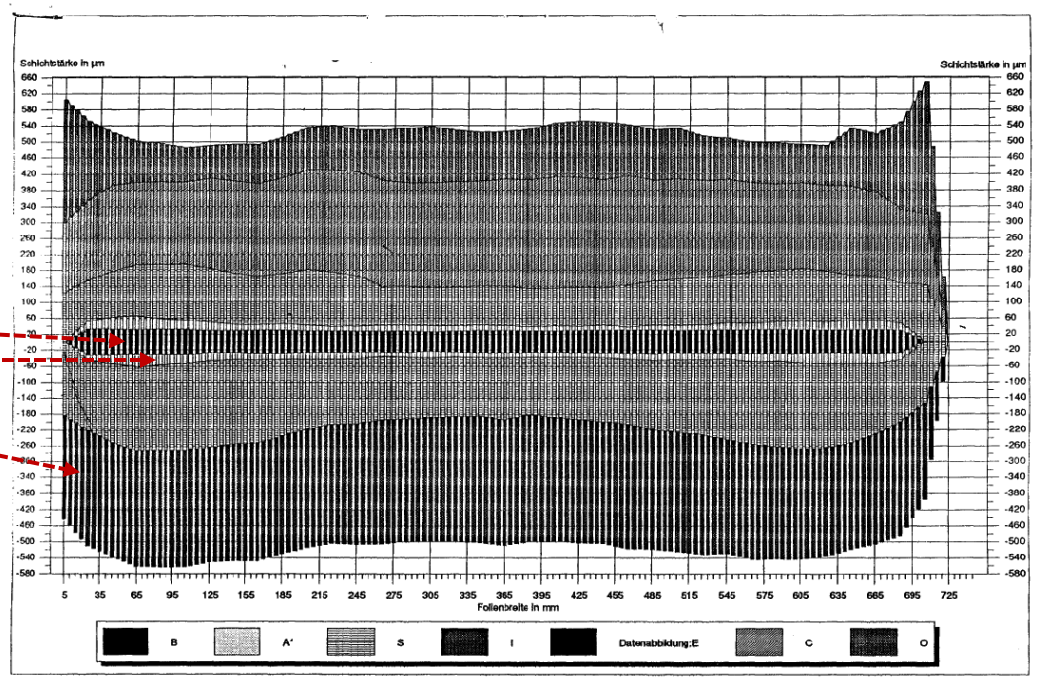
From competitor



Less usage of expensive raw materials such as e.g. here:

EVOH (barrier)
Admer (tie)
Master batch

Using KUHNE SMART SHEET equipment



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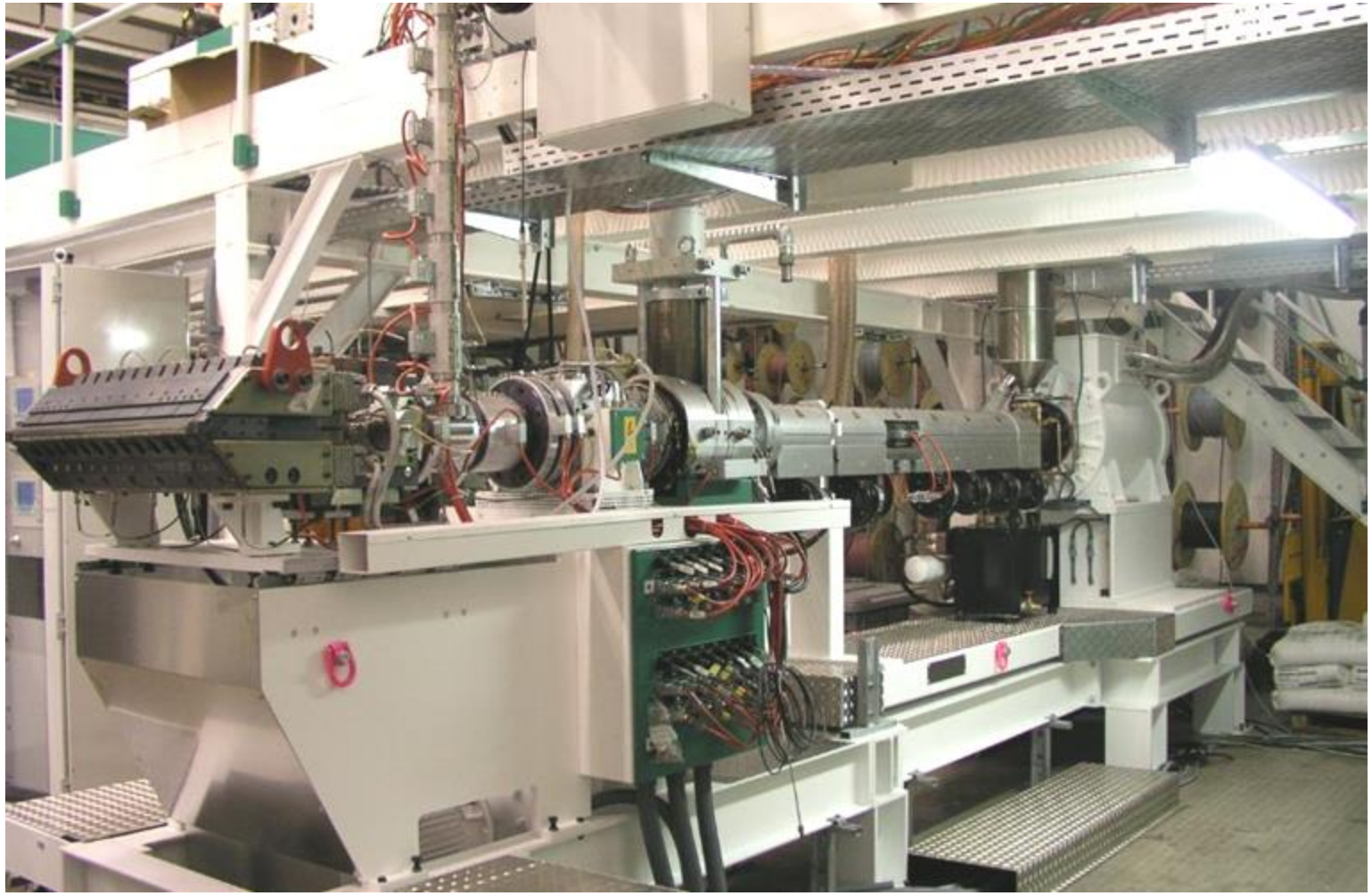
Extruders



- Three sizes of High Speed Extruders
- Length 33 or 39 L/D
- Single and double venting
- Direct Drives & High Torque Motors
- Planetary gear motors or
  AC + Gear Box on demand

- KHS 60
- Drive 68 – 116 kW
- Output range: **240 - 320 kg/h**

- KHS 70
- Drive 140 – 440 kW
- Output range: **500 – 1.800 kg/h**

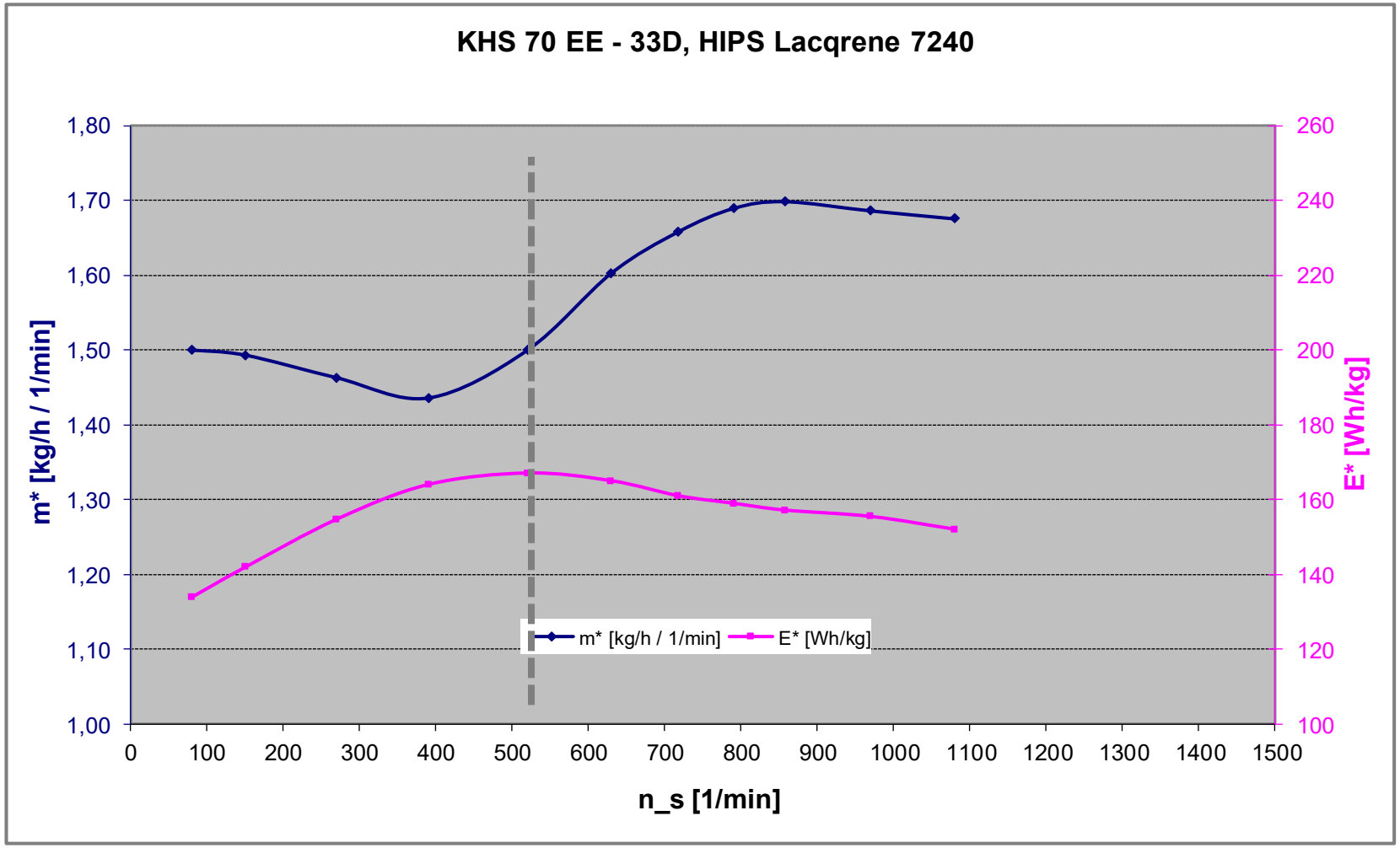
- KHS 90
- Drive 495 kW
- Output range: **2.400 kg/h**

High Speed Extrusion

Throughput/Energy Relation

- Degree of efficiency increases above 500 rpm on proposed material *!

* Results are material related!



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High Speed Extrusion

70 mm (2.75“) maximum throughputs:

- PS up to 1,800 kg/h (3,968 lb/h)
- PP up to 1,600 kg/h (3,527 lb/h)
- PLA up to 1,200 kg/h (2,645 lb/h)
- PET up to 1,200 kg/h (2,645 lb/h)
- ABS up to 800 kg/h (1,764 lb/h)
- PE up to 800 kg/h (1,764 lb/h) *Packaging Grades, no „A“ or „Z“

High Speed Extrusion

VB.-Nr.	02 / 25	Customer:		Product	PP-Test	Raw Material	PP
Date	18.02.2025	Line	KHS70/K45/GA4.4.4-1000	Supplier	Borealis	Grade	HC 205 TF
Feeding	smooth barrel	Extruder	K70-33D / B	Screw	EMFS 17	Pump	Nordson EP371 SE

Extruder:

TE [°C]	ns [min^{-1}]	ls [%]	Ps [kW]	Ms [Nm]	g/n_s [$kg/h/min^{-1}$]	Es [Wh/kg]	pvS [bar]	Tm [°C]	Tm_{man} [°C]
15	161	41%	29,54	1752,06	1,012	181,2	71	218	/
15	279	50%	62,43	2136,66	1,154	193,9	89	219	/
15	525	57%	133,9	2435,79	1,21	210,9	116	220	/
15	648	60%	174	2563,99	1,219	220,2	127	221	/

Melt Pump:

m [kg/h]	np [min^{-1}]	lp [%]	Pp [kW]	Mp [Nm]	g/n_p [$kg/h/min^{-1}$]	Ep [Wh/kg]	pvP [bar]	pnP [bar]	pnMx [bar]
163	10	19%	0,621	593,035	16,3	3,81	30	51	/
322	20	27%	1,765	842,734	16,1	5,481	30	71	/
635	40	35%	4,576	1092,43	15,88	7,206	30	92	/
790	50	37%	6,047	1154,86	15,8	7,654	30	98	/

Extruder	P_{nenn}	179	kW	ns_{nenn}	400	min^{-1}	ns_{max}	700	min^{-1}	I_{max}	365	A
Pump		18,5		np_{nenn}	56,6		np_{max}	56,6			35,1	

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High Speed Extrusion

VB.-Nr.	24/ 24	Customer		Product	Leistungstest	Raw Material	PP
Date	27.06.2024	Line	KHS70-33D- GA4-900	Supplier	Borealis	Grade	HC205TF
Feeding	smooth	Extruder	K70-33D	Screw	EMFS 17	Pump	Maag Extrex 70 HV

Extruder:

TE [°C]	ns [min^{-1}]	ls [%]	Ps [kW]	Ms [Nm]	g/n_s [kg/h/min^{-1}]	Es [Wh/kg]	pvS [bar]	Tm [°C]	Tm$_{man}$ [°C]
20	80,0	41 %	11,71	1398,29	1,22	120	50	-	
20	182,0	51 %	33,15	1739,34	1,07	170,2	61	-	
20	318,0	63 %	71,55	2148,59	1,214	185,3	75	-	
20	571,0	75 %	152,9	2557,85	1,341	199,8	99	-	
20	702,0	77 %	193,1	2626,06	1,345	204,5	98	-	
20	835,0	79 %	235,6	2694,27	1,356	208,1	101	-	

Melt Pump:

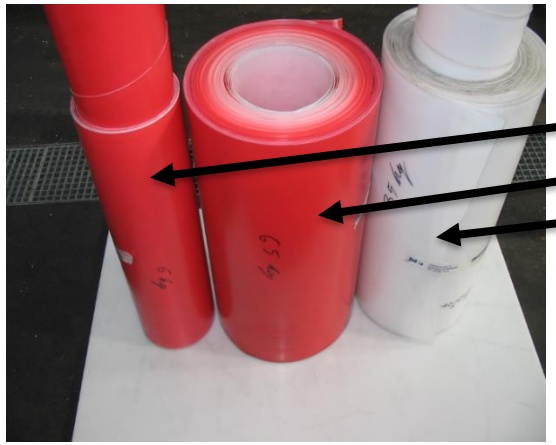
m [kg/h]	np [min^{-1}]	lp [%]	Pp [kW]	Mp [Nm]	g/n_p [kg/h/min^{-1}]	Ep [Wh/kg]	pvP [bar]	pnP [bar]	pnMx [bar]
97,6	10	16 %	0,012	11,6095	9,76	0,125	30	37	
194,8	20	27 %	0,041	19,5911	9,74	0,211	30	56	
386,2	40	40 %	0,122	29,0238	9,66	0,315	30	87	
765,6	80	54 %	0,328	39,1822	9,57	0,429	40	116	
944,0	100	57 %	0,433	41,359	9,44	0,459	40	119	
1132	120	59 %	0,538	42,8102	9,43	0,475	40	122	

Extruder	P$_{nenn}$	250	kW	ns$_{nenn}$	700	min^{-1}	ns$_{max}$	1000	min^{-1}	I$_{max}$	475	A
Pump		19,3		np$_{nenn}$	2540		np$_{max}$	3000			39	

In-Line-Extrusion today

High Speed Extrusion

Color Changing Process



Material consumption:

Approx. 6 kg
Approx. 65 kg
Approx. 35 kg

Approx. 110 kg

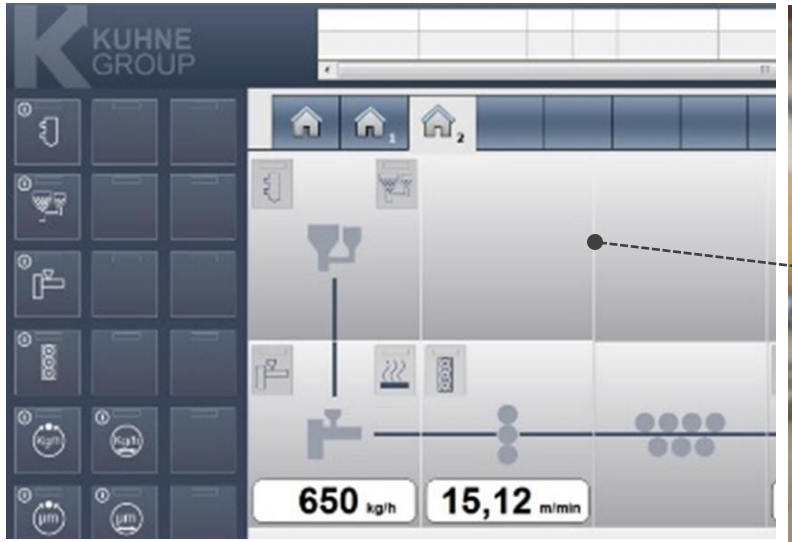
Extruder = 1.000 kg/h
→ ~ 10 min.

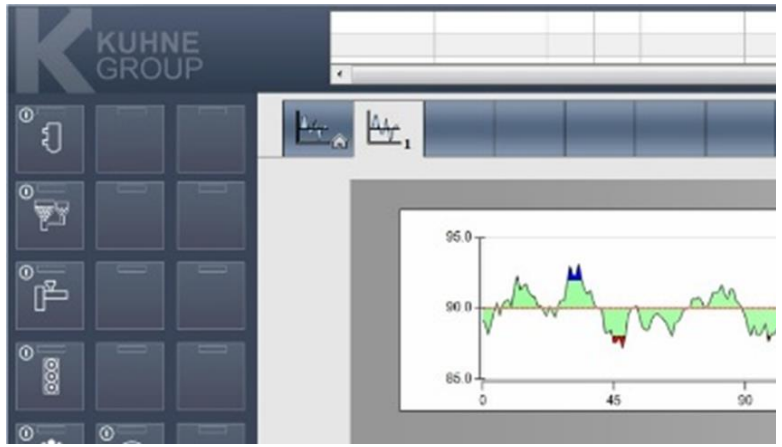
	KHS 70 Extruder	K 150 Extruder
Volume inside the extruder [kg]	~ 4	~ 35
Material requirement for colour change [kg]*	~ 150	~ 1100
Colour change time with low throughput [min]	~ 30	~ 50
Colour change time with high throughput [min]	~ 10	~ 35

Control Unit

„KEC“ Control Unit | Retrofit PLC

- Transition from HMI to MHI ongoing
- Hardware Controled in addition
  to Software controled
- Touch Screen Pannel
- Flow Chart Displaying
- Overview & Component Set-Up F&D
- Data Analysis
- Self explaining graphics





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Thank you for your attention!

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