Increase of efficiency and waste reduction in an extrusion coating plant

Presented by:
Michael Schröder
ER-WE-PA Davis Standard
Erkrath

DAVIS-STANDARD®

TOPICS

1. **Waste reduction with an edge bead reduction die**
2. **Improved flexibility with „Set up on Fly“**
3. **The process of correct Extruder sizing**
4. **Waste reduction – inline recycling**
5. **Energy savings at the Extruder**
6. **Industry 4.0 - DS Activ – Predictive maintenance**
7. **Summary**

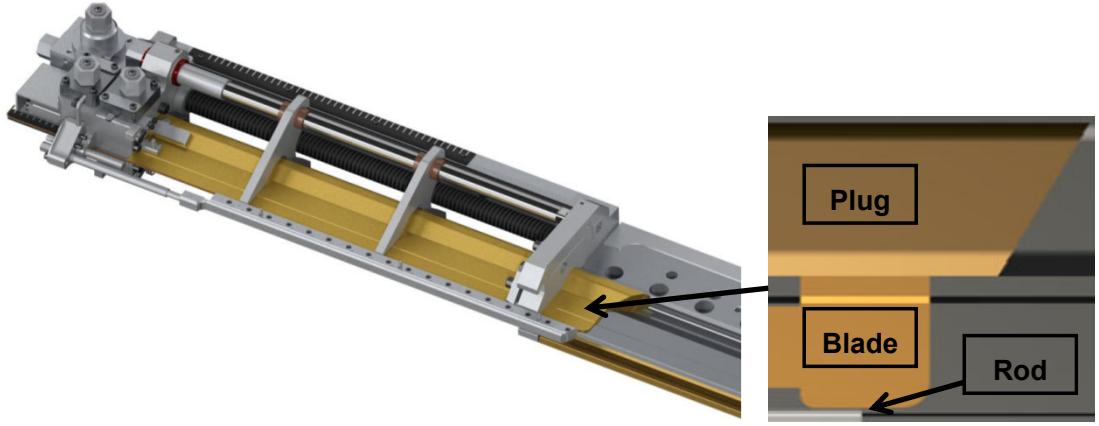
TOPICS

1. **Waste reduction with an edge bead reduction die**
2. **Improved flexibility with „Set up on Fly“**
3. **The process of correct Extruder sizing**
4. **Waste reduction – inline recycling**
5. **Energy savings at the Extruder**
6. **Industry 4.0 - DS Activ – Predictive maintenance**
7. **Summary**

Change from Coathanger die to T–die with edge bead reduction

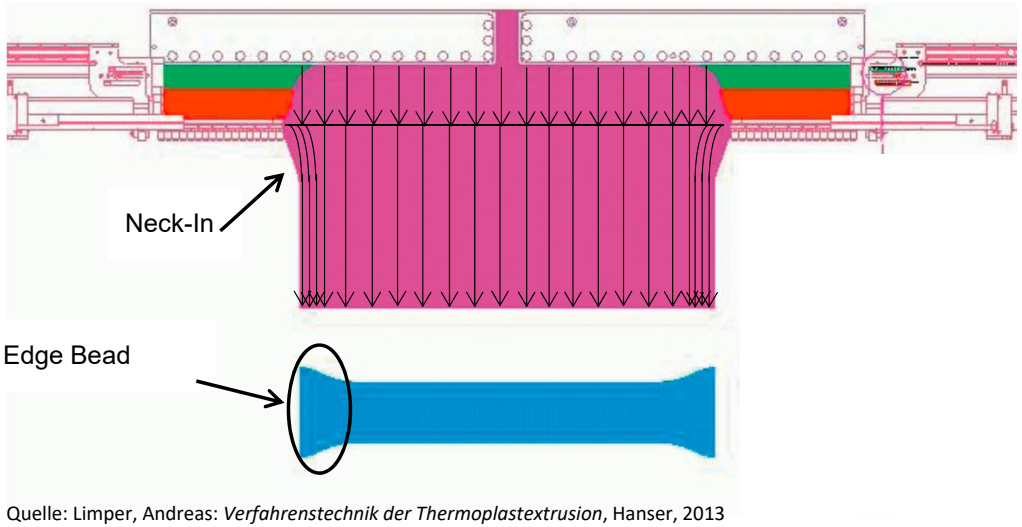
Internal deckling system

- Inserts that correspond to the internal die geometry
- The distributor channel, the Pre land and the lip zone are filled completely until the die is discharged
- Inserts can be moved via spindles preferable motorized
- As a result, the flow conditions in the distributor channel, Pre-land and lip zone can be matched separately
- Bottom deck (Rod) and external deckling defines the exit width



Desired condition

Neck In and edge bead

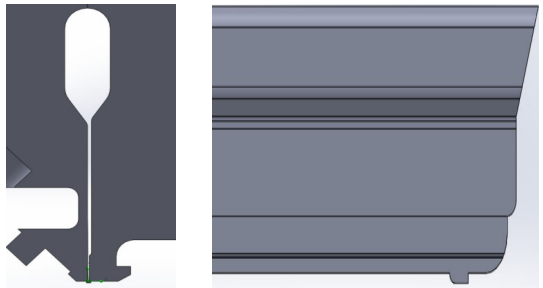


Quelle: Limper, Andreas: *Verfahrenstechnik der Thermoplastextrusion*, Hanser, 2013

- After the melt leaves the die lip, the melt curtain laces at the edges (neck-in)
- During the stretching of the film web, an edge thickening occurs between the die lip and the chill roll (air gap)
- As larger the neck-in, the greater the edge bead.
- Usually the edge bead must be trimmed, but more and more converters run without edge cut, and still require good profile at the edges without high edge enter into the finished roll

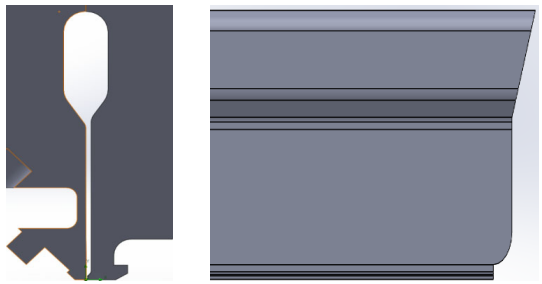
Start of simulation for short lip

- Modification of the geometry
- Modification of the deckling system



- **Version 2 (V2):** Lip lenght - 15 mm,
- Preland width - 2,2 mm
- 1st Blade - 52 mm,
- 2nd Blade - 40 mm

- **Version 3 (V3):** Lip lenght - 6 mm,
- Preland width - 2,2 mm
- 1st Blade - 61 mm,
- 2nd Blade - 31 mm



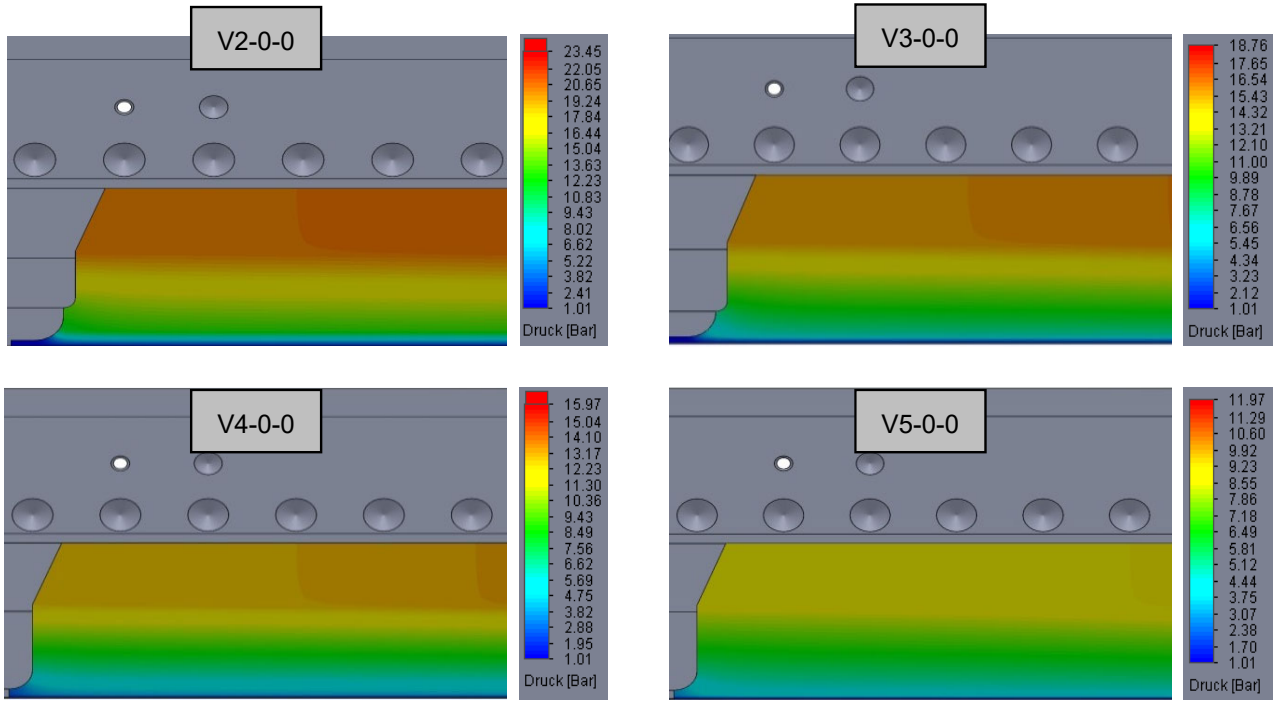
- **Version 4 (V4):** Lip lenght - 2 mm,
- Preland width - 2,2 mm
- **Version 5 (V5):** Lip lenght - 2 mm,
- Preland width - 3 mm
- Blade - 83 mm, Rod - 9mm

Simulation

- For each variant, simulations were performed on nine different deckling positions
- Analysis of the effects by changing the geometry and changing the deckling position
- Representation of the pressure distribution, the speed distribution and the shear rates
- Viscosity curves of the material were provided by the resin suppliers

Configuration	Project name	Nomination
Sim-1	**Flush**	**(V1-V5)-0-0**
Sim-2	Plug 10 mm inserted	(V1-V5)-10-0
Sim-3	Blade 10 mm inserted	(V1-V5)-0-10
Sim-4	Plug 10 mm, Blade 10 mm inserted	(V1-V5)-10-10
Sim-5	**Plug 20 mm, Blade 10 mm inserted**	**(V1-V5)-20-10**
Sim-6	Plug 20 mm, Blade 20 mm inserted	(V1-V5)-20-20
Sim-7	**Plug 30 mm, Blade 20 mm inserted**	**(V1-V5)-30-20**
Sim-8	Plug 40 mm, Blade 20 mm inserted	(V1-V5)-40-20
Sim-9	**Plug 40 mm, Blade 30 mm inserted**	**(V1-V5)-40-30**

Pressure distribution comparison

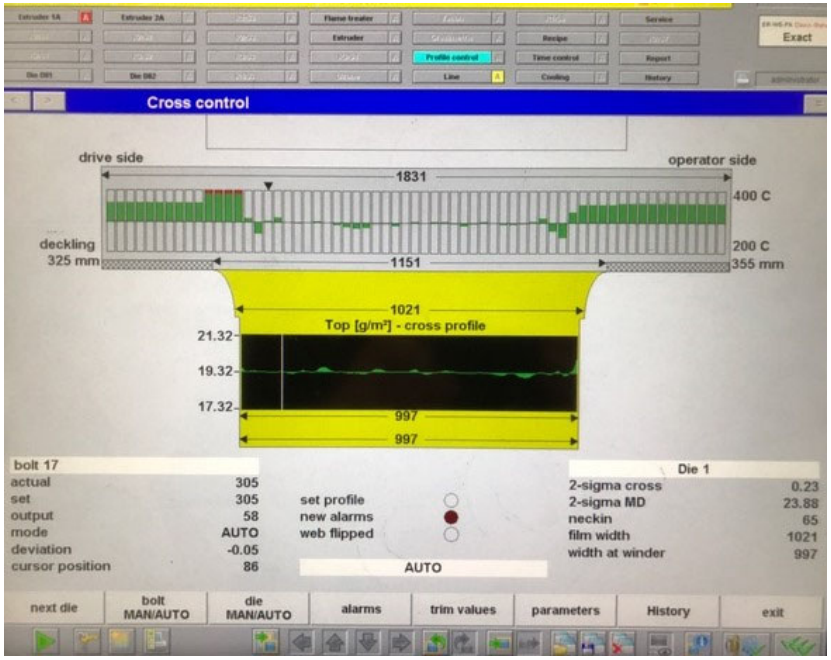


Pressure loss	30 mm (V1)	15 mm (V2)	6 mm (V3)	2 mm (V4)	2 mm (V5)
	28,73 Bar	22,44 Bar	17,75 Bar	14,96 Bar	10,96 Bar

Practical Results

- Condition
- Line speed 300 m/min
- Coating weight 25 gsm
- Resin LDPE DOW 722
- Working width 995 mm
- Melt temperature 328°C

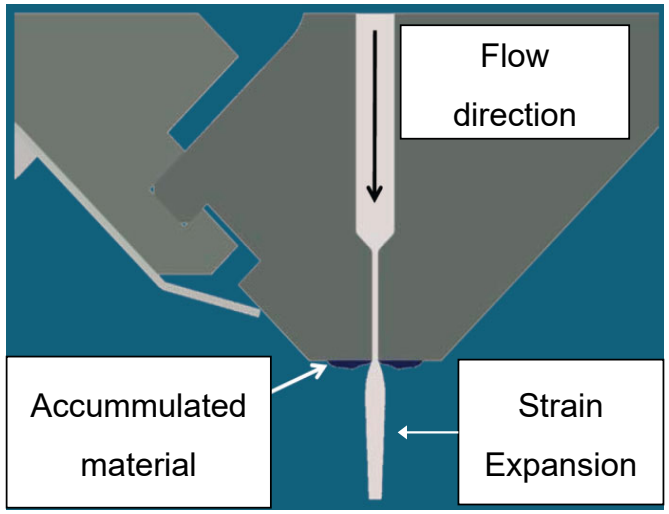
- Result
- 2 sigma cross 0,25
- No edge trim
- No high edges



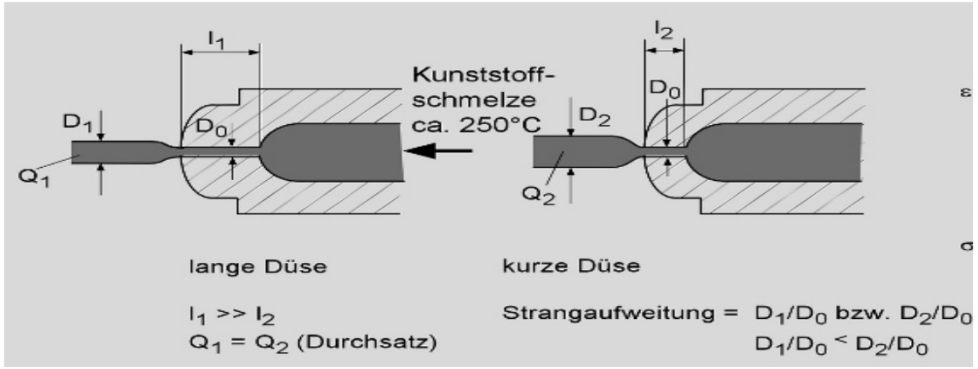
Important parameter for the die design

Various aspects have to be considered to optimize the die:
- Tightness of die (pressure)
- Strain expansion
- Neck-In and edge bead
- Speed profile and shear speed profile

Strain swell



Quelle: Oliver, Gary: *Extrusion Coating Dies and Feedblocks*



Quelle: Eyerer, Peter: *Polymer Engineering*, Springer, 2008

Results and consideration for the die design

- With shorter lip - lower pressure in the die better tightness
- With shorter lip - less neck-in smaller edge bead
- With a shorter lip, a more uneven speed profile and a shear speed profile are produced at the die lip exit
- With short lip-wide strain swell Material accumulations at the die lip exit Instabilities in the extrusion process
- Strain expansion also has an effect on the edge bead
- By inserting the deckling system less melt flow in the edge areas smaller edge bead

Savings with edge bead reduction

Savings with edge bead reduction die example for an Aseptic line		
Web width	mm	1300
Speed	m/min	500
Overcoating /side actually	mm	20
Overcoating with EBR die	mm	8
Total		
Coating thickness	gsm	69
Results:		
Output	kg/h	2795
Percentage of savings with less of PE overcoating	%	1,8%
Savings	kg/h	50
Running time per Year 200 days/24h	h	4800
Savings /Year	**tons**	**241,5**

Environmental friendly

TOPICS

1. Waste reduction with an edge bead reduction die
2. **Improved flexibility with „Set up on Fly“**
3. The process of correct Extruder sizing
4. Waste reduction – inline recycling
5. Energy savings at the Extruder
6. Industry 4.0 - DS Activ – Predictive maintenance
7. Summary

Set up on fly

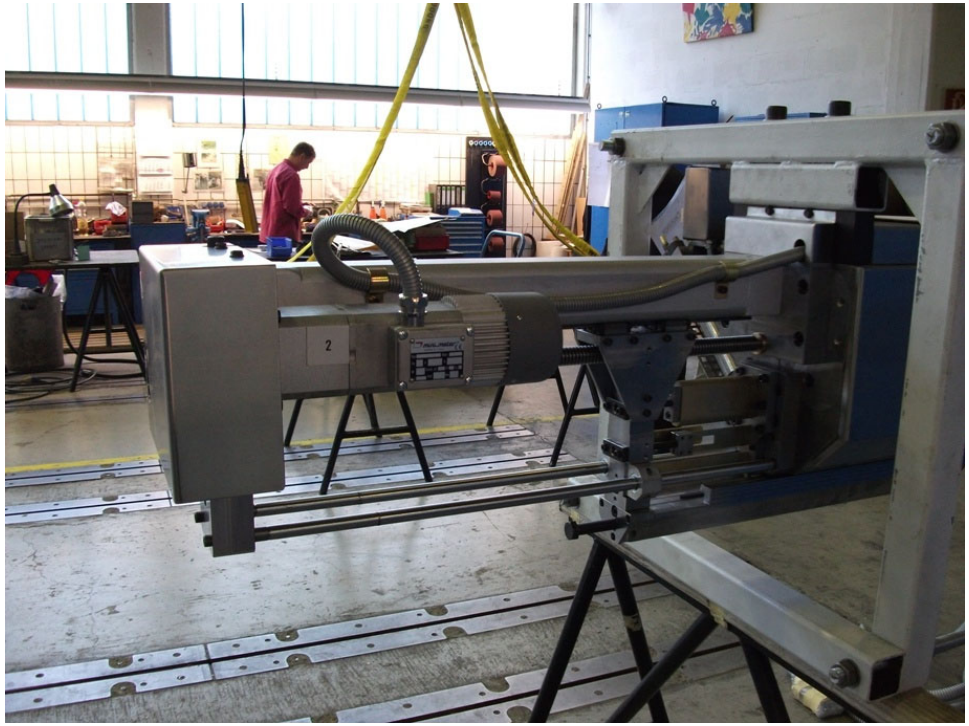
Set up on fly includes following features:

Motorized adjustment with way encoder on:

- Deckling at the Flame Treatment – savings of gas consumption up to 20%
- Internal and external Extrusion die deckling
- Teflon tape system at the Laminator
- Edge trim knives and suction dies
- Result :
- Width change with recipe in very short time and save machine downtime

Automatic die 510 A

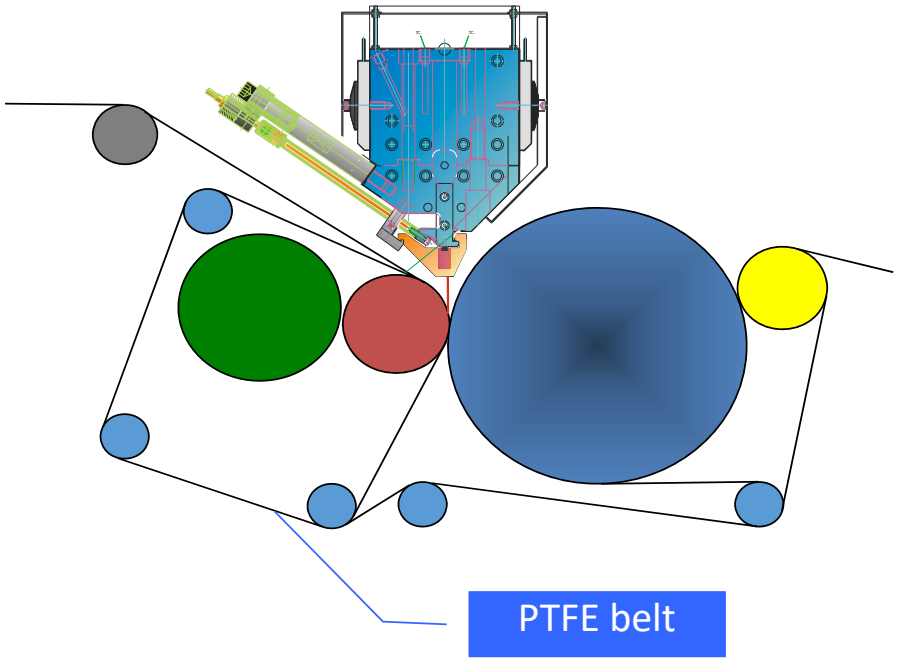
Motorized deckling system with way encoder



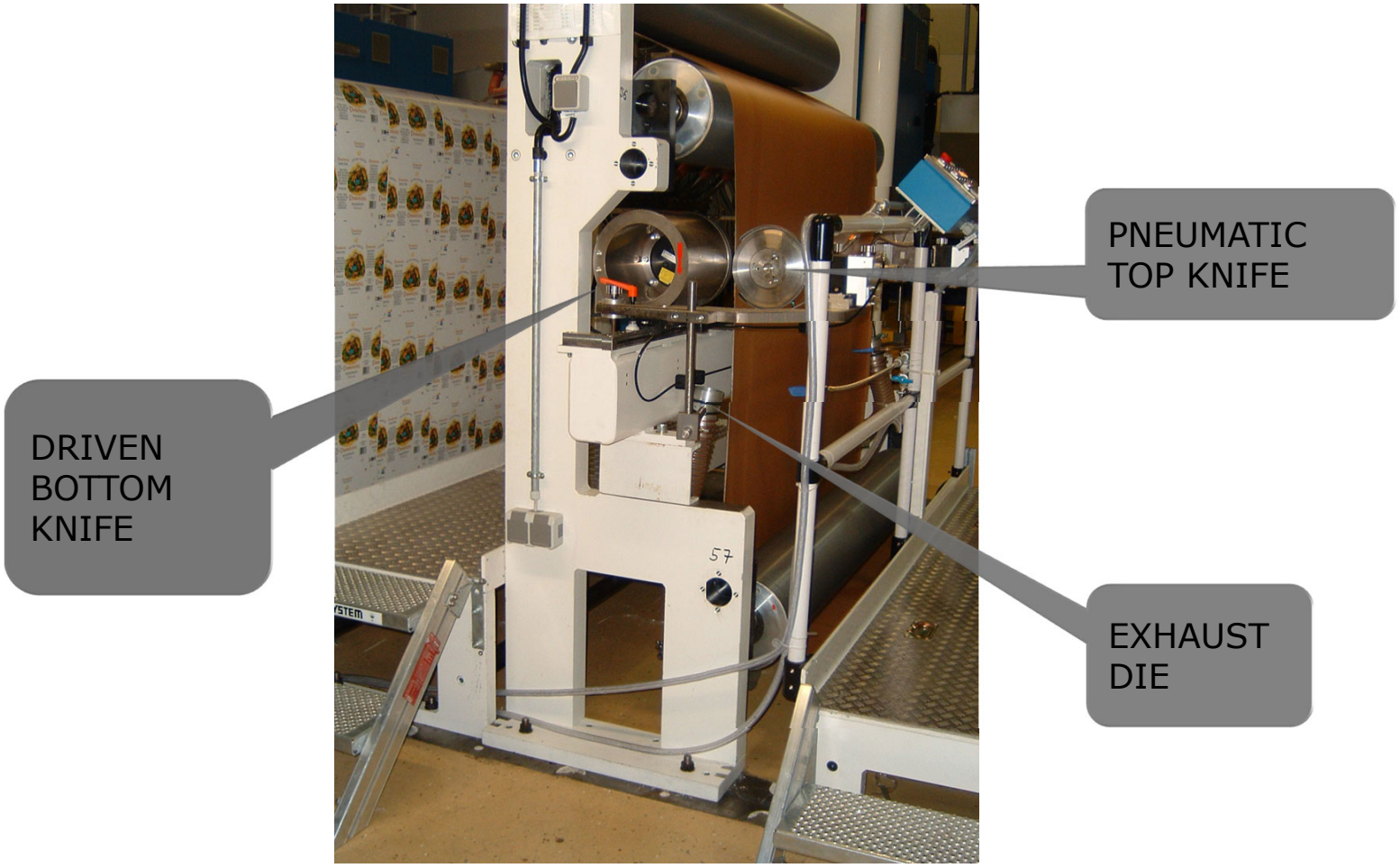
Motorized Teflon tape sytem

Extrusion Laminator

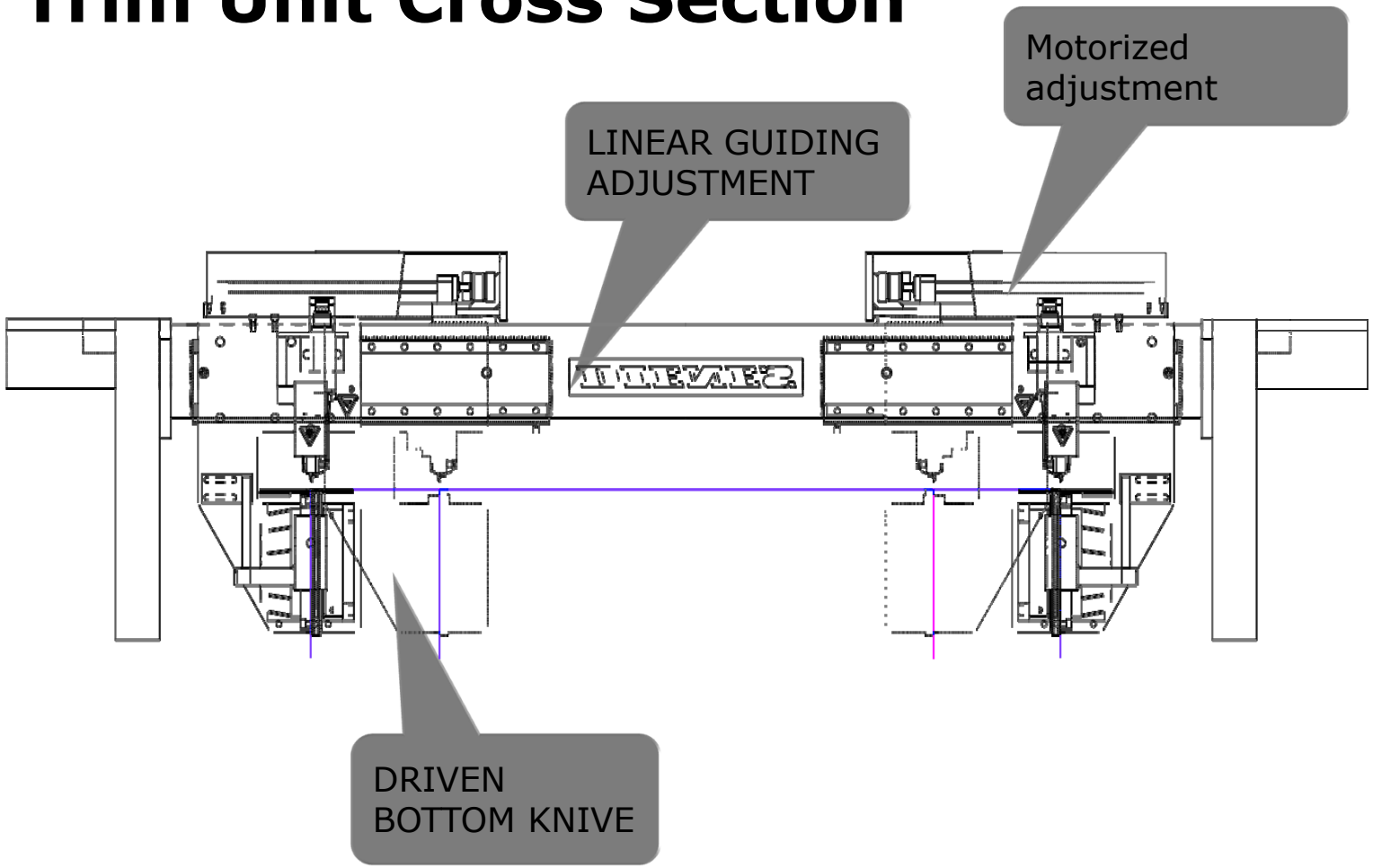
Motorized Teflon tape system with displacement counter/sensor for quick grade changes



Edge Trim Station

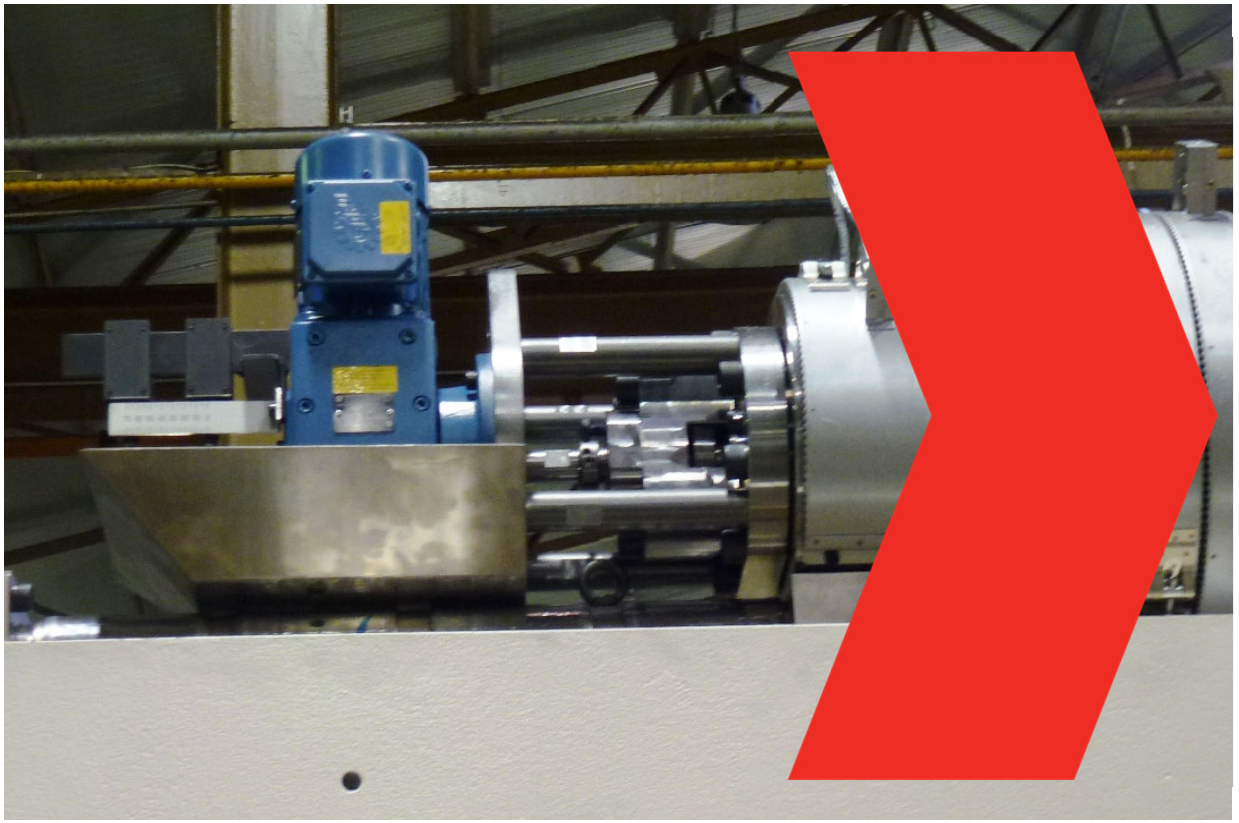


Edge Trim Unit Cross Section



QSE Adapter

With motorized pressure spindle



Safe operation

TOPICS

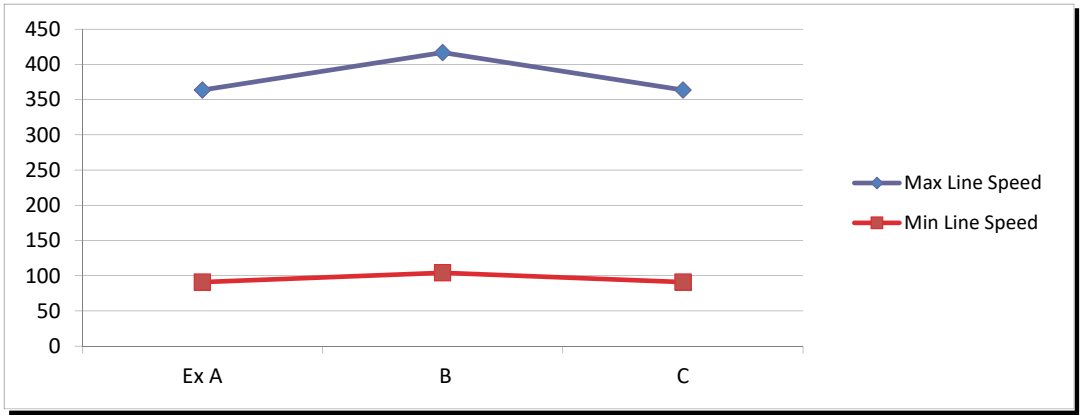
1. Waste reduction with an edge bead reduction die
2. Improved flexibility with „Set up on Fly“
3. **The process of correct Extruder sizing**
4. Waste reduction – inline recycling
5. Energy savings at the Extruder
6. Industry 4.0 - DS Activ – Predictive maintenance
7. Summary

Extruder sizing

- **Various factors:**
- Layer thickness
- Extruder working range
  - 4 to 1 for PE resin
  - 3 to 1 for Tie resin
  - 2 to 1 for sensitive resin = EVOH
- Machine width min/max = usually 100 down to 50%
- Machine speed min/max = from 80 to 600 m/min

Layer distribution – Line speed

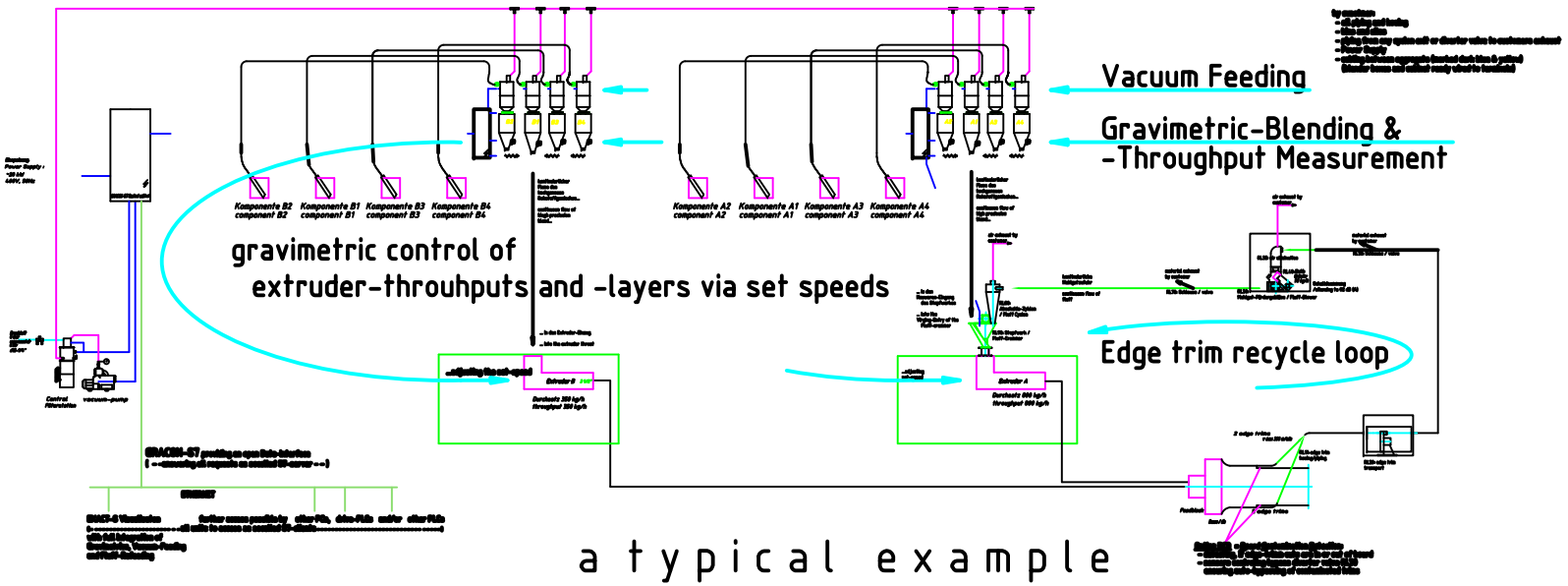
	AB		v max					
	mm		m/min					
	1000							
	weight	Resin	temp	Extruder	Output	Speed	Output	Speed
	gsm	type	°C	mm	kg/hr	m/min	kg/hr	m/min
					min	min	max	max
Extruder								
Adhesive	5	Lotador /LDPE mix	280	75	30	91	120	364
Sealing	10	LDPE/HDPE mix	300	100	69	104	275	417
Top layer	5	Bestpeel Lotaryl	300	75	30	91	120	364
			100					



TOPICS

1. Waste reduction with an edge bead reduction die
2. Improved flexibility with „Set up on Fly“
3. The process of correct Extruder sizing
4. **Waste reduction – inline recycling**
5. Energy savings at the Extruder
6. Industry 4.0 - DS Activ – Predictive maintenance
7. Summary

Schematic of recycling system



Recycling system

Recycling savings

Savings Recycling System example for an Aseptic line		
Web width	mm	1300
Speed	m/min	500
Overcoating /side	mm	20
Edge cut /side	mm	17
Total		
Coating thickness	gsm	69
Results:		
Output	kg/h	2795
Percentage of edge trim and savings of PE	%	2,5%
Savings	kg/h	70
Running time per Year 200 days/24 h	h	4800
Savings /Year	**tons**	**336**

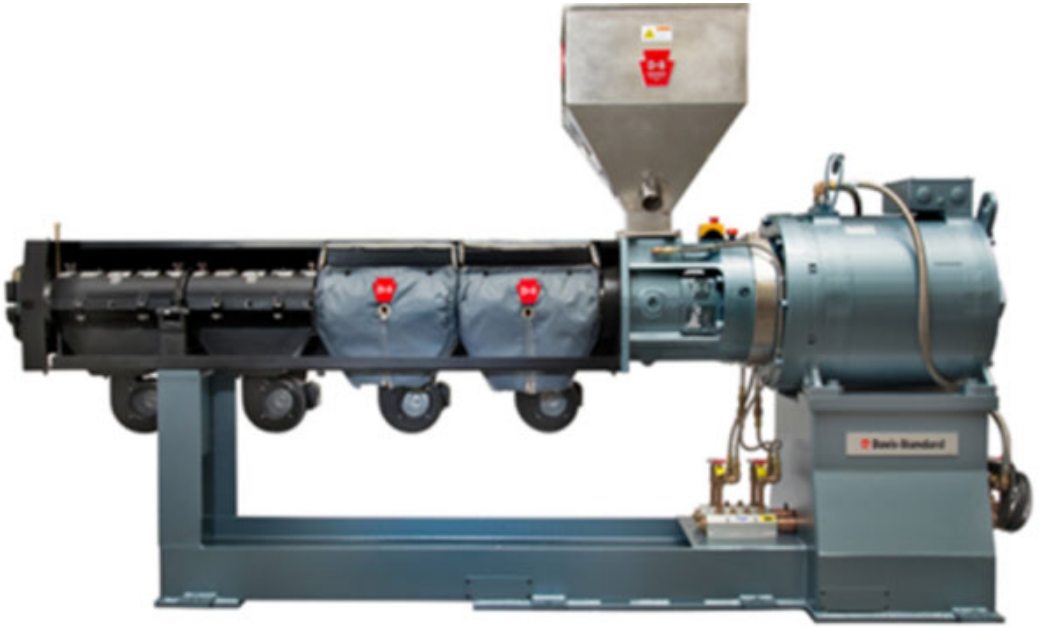
Environmental friendly

TOPICS

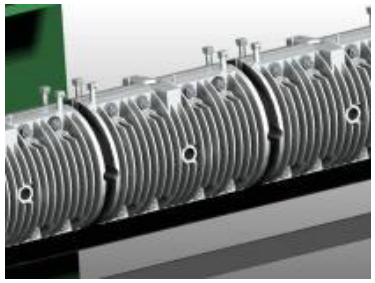
1. Waste reduction with an edge bead reduction die
2. Improved flexibility with „Set up on Fly“
3. The process of correct Extruder sizing
4. Waste reduction – inline recycling
5. **Energy savings at the Extruder**
6. Industry 4.0 - DS Activ – Predictive maintenance
7. Summary

Heater Design - Room for improvement

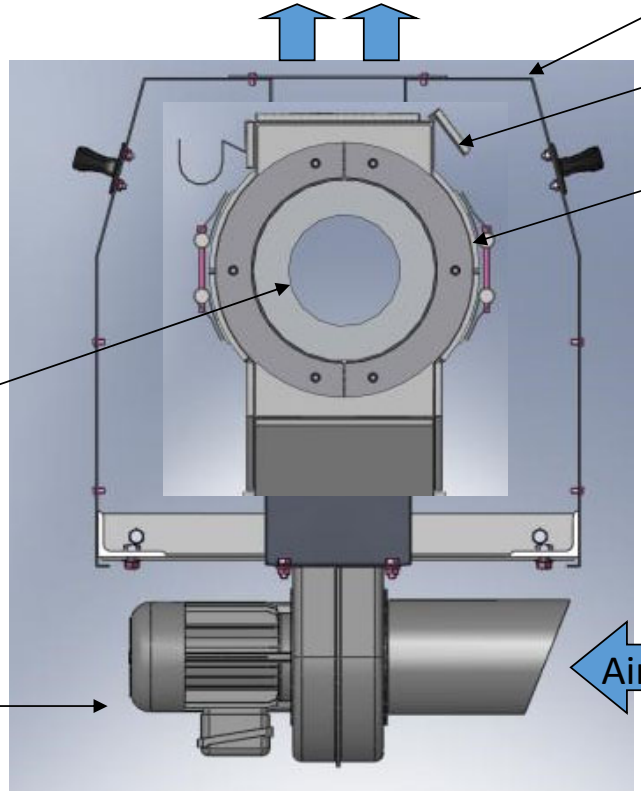
- Reducing Convective & Radiant heat losses



Energy Efficient ACEH Design



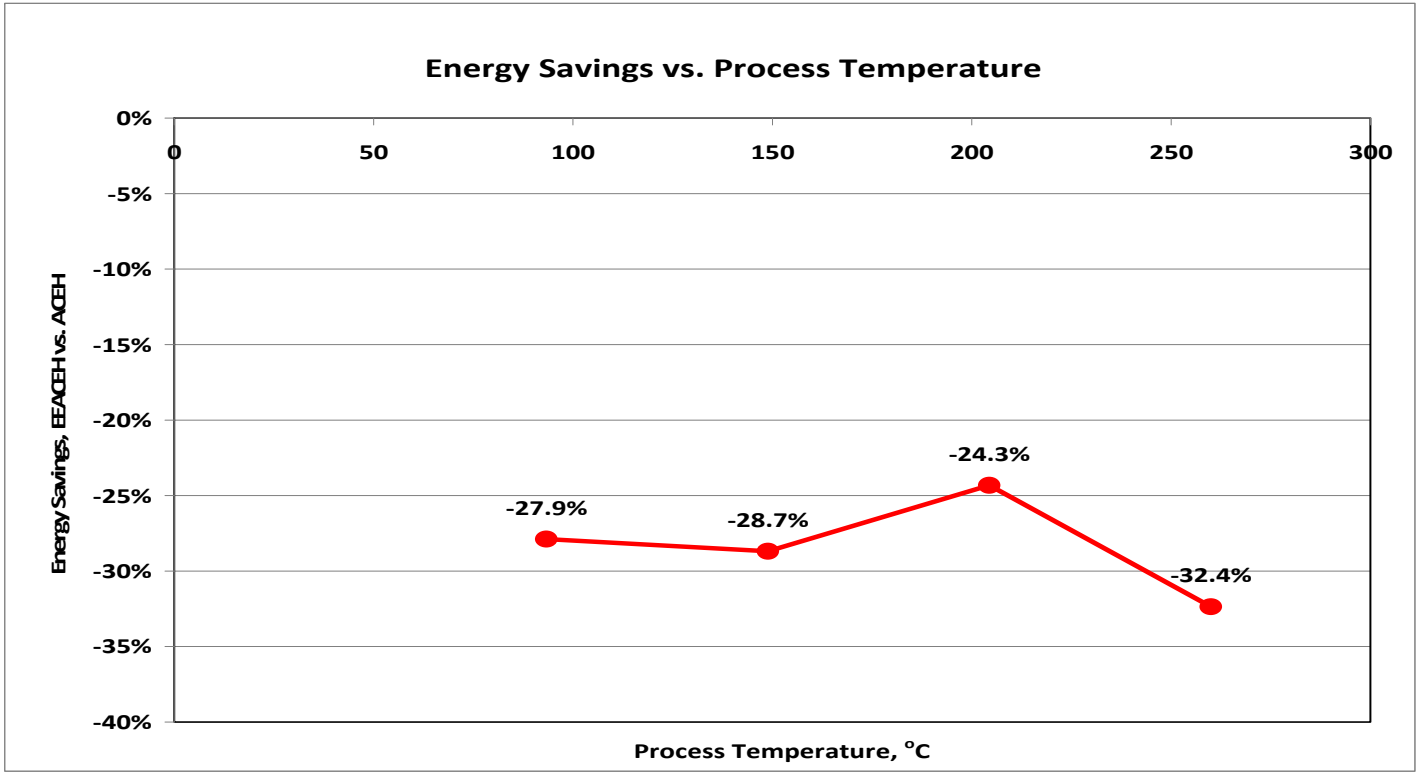
Heater w/ Fins



Energy Efficiency - Heater Insulation

ACEH vs. EEACEH

Energy Savings vs. Conventional Technology



ACEH = air cooled + electrically heated

EEACEH = Energy efficiency air cooled + electrically heated

Environmental friendly

TOPICS

1. Waste reduction with an edge bead reduction die
2. Improved flexibility with „Set up on Fly“
3. The process of correct Extruder sizing
4. Waste reduction – inline recycling
5. Energy savings at the Extruder
6. **Industry 4.0 - DS Activ – Predictive maintenance**
7. Summary

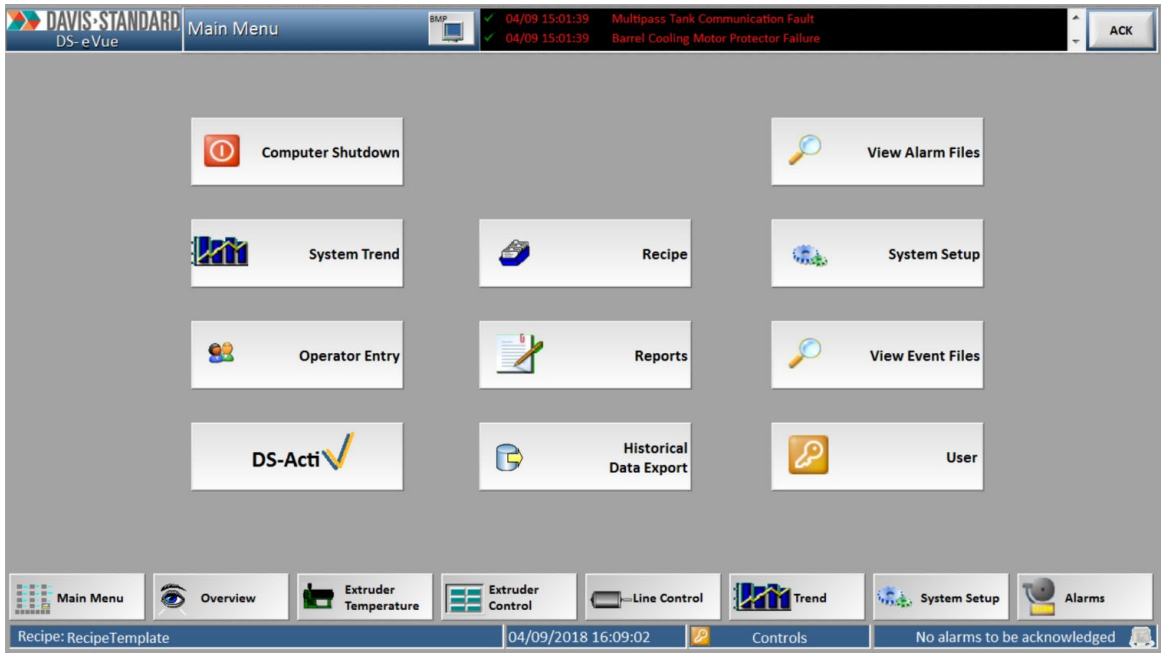
DS-Acti

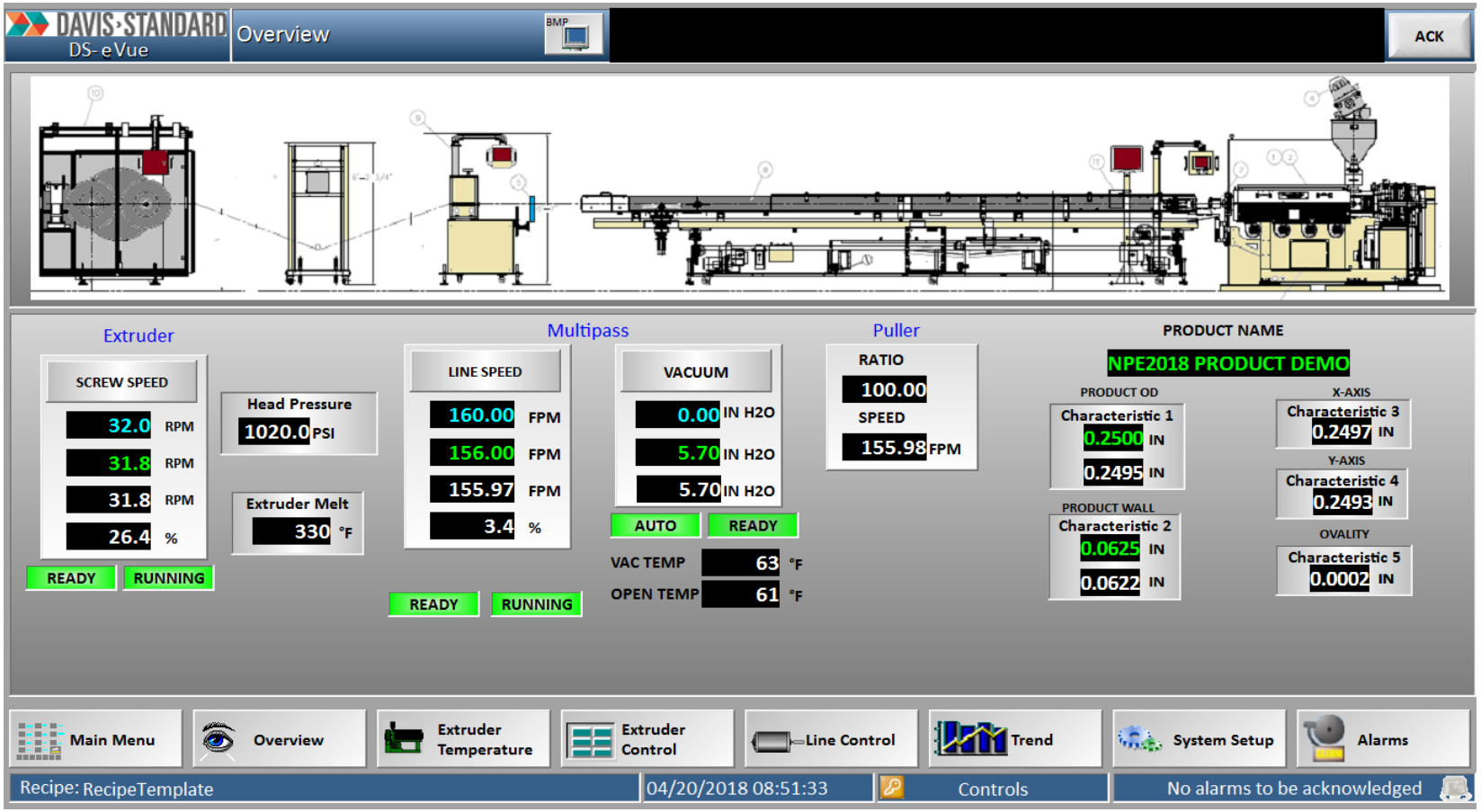
Provides customers with continuous machine condition monitoring

Users receive notifications via email and text, and continuous monitoring of production and machine status is available on smart devices and remote PCs

Key parameters monitored include:

Extruder reducer
Reducer lubrication system
Extruder motor characteristics
Drive power unit
Barrel heating and cooling
Screw and barrel:




DAVIS-STANDARD
DS-eVue
Overview
BMP
ACK
Extruder
SCREW SPEED
32.0 RPM
31.8 RPM
31.8 RPM
26.4 %
READY
RUNNING
Head Pressure
1020.0 PSI
Extruder Melt
330 °F
Multipass
LINE SPEED
160.00 FPM
156.00 FPM
155.97 FPM
3.4 %
READY
RUNNING
VACUUM
0.00 IN H2O
5.70 IN H2O
5.70 IN H2O
AUTO
READY
VAC TEMP 63 °F
OPEN TEMP 61 °F
Puller
RATIO
100.00
SPEED
155.98 FPM
PRODUCT NAME
NPE2018 PRODUCT DEMO
PRODUCT OD
Characteristic 1
0.2500 IN
0.2495 IN
PRODUCT WALL
Characteristic 2
0.0625 IN
0.0622 IN
X-AXIS
Characteristic 3
0.2497 IN
Y-AXIS
Characteristic 4
0.2493 IN
OVALITY
Characteristic 5
0.0002 IN
Main Menu
Overview
Extruder Temperature
Extruder Control
Line Control
Trend
System Setup
Alarms
Recipe: RecipeTemplate
04/20/2018 08:51:33
Controls
No alarms to be acknowledged

Reducer and Motor Section:

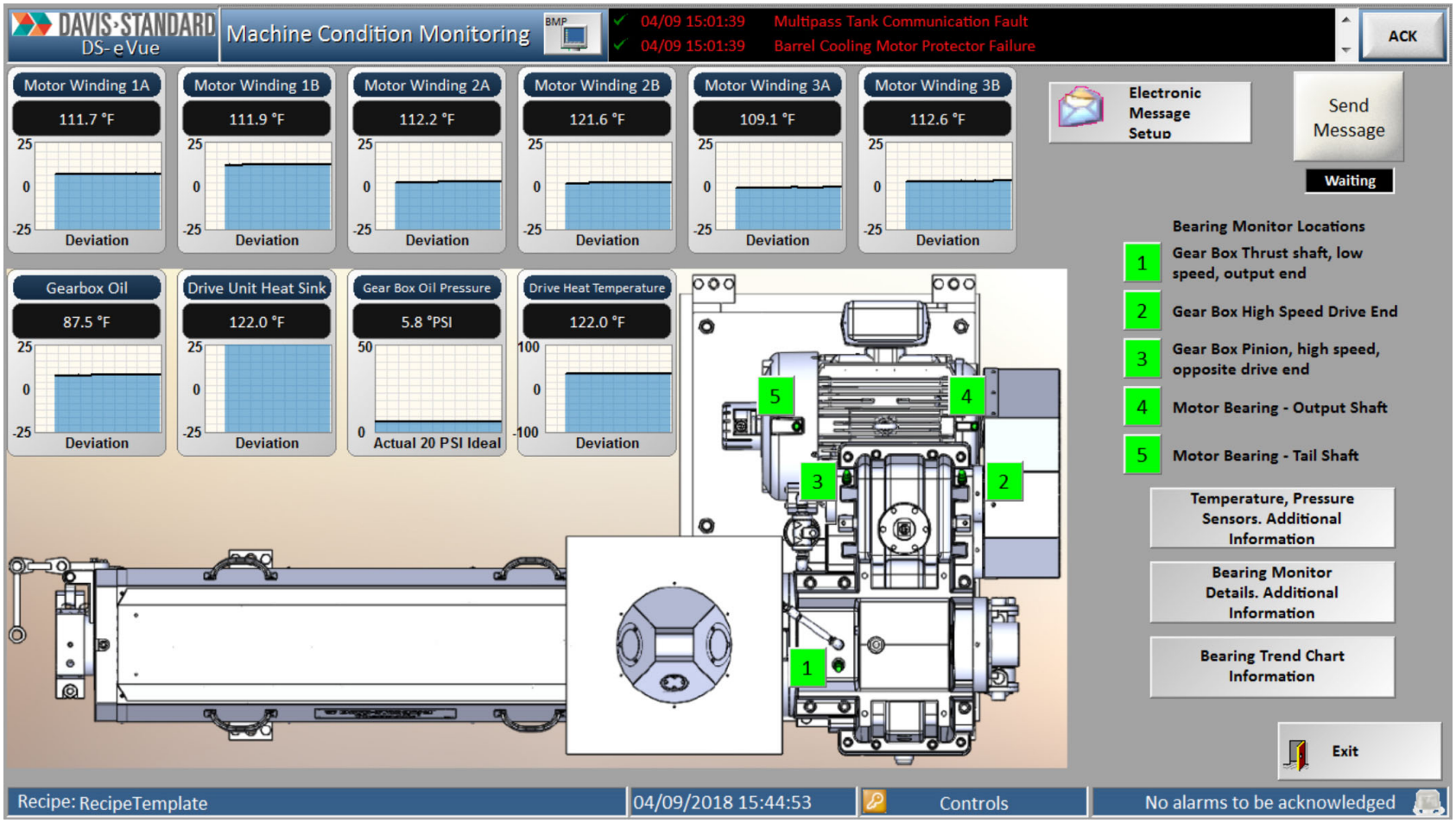
Vibration sensors are strategically located on the extruder reducer housing to assess the overall condition of the gears, bearings and lubrication system

Reducer lubrication system includes pressure, flow and temperature sensors to indicate that the system is performing within acceptable parameters.

Monitoring of instrumentation as well as speed and load provide indication of overall motor conditions and performance

Should the performance of these systems change a notification will be sent indicating that a parameter deviation has occurred and requires attention to prevent unplanned downtime.

.


DAVIS-STANDARD
DS-eVue
Machine Condition Monitoring
BMP
04/09 15:01:39 Multipass Tank Communication Fault
04/09 15:01:39 Barrel Cooling Motor Protector Failure
ACK
Motor Winding 1A
111.7 °F
Motor Winding 1B
111.9 °F
Motor Winding 2A
112.2 °F
Motor Winding 2B
121.6 °F
Motor Winding 3A
109.1 °F
Motor Winding 3B
112.6 °F
25
0
-25
Deviation
Electronic Message Setup
Send Message
Waiting
Gearbox Oil
87.5 °F
Drive Unit Heat Sink
122.0 °F
Gear Box Oil Pressure
5.8 °PSI
Drive Heat Temperature
122.0 °F
50
100
-100
Actual 20 PSI Ideal
Bearing Monitor Locations
1 Gear Box Thrust shaft, low speed, output end
2 Gear Box High Speed Drive End
3 Gear Box Pinion, high speed, opposite drive end
4 Motor Bearing - Output Shaft
5 Motor Bearing - Tail Shaft
Temperature, Pressure Sensors. Additional Information
Bearing Monitor Details. Additional Information
Bearing Trend Chart Information
Exit
Recipe: RecipeTemplate
04/09/2018 15:44:53
Controls
No alarms to be acknowledged

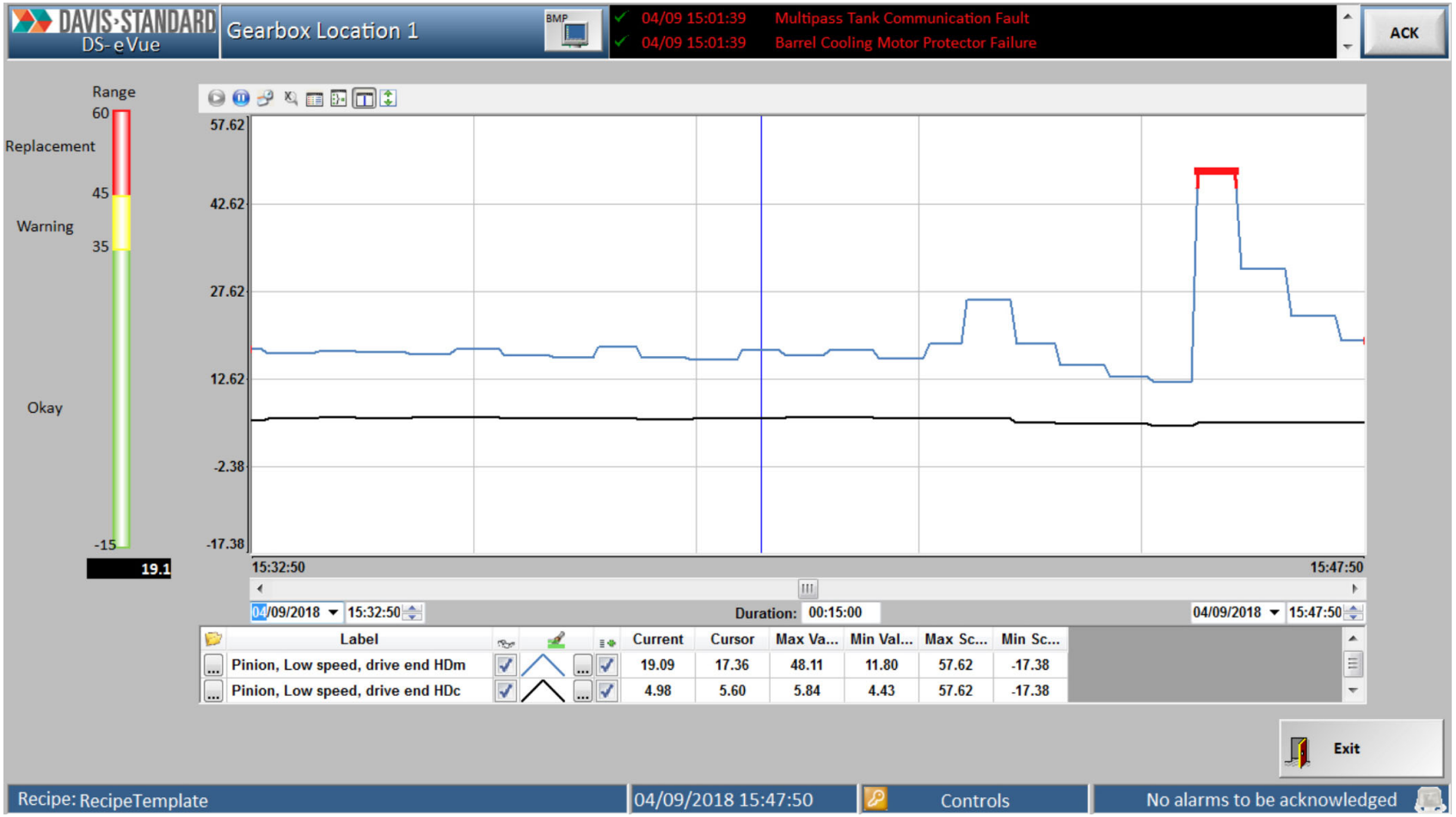
Maintenance Screens

Provide quick view of machine condition and status utilizing color coding near instrumentation and trending charts.

Color coding follows accepted standards:

- Green indication – operating within operating limits, no potential issues detected
- Yellow indication – warning condition of potential upcoming failure
- Red indication – failure is eminent

Warnings and fault indications result with notifications being sent to assigned customer contacts via email or SMS.


DAVIS-STANDARD
DS-eVue
Gearbox Location 1
BMP
04/09 15:01:39 Multipass Tank Communication Fault
04/09 15:01:39 Barrel Cooling Motor Protector Failure
ACK
Range
60
Replacement
45
Warning
35
Okay
-15
19.1
57.62
42.62
27.62
12.62
-2.38
-17.38
15:32:50
15:47:50
04/09/2018
15:32:50
Duration: 00:15:00
04/09/2018
15:47:50
Label
Current
Cursor
Max Va...
Min Val...
Max Sc...
Min Sc...
Pinion, Low speed, drive end HDm
19.09
17.36
48.11
11.80
57.62
-17.38
Pinion, Low speed, drive end HDc
4.98
5.60
5.84
4.43
57.62
-17.38
Exit
Recipe: RecipeTemplate
04/09/2018 15:47:50
Controls
No alarms to be acknowledged

TOPICS

1. Waste reduction with an edge bead reduction die
2. Improved flexibility with „Set up on Fly“
3. The process of correct Extruder sizing
4. Waste reduction – inline recycling
5. Energy savings at the Extruder
6. Industry 4.0 - DS Activ – Predictive maintenance
7. **Summary**

Summary

Most important topics for converters:

- Flexibility of the machine for shorter production runs

  → Quick grade changes with higher automation
- Machine availability
- Waste reduction
- Energy reduction
- Environmental friendly impact

New targets:

- Predictive maintenance for constant production in order to increase productivity

“Thank You”
for your patience

Presented by:

Michael Schröder
ER-WE-PA Davis Standard

Michael.schroeder@er-we-pa.de

PLACE
POLYMERS | LAMINATIONS | ADHESIVES | COATINGS | EXTRUSIONS
www.tappiplace.org

DAVIS-STANDARD®