Twin-Screw Extruder EcoTwin™ BCTA.

Innovations for a **better world.**

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Twin-Screw Extruder EcoTwin™ BCTA.

EcoTwin™ – Twin-Screw Extrusion System for fish and pet food of consistently high quality.

- Modules for desired product properties
- High product quality through reliable process control
- Extremely user-friendly
- Flexible cutter

The twin-screw extrusion system EcoTwin™ is especially tailored to the needs of feed production, particularly the production of pet food and feed for industrial fish farming. The EcoTwin™ is optionally available with an SME module and density control module.

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Desired product quality thanks to flexible system.

- With the SME (specific mechanical energy)and density control modules, the cooking degreeand density of the end product can be adjusted according to customer specifications.

- The intelligent process control of EcoTwin™ monitors the various production parameters, thus guaranteeing the consistent quality of the product.

- The unique screw ejection unit solves the problem of seized screws: instead of having to disassemble the machine, all that's necessary to eject the pair of screws is a single touch on the touch-screen.

-

- The twin-screw extruder is equipped with a cutter that can be moved laterally – the knife can be adjusted while the machine is in operation.

The Bühler twin-screw Extruder EcoTwin™.

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Twin-Screw Extrusion System EcoTwin™ BCTA.

Contents.

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Contents.

Twin-Screw Extrusion System EcoTwin™ BCTA.
Basics.

Density Control System

Energy recovery

Horizontal forced feeder to extruder

Two step preconditioner

Cutter

SME control and / or density control

Compact, low profile

Hydraulic screw push out

Automatic control system

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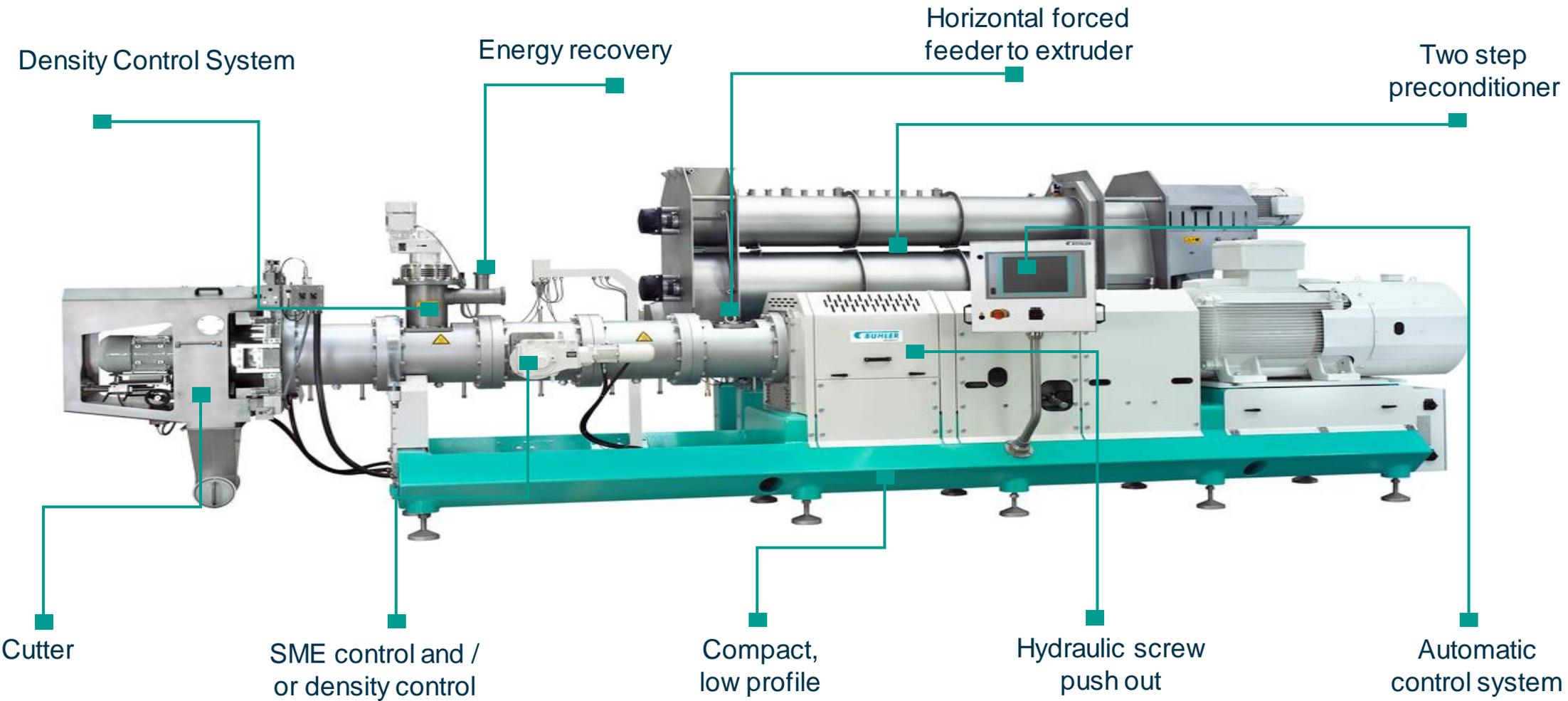
Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Hydraulic screw removal.

- Integrated high pressure hydraulic screw extraction unit.

- Patented device operated by push button.

- Easy operation on clean.

- Screw push-out with tight-tensioned screw elements.

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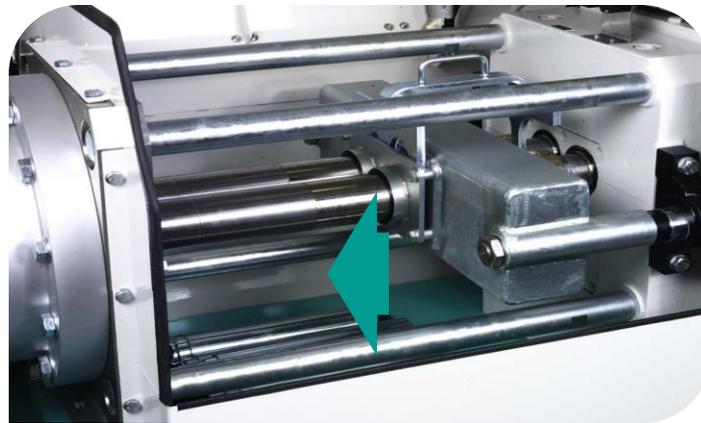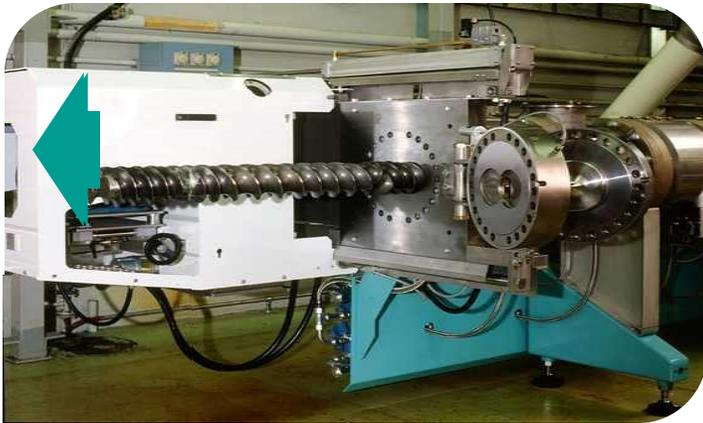
Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Recent modifications.

- Conditioner, drive and support.

- Side feeder concept.

- Coupling plenum, shaft seal.

- Hydraulic screw removal device.

- Modular barrel design.

- Redesigned venting screw.

- Cutter reinforcement for high speed cutting of small pellets.

- Modular die design.

- Additional control modes for faster starting of preconditioning and SME control.
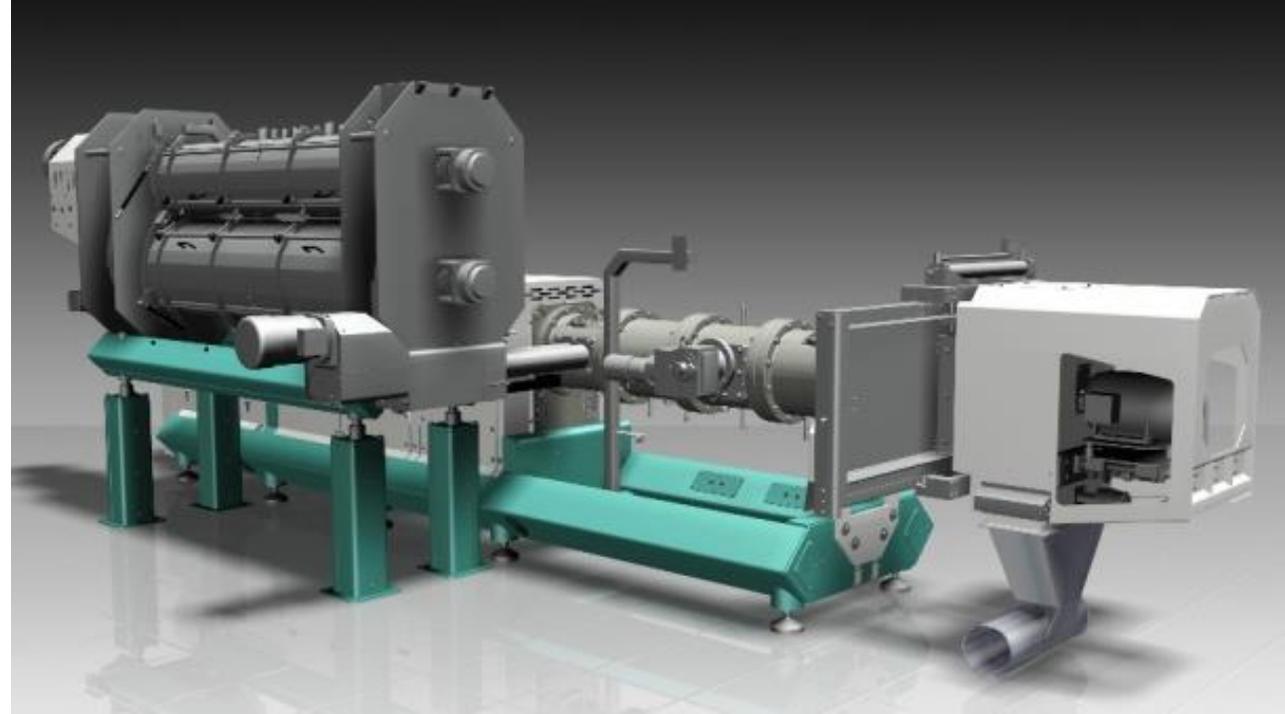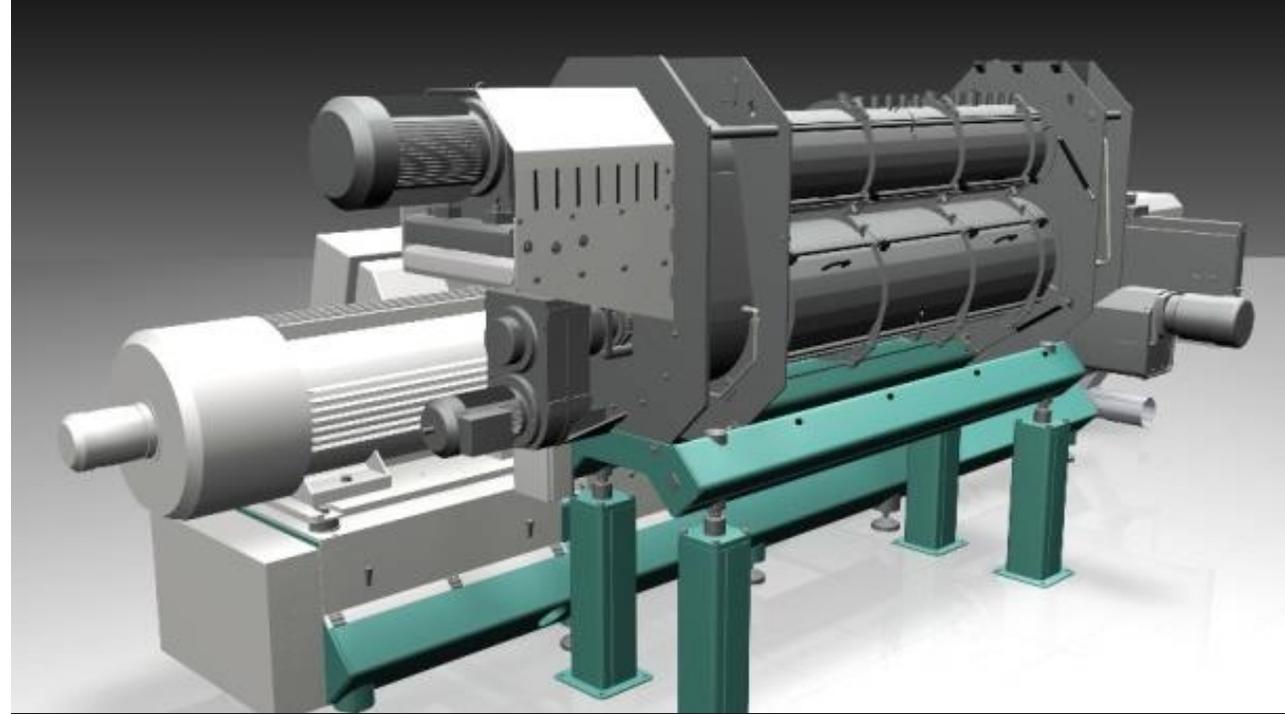
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Twin-screw extrusion system EcoTwin™ BCTA.
Execution with laterally movable cutting head (I).
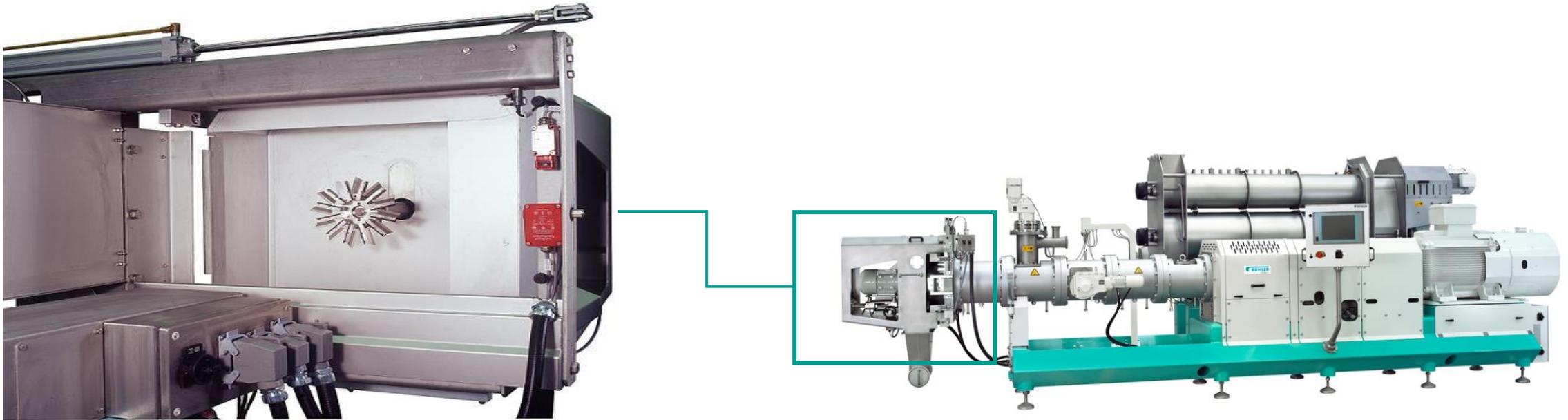
Hinged door for ease of access to the knife head.

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Twin-screw extrusion system EcoTwin™ BCTA.
Execution with laterally movable cutting head (II).

Closed cutter.

Open cutter.

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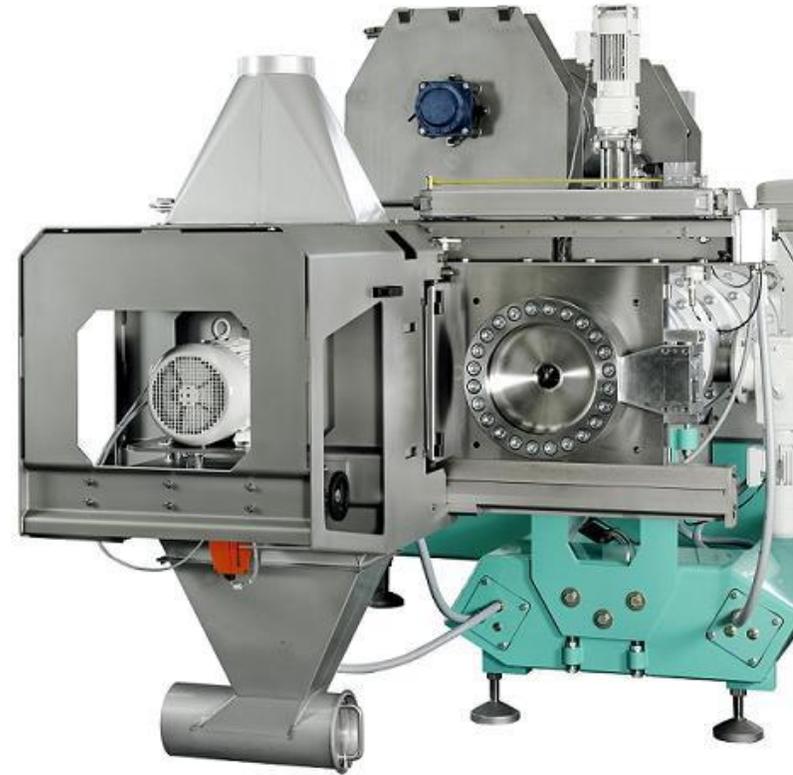
Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Cutter designs – sliding cutter design arrangements.

- Standard feature of EcoTwin™ series.

- Allowing to start under wet conditions with knife head disengaged.

- Engagement of knives starts only after right consistency of dough has been reached.

- Allows for easy and fast die change.

- Clean cutter plenum, fast and simple die design and die change.

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# Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Die designs.

Straight bore.

- Centering asymmetric flow and distribution to concentric die hole arrangement.

- Typical for die plates with large number of small holes.
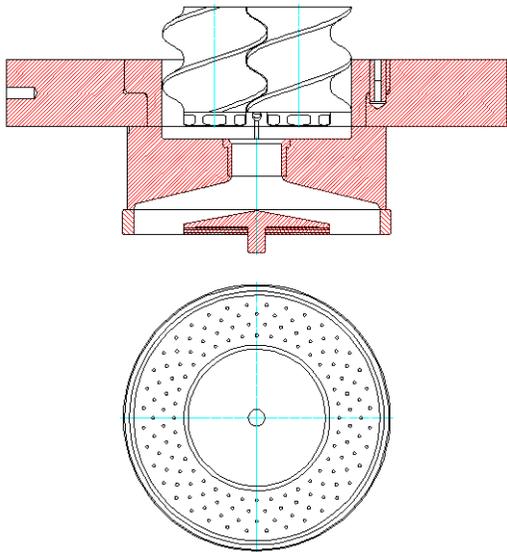
Venturi.

- Same as straight bore but for less pressure drop.

- Very flexible for combinations with different die plates and pre-die plates.
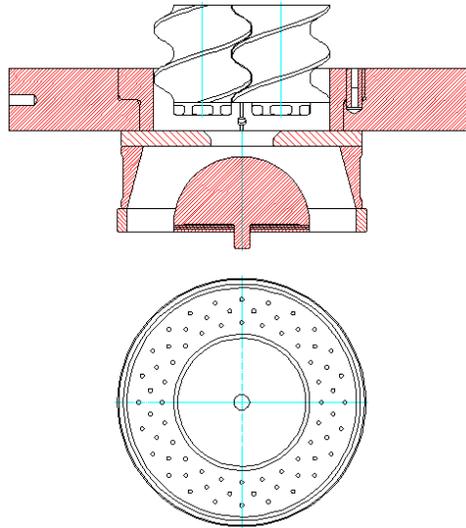
Revolver.

- Long guidance through plastic lined channels for equal pellet length and cylindrical shapes.
- Ideal for larger pellet sizes above 6 mm.
- Flow on all holes with equal history.
- Requires quick change of inserts only.

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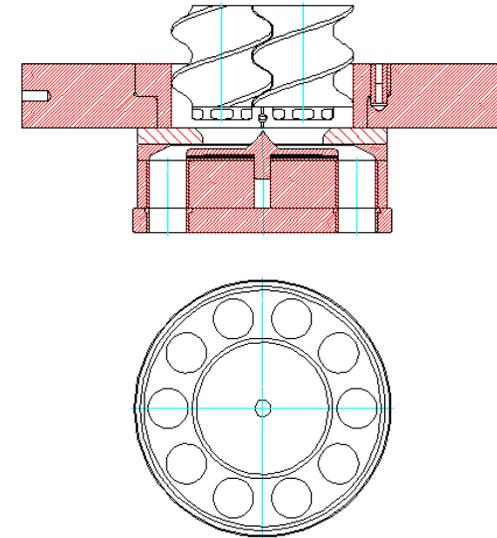
Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Coupling plenum.

- Vented hood with perforated grid to avoid condensation.

- Open bottom for wash-down.

- New, drive lantern seal with stuffing box packing and grease barrier.

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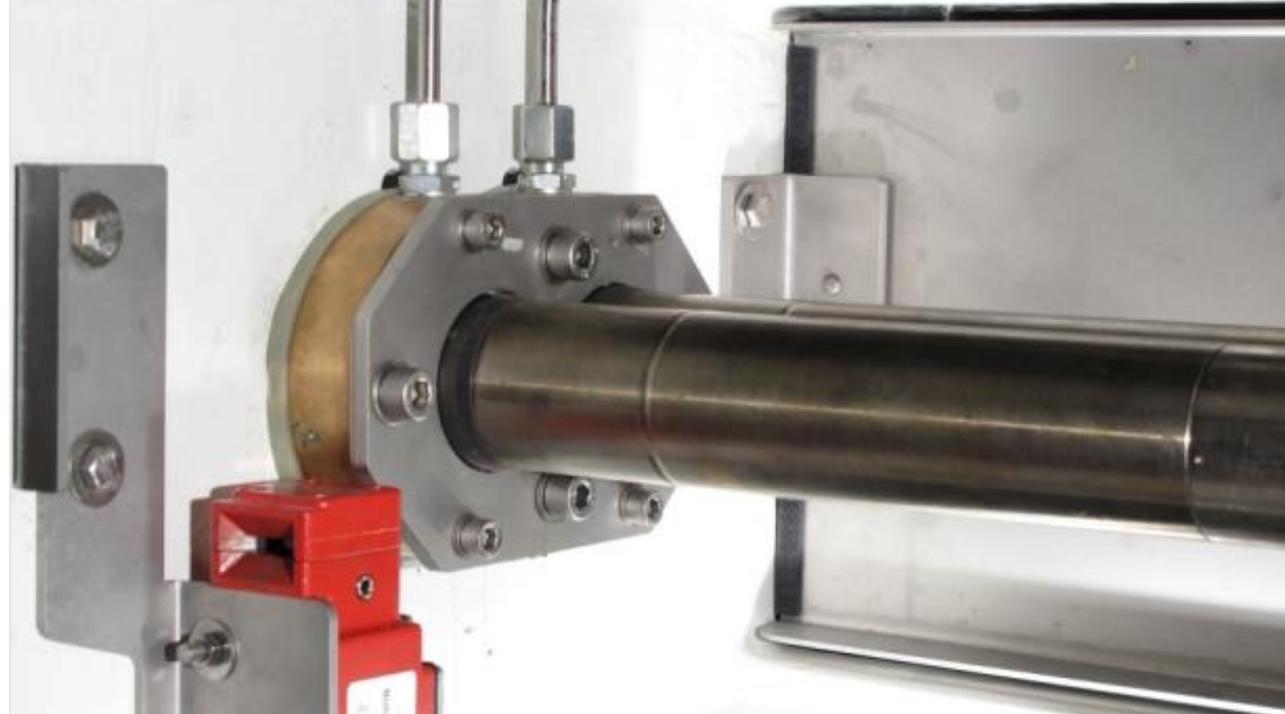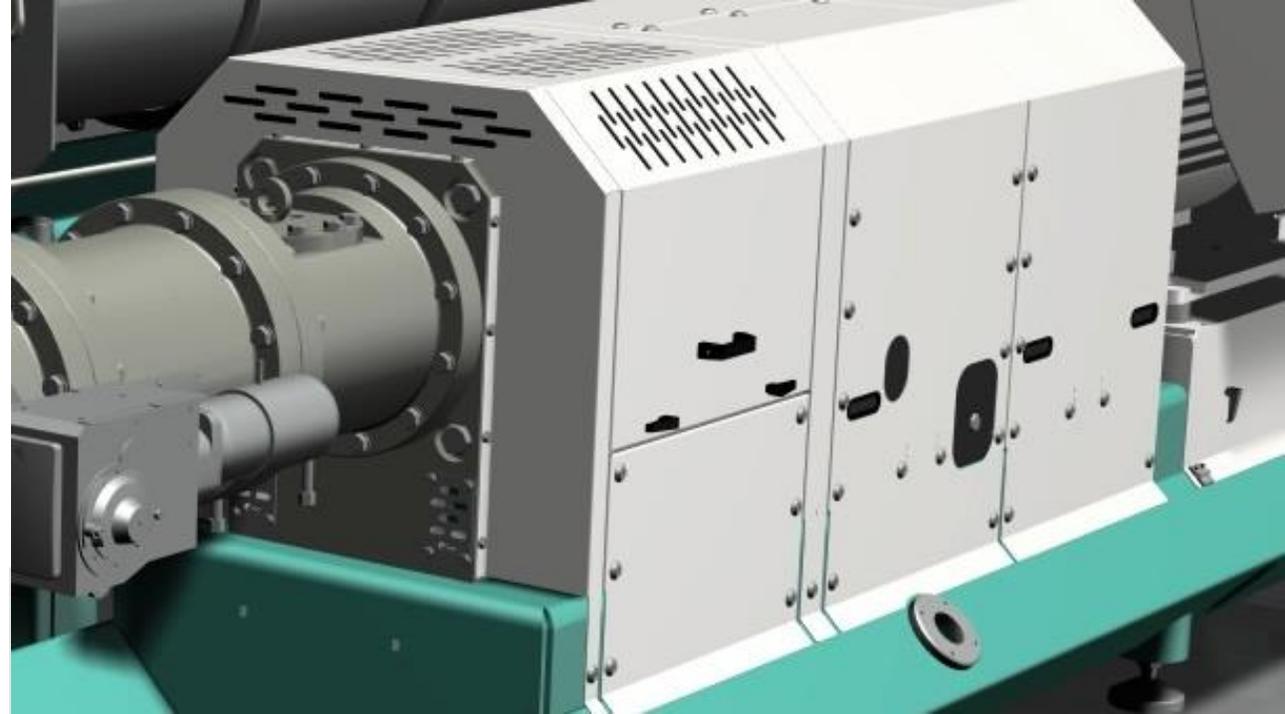
Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Modular barrel arrangement.

Inlet barrel for side feeder.
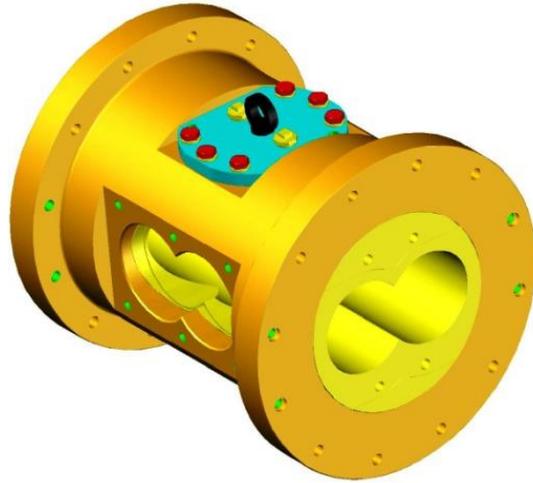
Venting barrel.

Closed barrel, no heating, no cooling.
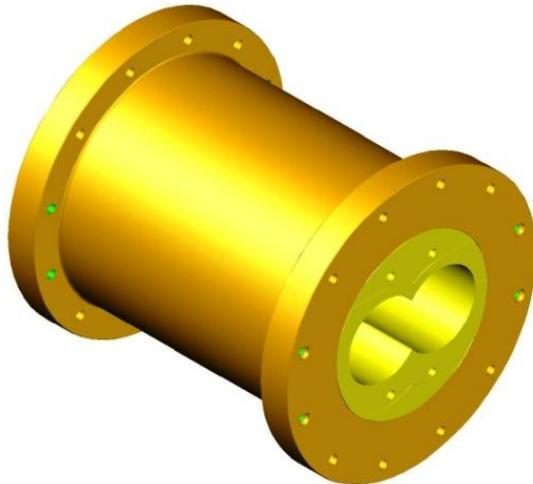
Cooling barrel, with cooling liner.

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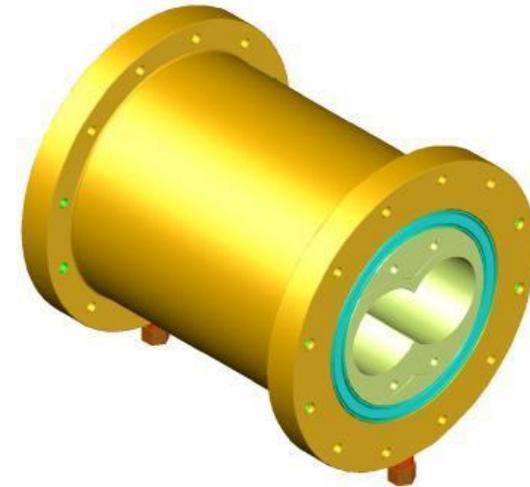
Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Venting screw.

- Slow turning gear motor.

- Reinforced screw design.

- New seal arrangement with stuffing box packing and spin disk.
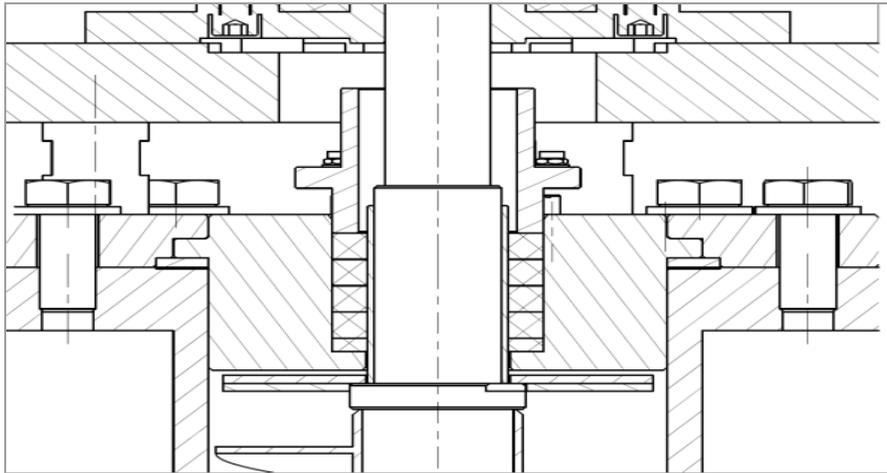
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Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Capacity range of Bühler TSE extruders for Aqua Feed.

- Based on 1.4 d pitch elements in infeed and venting section.

- Considering the limited absolute dimensions of the spouting especially for small extruders.

- Maintaining 10 – 15% spare capacity on large production machines.

Extruder type	Screw diameter	Screw rpm	Theoretical scale-up kg/h	„Standard" (nominal) capacity
BCTG	62	1´000	1´500	1´000
BCTF	93	1´000	5´063	4´000
BCTH	125	800	9´834	8´000
BCTJ	175	600	20´239	18´000

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Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Tailored for high-volume feed applications.

- **Pet food:** High or low density without compromising degree of gelatinization.

- **Fish feed:** Sinking or floating, without compromising water stability.

- **Shrimp feed:** High density, water stable and good food conversion.

Advantages:

- Influence of different formulas can be compensated without changing screw configuration.

- Extreme flexibility for changing between all of above applications.

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Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Economic considerations (I).

Feature	Description	Savings
Raw material savings.	▪ TSE extrusion process with SME and density control operates over a wider range of raw material specifications than SSE. ▪ Improved conversion rates increase value of final product.	Saves raw material costs.
Less waste material.	▪ ECOtwin™ in automatic mode, together with SME and density control features allows extremely fast start/stops with minimal offspec material. ▪ With integrated slurry system tailings and flush water can be recycled online.	Saves raw material and handling.
Fast changeover.	▪ Product and die change with pneumatic cutting device can be as short as five minutes. ▪ Increases average capacity, especially with short production runs.	Increases average capacity.

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Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Economic considerations (II).

Feature	Description	Savings
Automation.	▪ High degree of sophistication allows faster response, reaches better quality of product with less handling of offspec materials, reduces bad starts, etc.	Less cost and human error, improves traceability.
Improved conversion rates.	▪ TSE can produce pellets with better water stability and less fines. ▪ Due optimal cooking conditions better product quality possible, independent of raw material fluctuations.	Increases product value and improves market position.
Less power consumption.	▪ SME control permits running at ideal process condition independent of screw configuration, resulting in generally lower average SME consumption. ▪ Expansion can be supported by steam injection rather than excessive SME dissipation.	Saves electricity, reduce water.

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Twin-Screw Extrusion System EcoTwin™ BCTA – Basics.
Economic considerations (III).

| Feature	Description	Savings
Energy recovery.	▪ Exhausted steam from vented port is fully recycled, likewise the hot water from the vacuum pump.	Saves energy.
Higher gelatinization than SSE or traditional TSE.	▪ Twin-screw extruder, has no traction problems of screw with soft and sticky product like SSE. ▪ Two-step pre-conditioning. ▪ SME control allows optimized process conditions independent of raw material and screw configuration.	Increases product value and improves market position.
Less power consumption.	▪ Two-step conditioner and TSE process tendentially require 1 – 2 % less moisture than SSE.	Saves drying cost, increases capacity.
Reduced wear cost.	▪ TSE is less susceptible to wear than SSE. ▪ SME control automatically compensates for progressing wear. ECOtwin™ works with cast screw elements with extreme durability.	Reduces wear cost.

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Contents.

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EcoTwin™ – SME control module.

EcoTwin™ – SME control module.
Overview.

- Variable restriction device with two valve cylinders.

- Closing of valve cylinders will increase material backup length ahead of restriction.

- This causes the filling degree and the retention time to rise, in turn increasing the SME.

- Can be incorporated at any required point of the process.

- Possibility of separating the cooking and shaping process.

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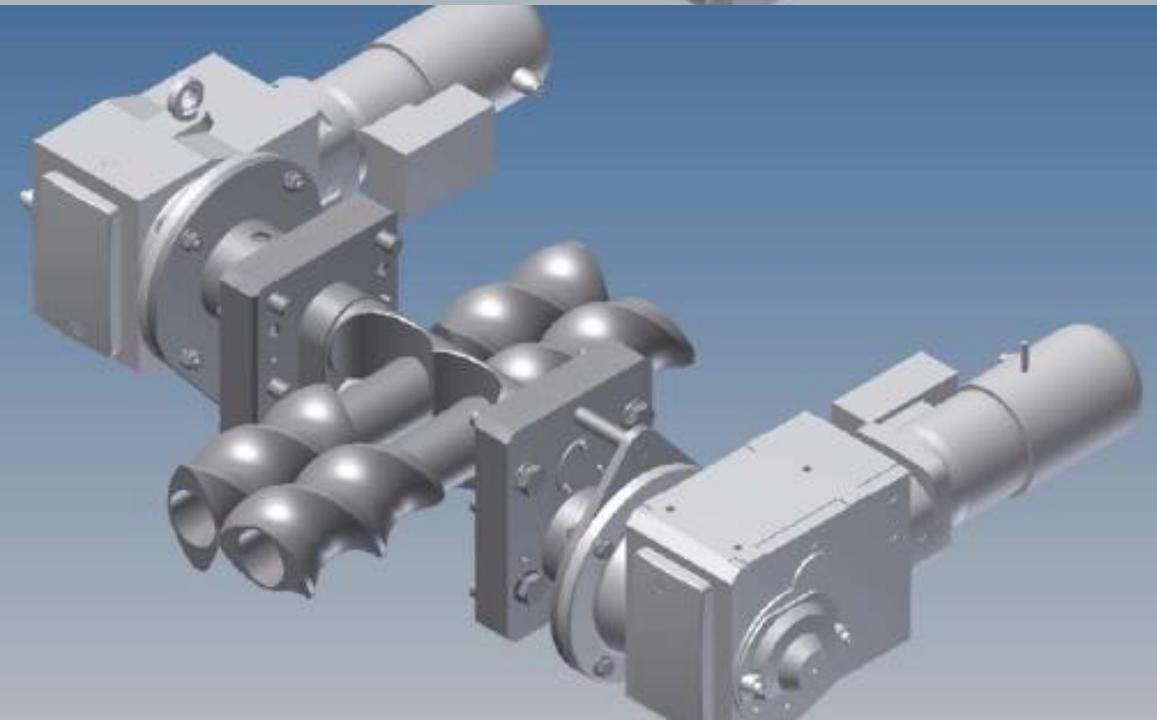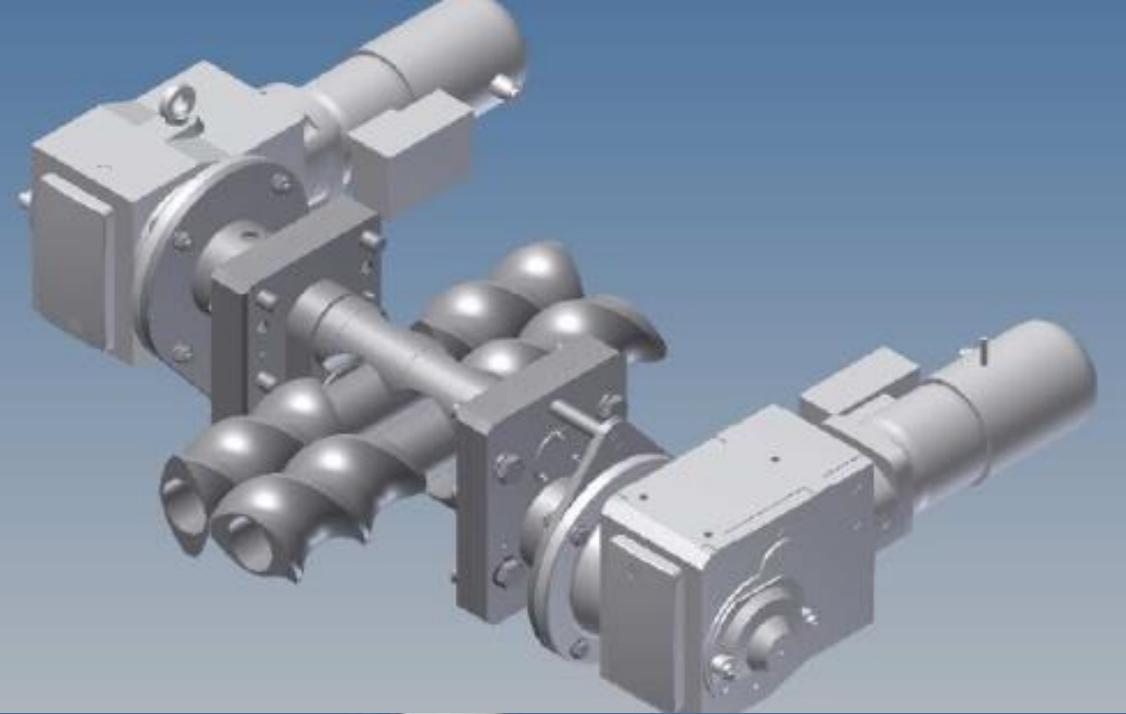
EcoTwin™ – SME control module.
Practical aspects.

- SME control module comes complete with barrel, valve, drives and frequency inverters.

- Includes special screw elements for modification of traditional screw configuration.

- Automatically controlled by BCTB2 control system.

Note:

- If fully opened and inactivated (by simple parameter setting in BCTB), the extruder can also be run with traditional screw configuration. The SME control module then works as regular closed barrel.

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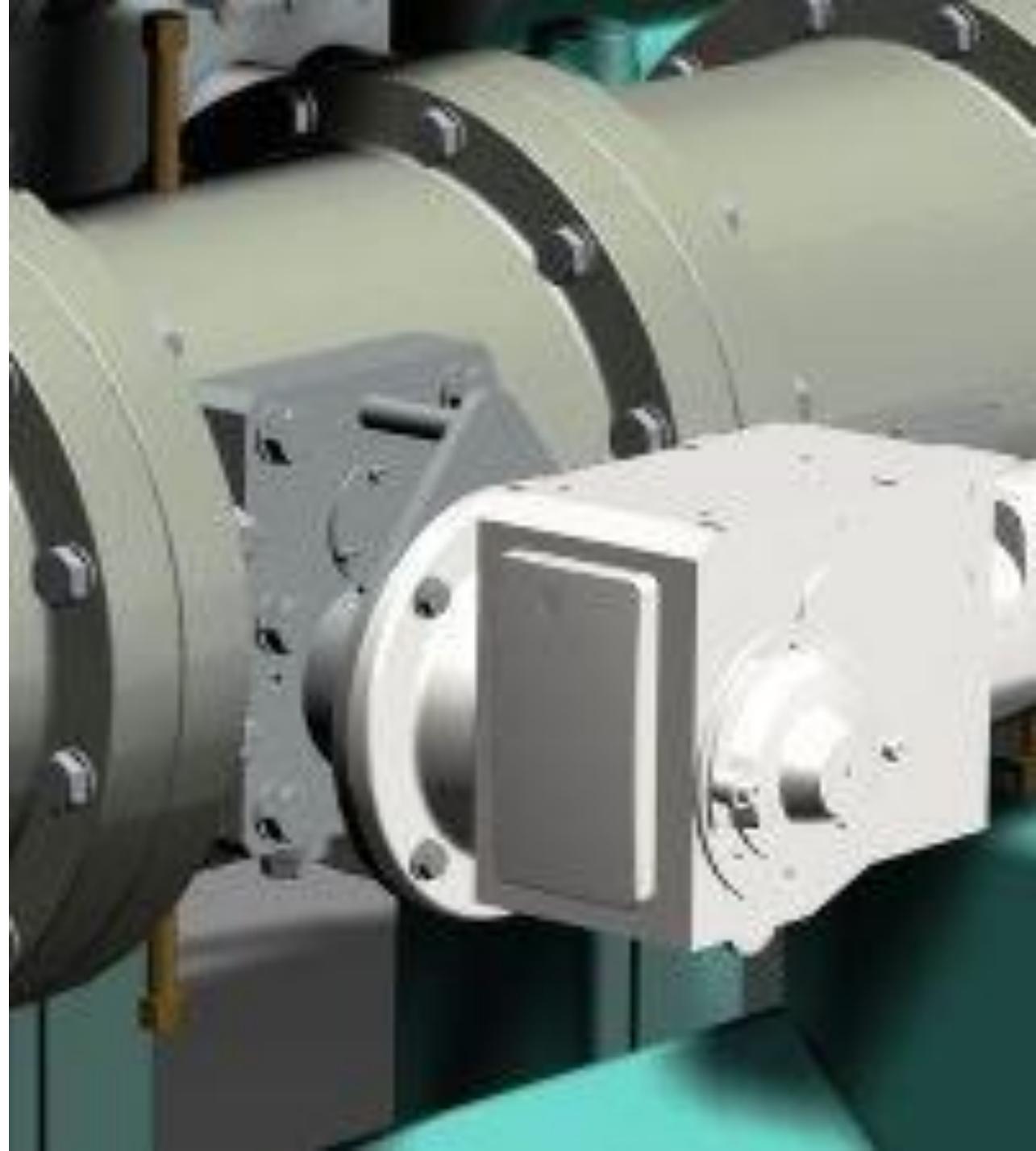
EcoTwin™ – SME control module.
Screw configuration – example screw pitch and filling degree.
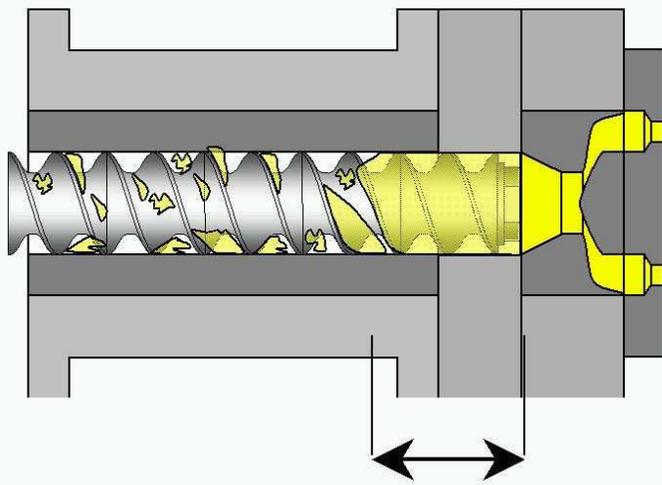
Short pitch, slow forward motion, good traction.
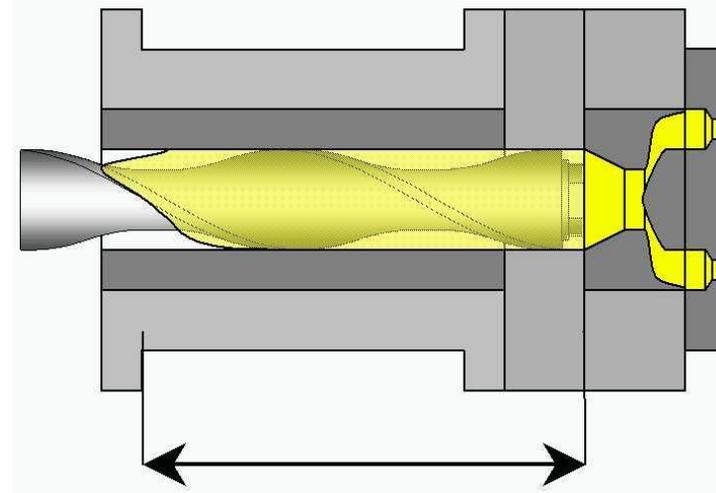
Long pitch, fast forward motion, bad traction, long backfill.

Without backfill – no energy dissipation.
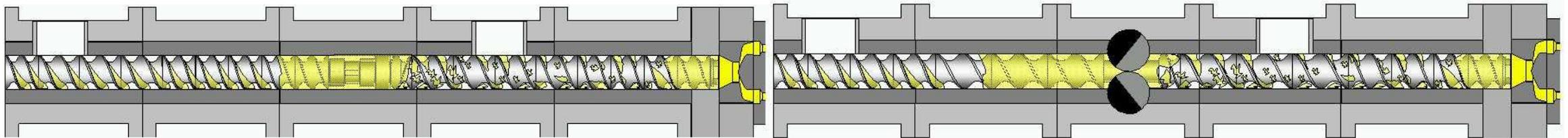
Traditional screw configuration.

ECOtwin™, long pitch screw elements, reduced diameters.

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EcoTwin™ – SME control module.
SME valve acts as a bearing.

Screw is lubricated by the product, no contact with the barrels.

Product flow.

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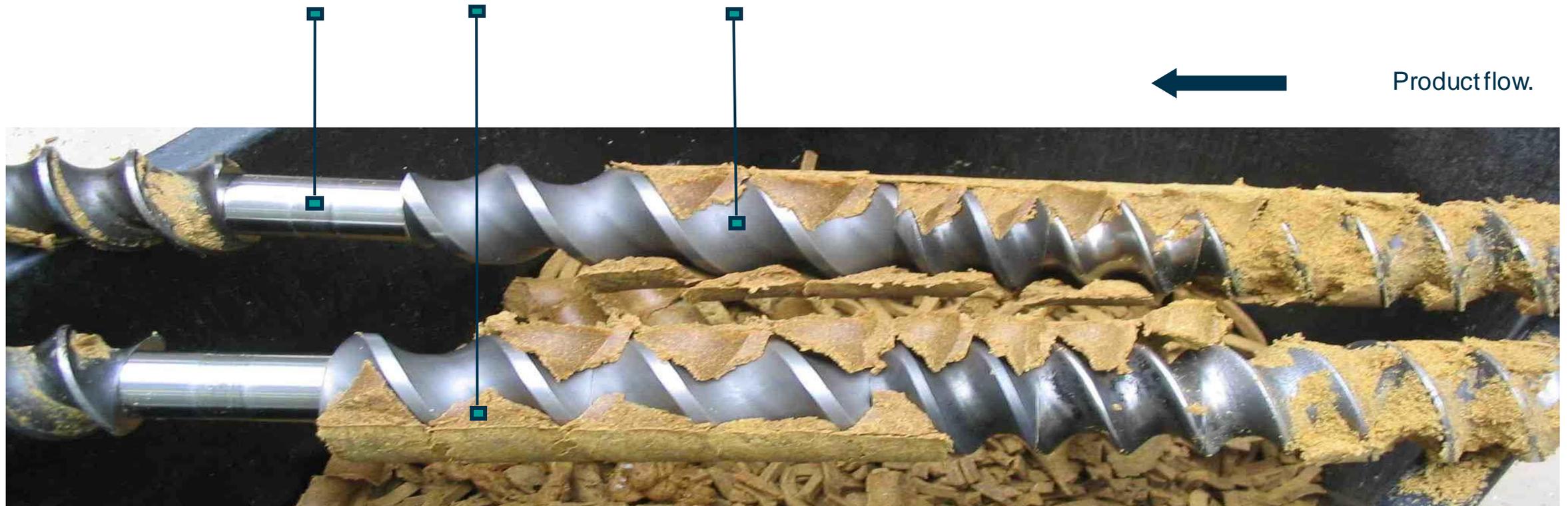
EcoTwin™ – SME control module.
Cooking, venting and compression zone.

Backfill due to die resistance.

Crumbs in venting zone.

Hot meal infeed.

Backfill at high torque.

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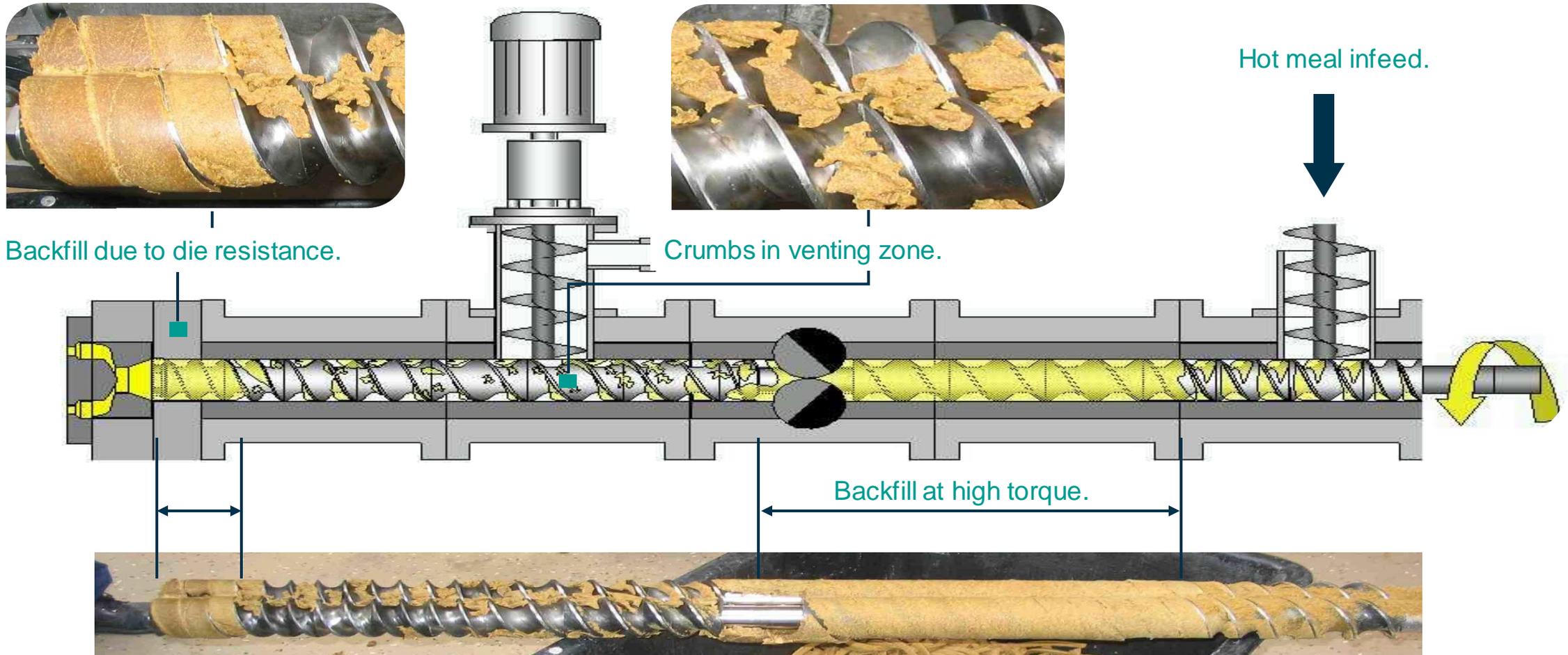
EcoTwin™ – SME control module.
Variation of torque (SME, temperature increase) by valve pos.
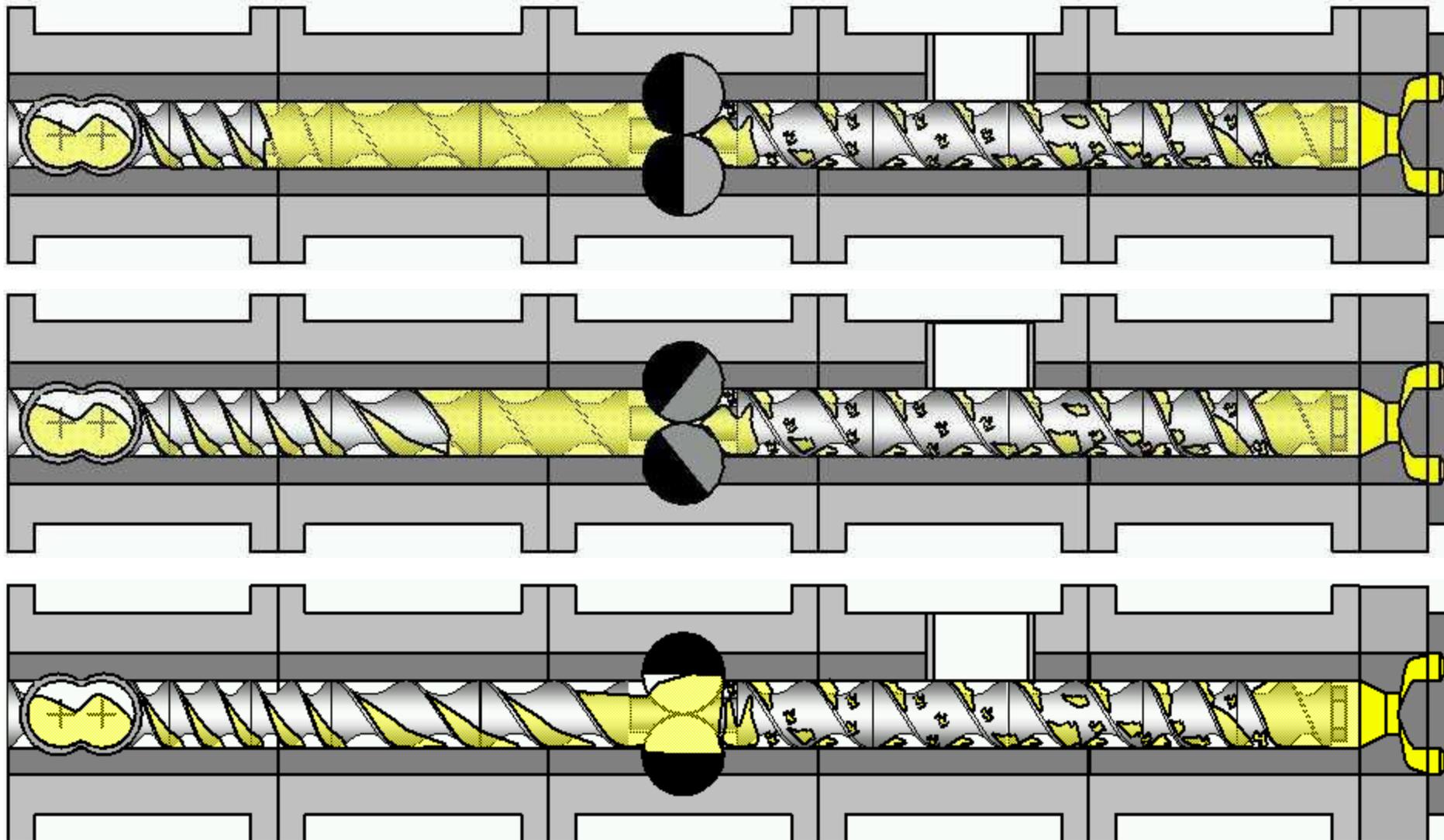
40 Wh / kg
Δt 52 °C

25 Wh / kg
Δt 33 °C

10 Wh / kg
Δt 13 °C

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EcoTwin™ – SME control module.
Example – temperature increase due to SME (I).

Dry infeed to conditioner (throughput base for SME calculation) 8 t/h.

- Moisture content of meal m_w _____
  _____10%.

- Solids content of meal m_s _____
  _____90%.

- Moisture added in conditioner (8% steam and 15% water) m_{wa}_____23%.
  - i.e. mass flow at inlet of extruder is 9840 kg/h at 26.8% moisture.

- Specific heat capacity of solids content of meal c_s_____approx. 1.5 kJ/kg°C.

- Specific heat capacity of water cw_____
  _____(4.187 kJ/kg°C).

- Temperature after pre-conditioner_____
  _____95 °C.

- Extruder torque_____
  _____3000 Nm or 3.0 kNm.

- Screw speed_____
  _____
  _____700 rpm.

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EcoTwin™ – SME control module.
Example – temperature increase due to SME (II).

- SME = 27.475 kWh/t (based on dry infeed).

- Δt (temperature increase in extruder) = 36 °C.

$$\text{SME [kWh/t]} = \frac{2 \cdot \pi}{60 \text{ [s/min]}} \cdot \frac{\text{screw speed [1/min]} \cdot \text{torque [kNm]}}{\text{throughput [t/h]}}$$

$$\Delta t \text{ [°C]} = \frac{100 \cdot \text{SME [kWh/t]}}{(((m_s \cdot c_s) + ((m_w + m_{wa}) \cdot c_w)))} \cdot \frac{3600 \text{ [s/h]}}{1000 \text{ [kg/t]}}$$

3000 Nm
700 rpm

220 kW

9840 kg/h
26.8%, 95°C

approx.
18 kWh/t

closed

approx.
9 kWh/t

131 °C

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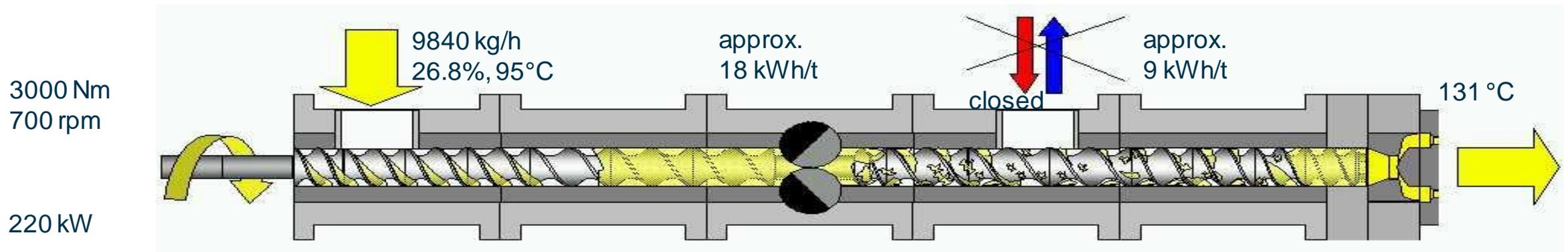
EcoTwin™ – SME control module.
Effect of oil addition (I).

- Trial date 20.10.04.

- 29 % protein, 7% fat in premix.

- Total flow = 630 kg/hr.

- Screw rpm = 800.

- Soya oil addition.
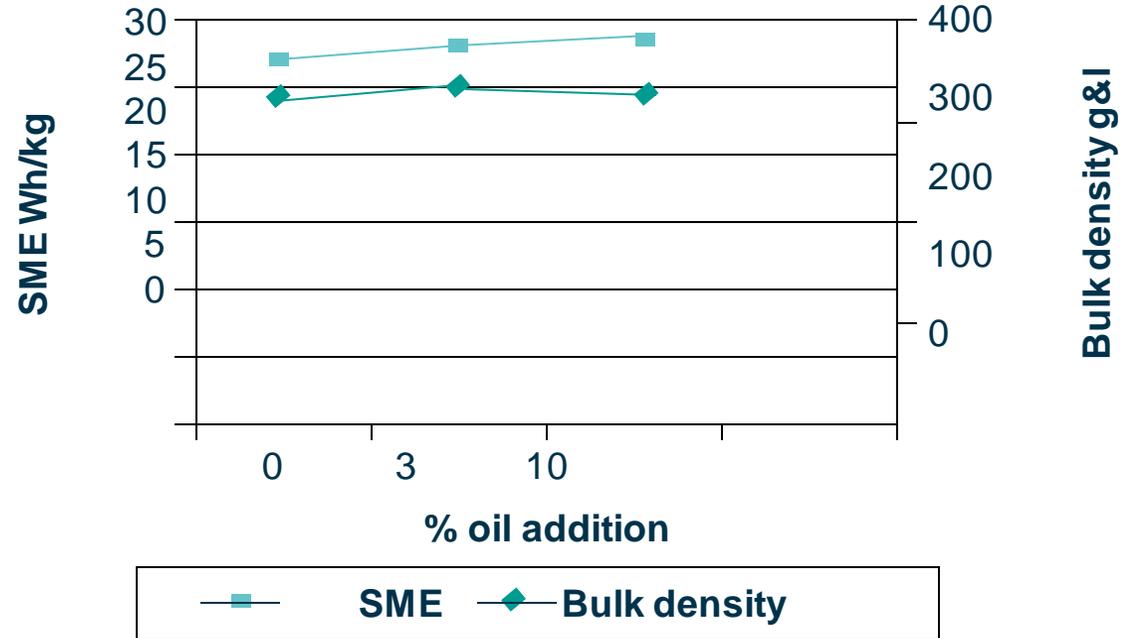
EcoTwin™ – SME control module.
Effect of oil addition (II).
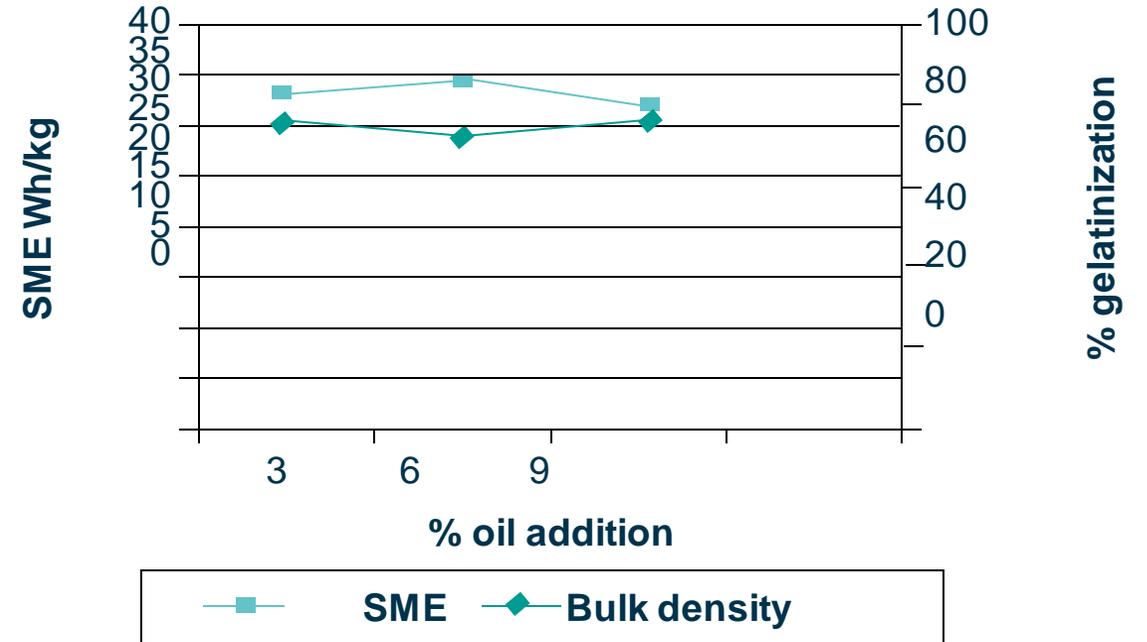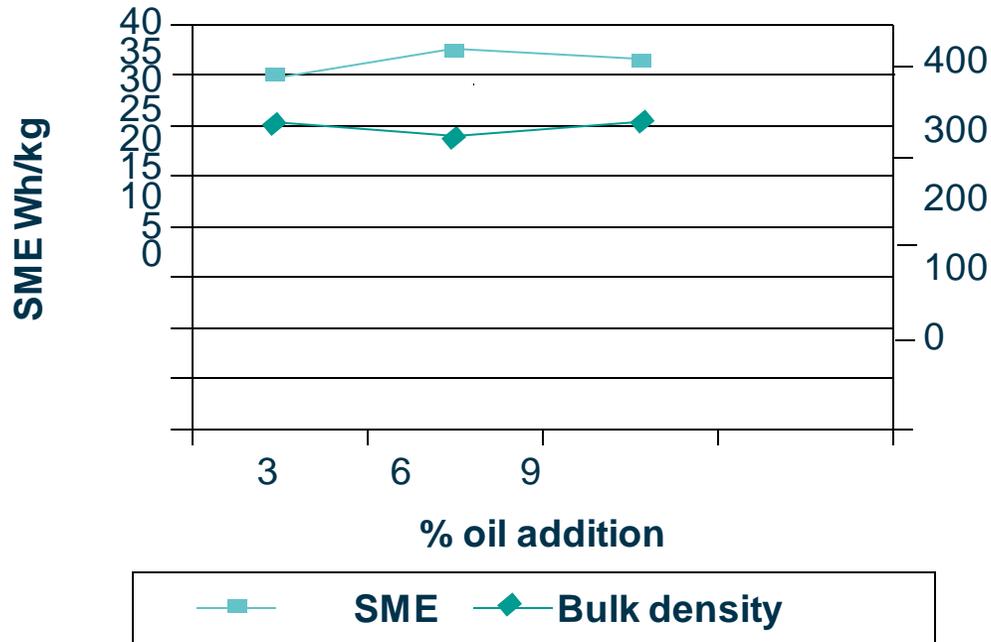
- Trial date 23.03.05.
- Pet food formulation.
- Total flow = 525 kg/hr.
- Screw rpm = 570.
- Soya oil addition.

3%   6%   9%   oil addition

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EcoTwin™ – SME control module.
SME valve alignment – fully open / fully closed position.

- In open position the surface of the SME shafts have to be flush with the barrels.

- Needs to be checked manually through the venting.

- Without a venting port the horizontal position is also marked on the shaft ends.

- In fully closed position the valve has to be aligned with the center line and form a perfectly round opening.
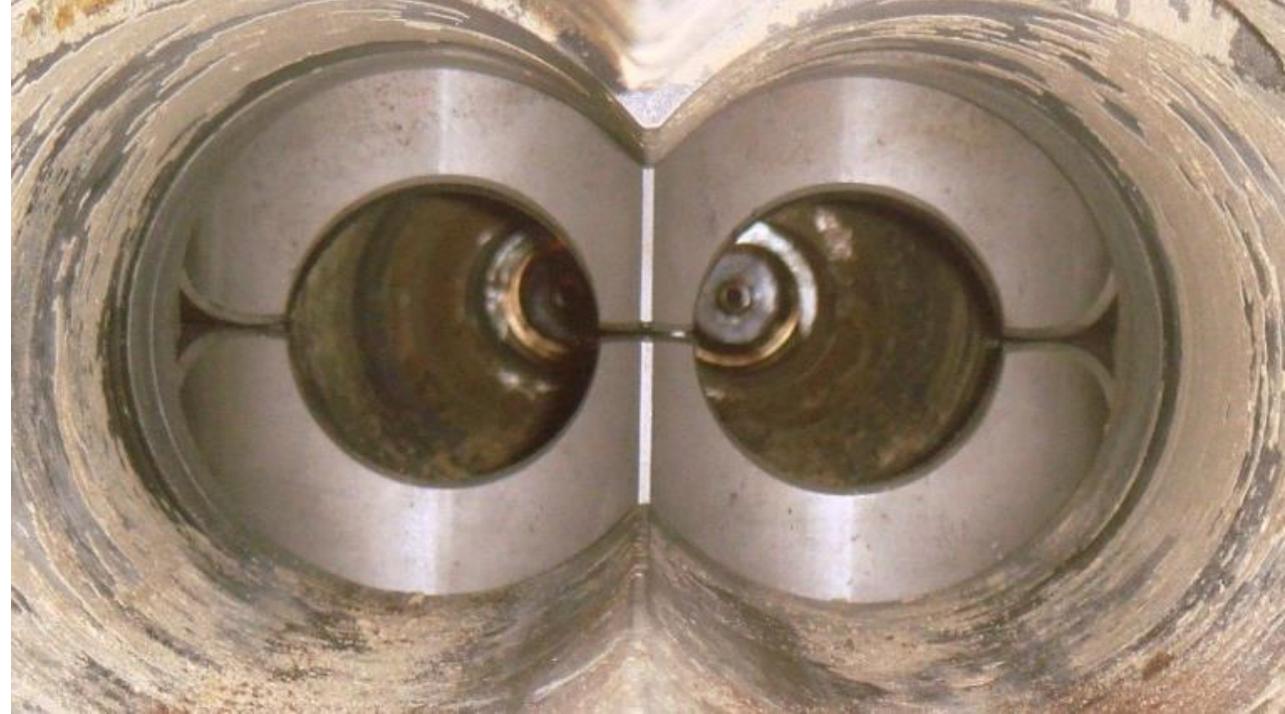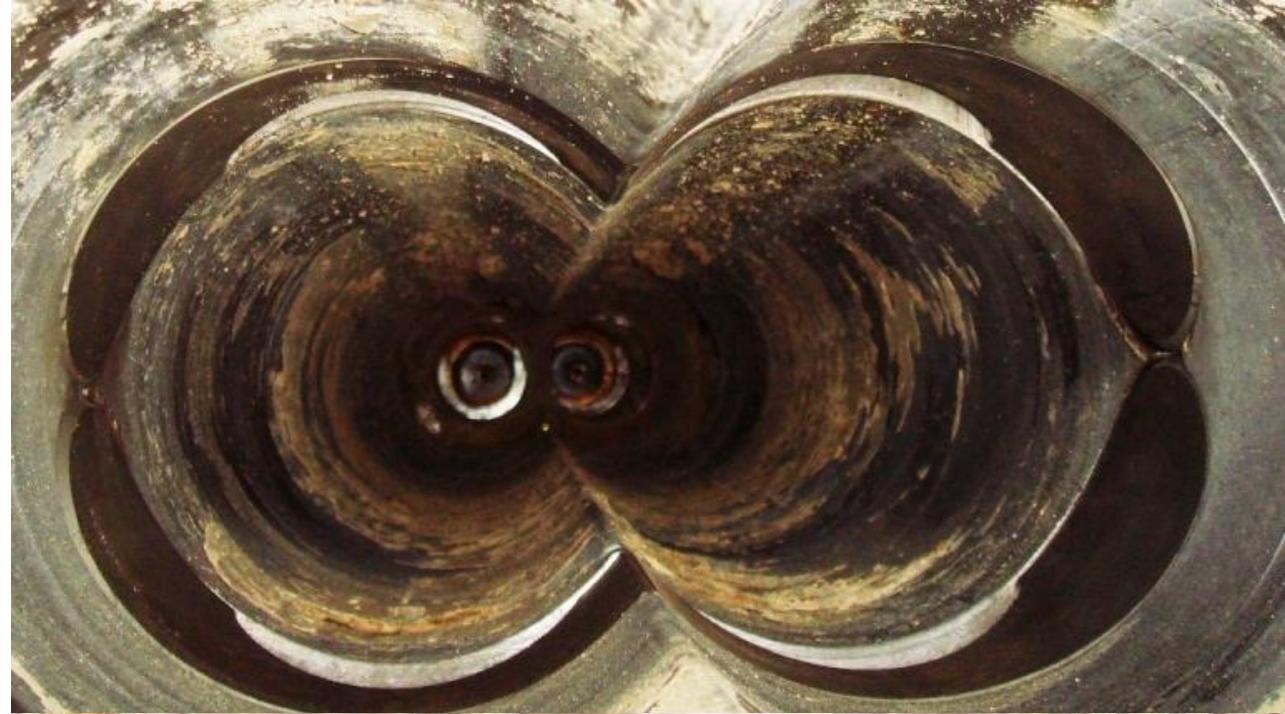
Contents.

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EcoTwin™ – Density control.

EcoTwin™ – Density control.

- Closed loop controls of the position of three valves according to desired pressure.

- Configurable at any barrel position of the extruder.

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EcoTwin™ – Density control.
Density range for SME and density control.

SME (dry infeed) [kWh/t]	10	20	30	40
Temperature increase	13	26	39	52
Pet Food, Aqua Feed, approximately bulk densities [g/l]				
Steam injection	500	440	380	300
Neutral	570	500	430	360
Steam venting	680	650	620	590
Vacuum	700	680	660	640

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EcoTwin™ – Density control.
Density control and steam recycling.

Steam addition

Water addition

Venting spout

Slurry pump

Liquids addition

Solids trap

Vacuum pump

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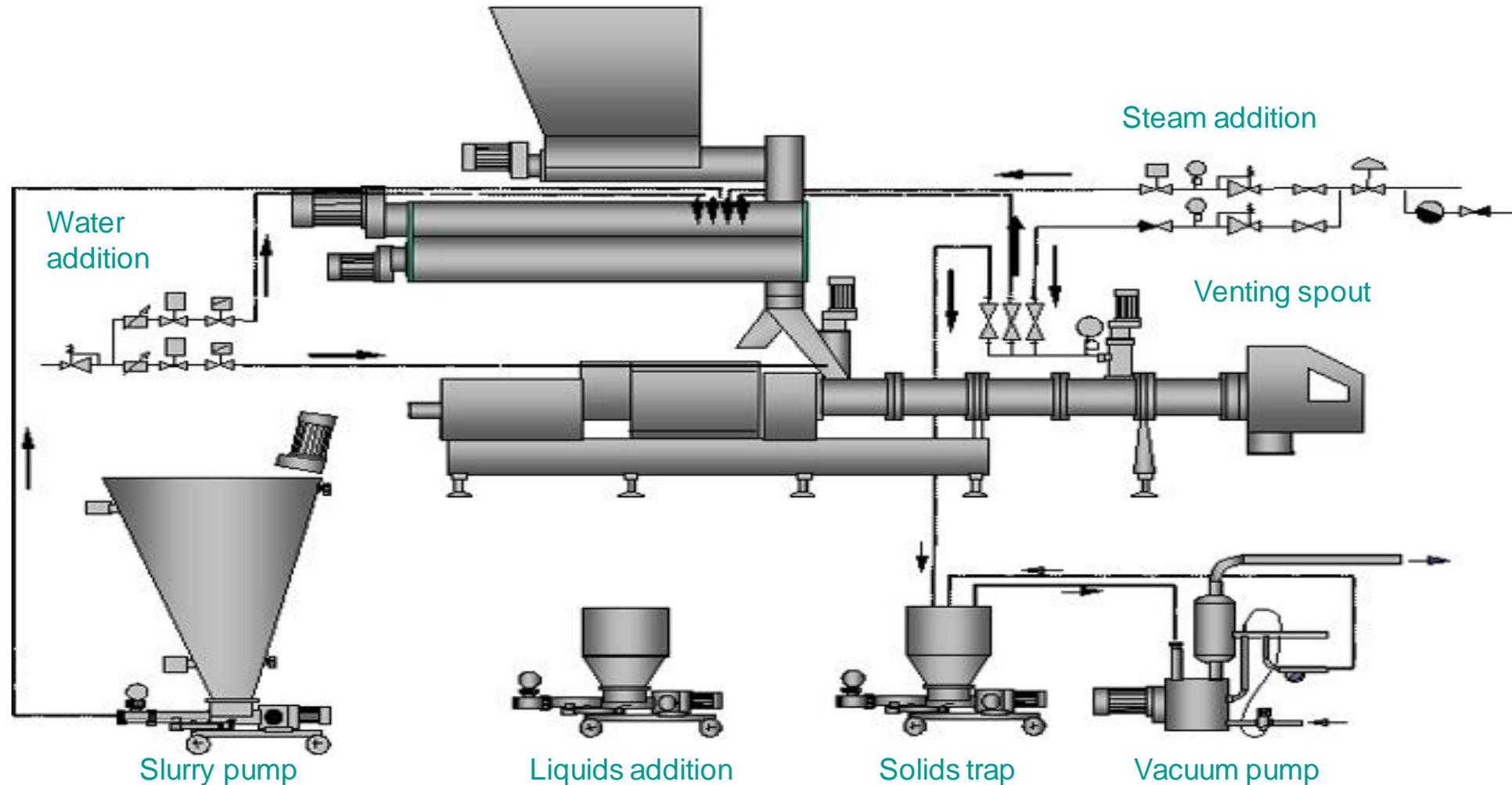
EcoTwin™ – Density control.
Overview.

- Steam into extruder.

- Steam recycling to conditioner.

- Vacuum (optional).

EcoTwin™ - Density control.

Manually controlled.

# EcoTwin™ – Density control.
Integration in control system.
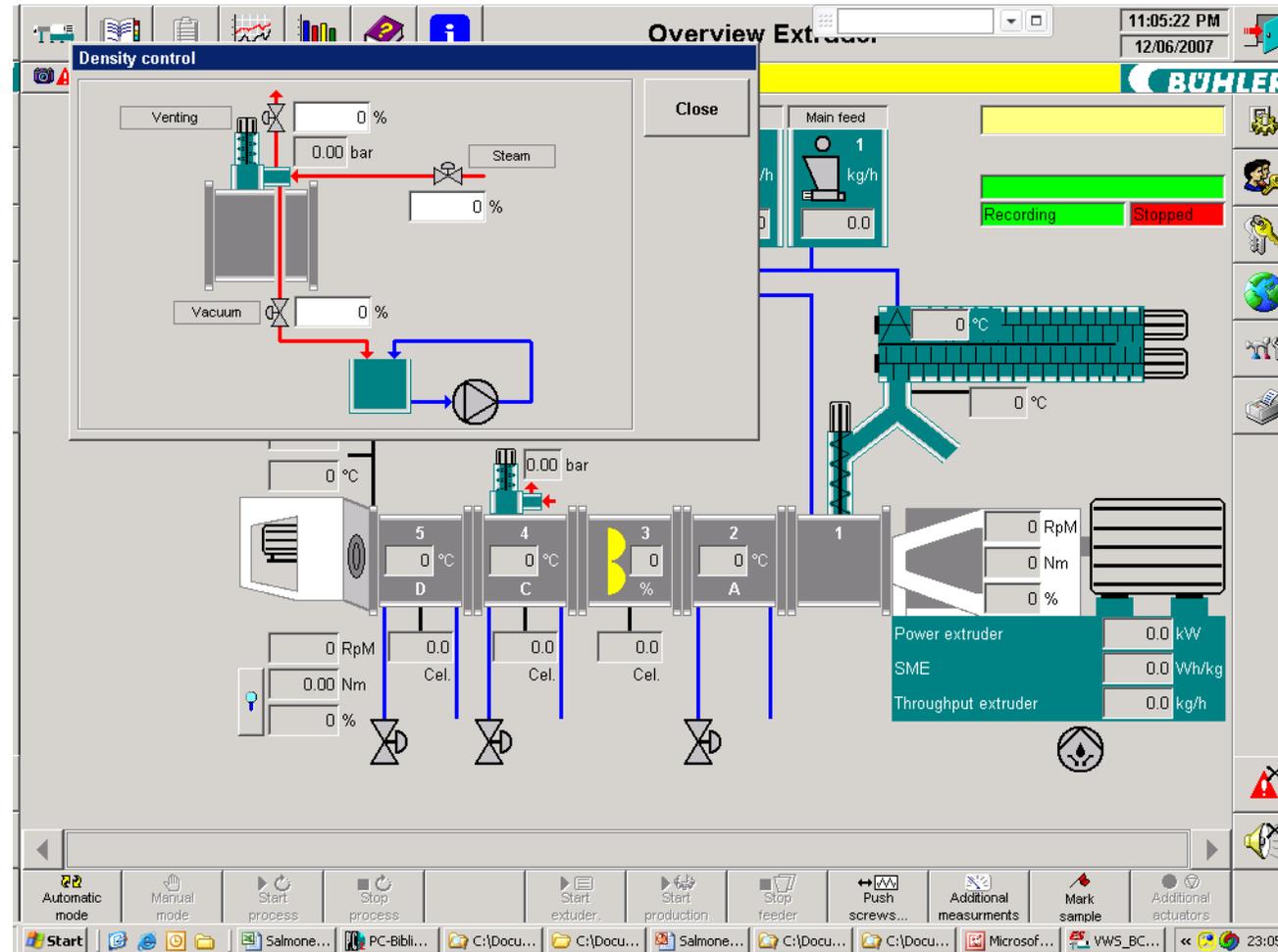
EcoTwin™ – Density control.
Online control of product density.
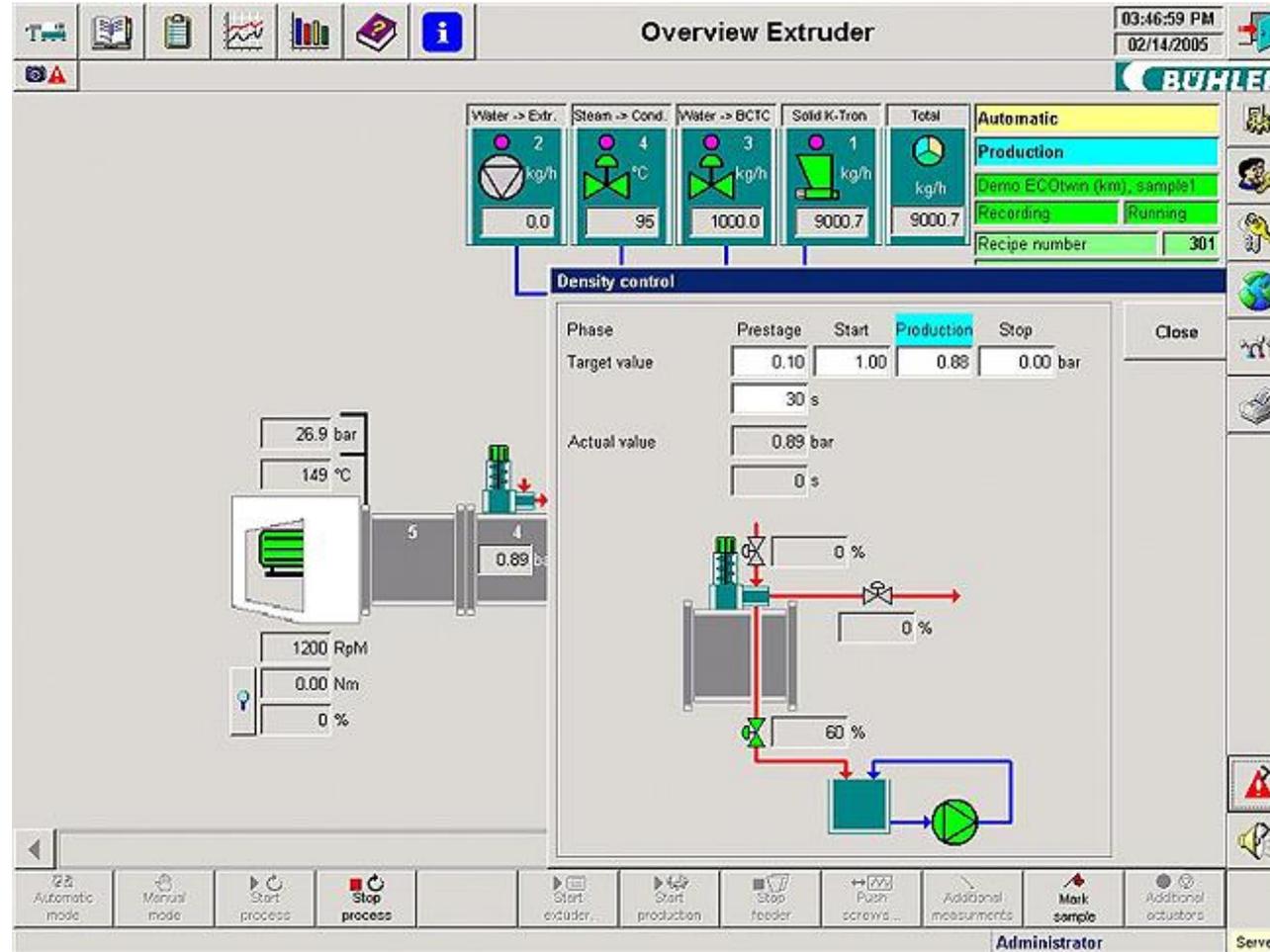
EcoTwin™ – Density control.
SME and density control module.

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EcoTwin™ – Conditioner EcoTherm™.

EcoTwin™ – Conditioner
EcoTherm™ (I).

- Two-step pre-conditioning process, combining high speed mixing and slow speed retaining section with variable speed drive.

- All non-wiped surfaces heated by indirect steam, avoiding condensate and build-up.

- Installed directly beside extruder.

- Force fed to extruder.

- Excellent accessibility to both sections directly from working floor.

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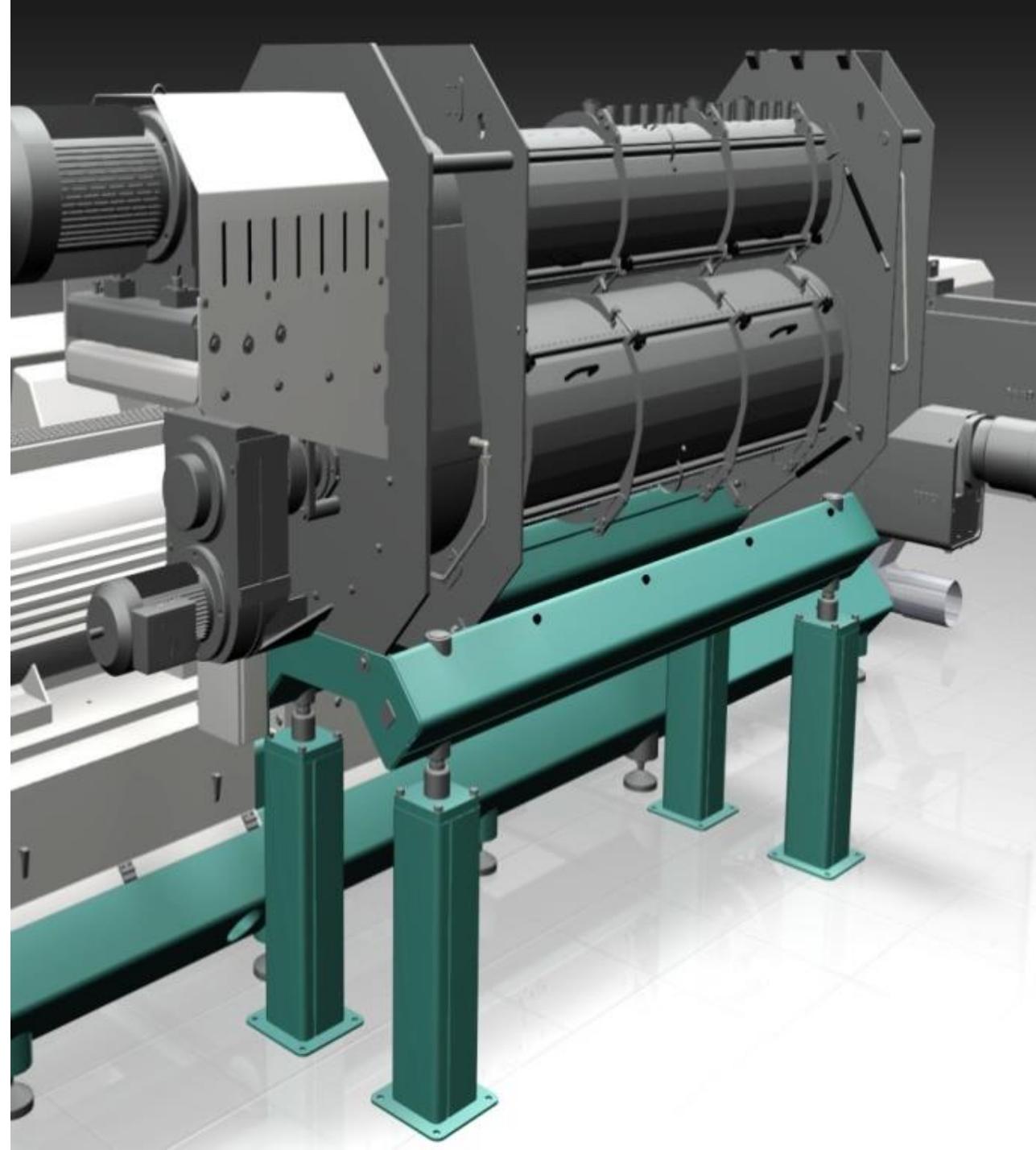
EcoTwin™ – Conditioner
EcoTherm™ (II).

- Redesigned drive sections and anti-vibration support.

- Available with 1000 l volume for BCTH125 and 1600 l for BCTJ175.

Transition: Feeder form conditioner to the extruder.

With the new **feeder screw**

- higher throughput due to **enforced infeed** and higher filling degree in the extruder are archived

- the conditioner is placed beside the extruder. This makes **wet cleaning** possible without contaminating the extrusion system with waste water

- **stable running** conditions are ensured

- Insufficient conditioned material during start up and stopping procedure can be sorted out by the **bypass flap**
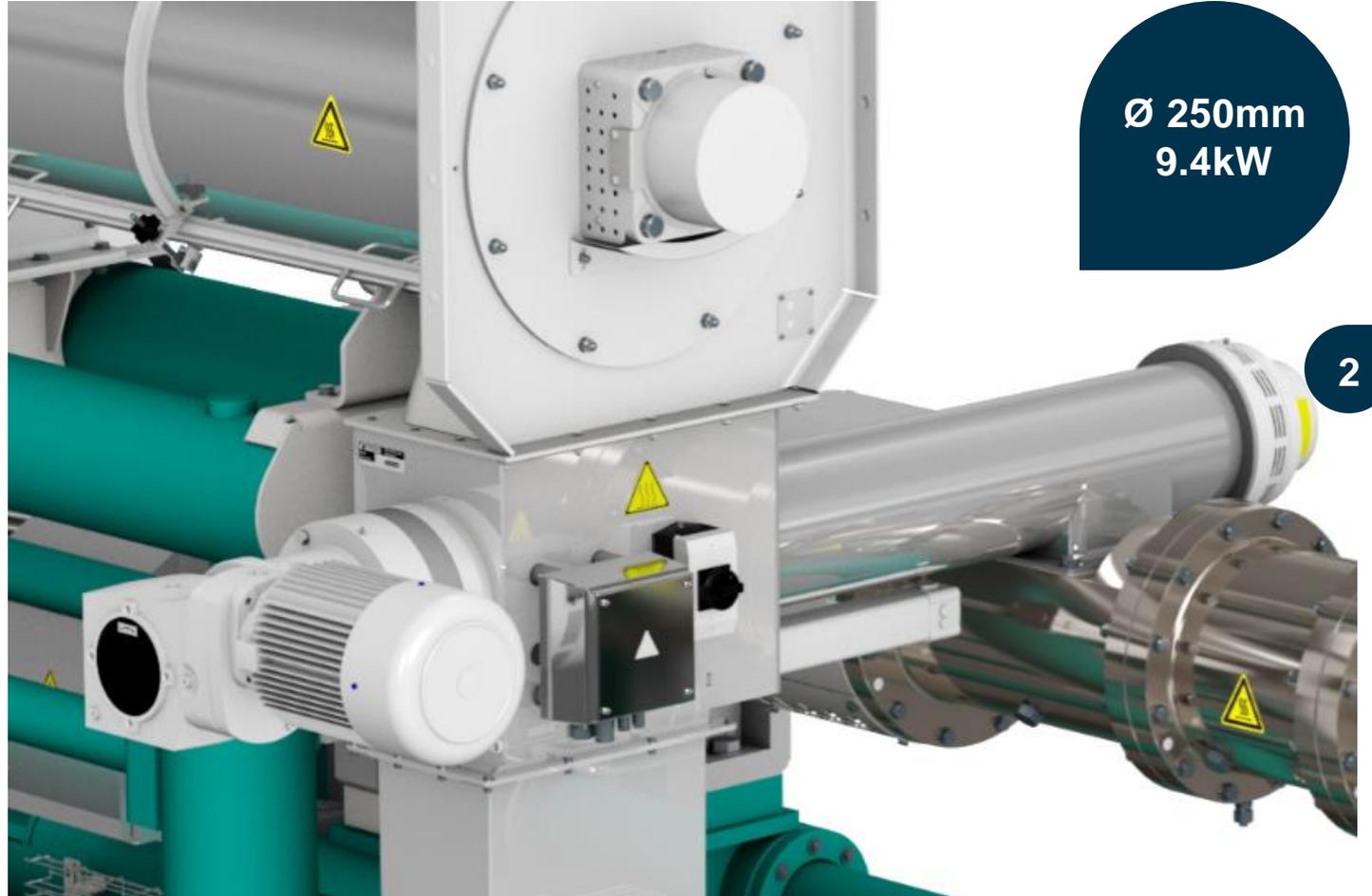
Ø 250mm 9.4kW

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Contents.

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EcoTwin™ – Control system EcoControl™.

PolyControl™ .
Full automatic control for extruder.

Efficient

How can you improve production time?

Flexible

How do you manage different machine setups?

Comfortable Operation

How your operator can work efficient?

Quality Control

How do you monitor the production quality?

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Efficient.

Increased production running time.

Automatic Operation

Product Recipes

Pre-Tempering

Remote Maintenance
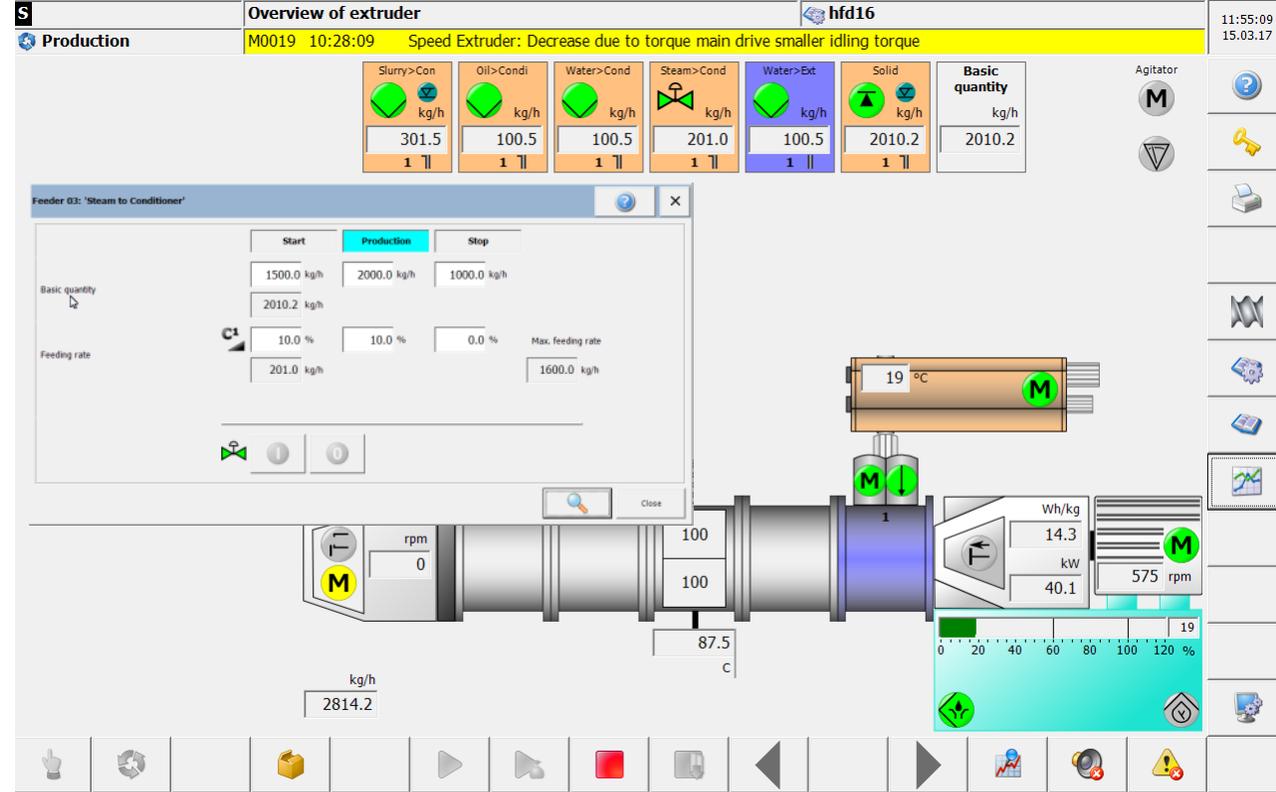
- Monitoring of torque and regulation of all relevant process parameters.

- Defined start-up and shut-down phases. A short start-up and shut-down increase the production running time.

- Manual operation available.

Efficient.
Easy production exchange.

- Automatic Operation
- Product Recipes
- Pre-Tempering
- Remote Maintenance

- Constant quality ensured through the use of product recipes.

- Fast production start without many parameter changes.

Efficient.
Less preparation time needed.

Automatic Operation

Product Recipes

Pre-Tempering

Remote Maintenance

- Barrels are pre-temperated, which minimizes waiting times at production start.

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Efficient.
Fast help if needed.

Automatic Operation

Product Recipes

Pre-Tempering

Remote Maintenance

- Fast problem recognition and solving using remote access by Bühler engineers.

Flexible.
Easy change of machine setup.

Enter your barrel setup

Enter your liquid additions

Set and configure your measuring points

Configure your look and feel

Units and formats		Process control	
Main drive		☑ End plate	
Oil supply unit / Ejection unit		☑ Cutter	
Other elements		Outlet pressure control	
Number of barrels	7	Filling mass system	

- Adaptable amount of barrels.

- Parameterization of the machine equipment.

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Flexible.
Easy change of machine setup.

Enter your barrel setup

Enter your liquid additions

Set and configure your measuring points

Configure your look and feel

- Selection of liquids, solids or steam, which needs to be added.

Flexible.
Easy change of machine setup.

Enter your barrel setup

Enter your liquid additions

Set and configure your measuring points

Configure your look and feel

- Measuring points can be defined individually.

- Name, unit, and fault reaction can be set according to the specific requirements.

- An addition of various sensors is possible due to the adjustable parameters.

Flexible.
Easy change of machine setup.

Enter your barrel setup

Enter your liquid additions

Set and configure your measuring points

Configure your look and feel
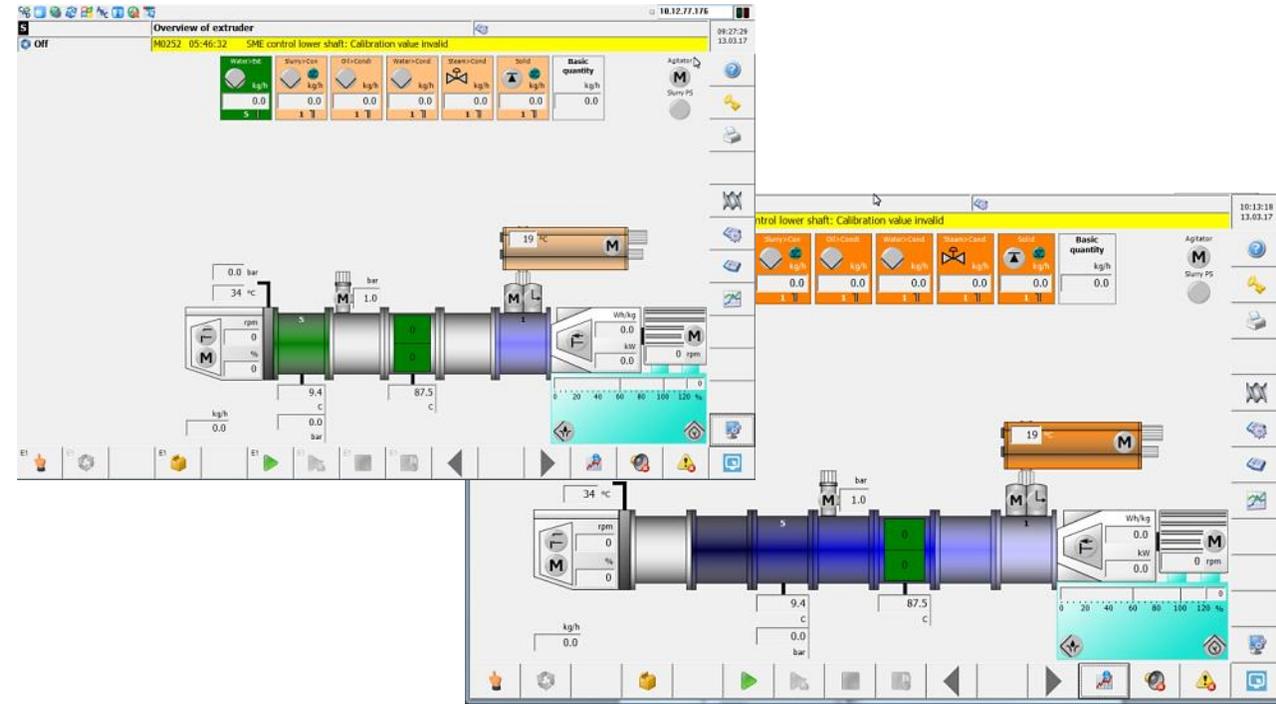
- Different selectable colors can be assigned to barrels and conditioners for a better overview.

- Corresponding additions are automatically colored accordingly.

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Comfortable Operation.
Self-explanatory.

Self-explanatory operation via touch screen

Context-sensitive help

Remote operating station

Interface to plant control system

- A clear overview of the process at any time.

- Self-explanatory icons supporting the menu navigation.

Comfortable Operation.
Help at any given point.

S	Current messages			
⚙ Off	M0001 09:27:50 PLC: Inputs/outputs are in simulation mode			

No.	Time	Class	Text	
M0252	14.03.17 09:27:50	Operation	SME control lower shaft: Calibration value invalid	▲
M0251	14.03.17 09:27:50	Operation	SME control upper shaft: Calibration value invalid	
M0001	14.03.17 09:27:50	Operation	PLC: Inputs/outputs are in simulation mode	

M0251   SME control upper shaft: Calibration value invalid

| Cause	Correction
The saved calibration value of the upper SME shaft for the position "100% opening" does not match the parameter "Px 20.01.02".	▶ Adapt the parameter if necessary. See parameter "Px 20.01.02".
	▶ Recalibrate the SME position "100% opening" of the SME shaft. See chapter "Calibrating the SME module".

Self-explanatory operation via touch screen

Context-sensitive help

Remote operating station

Interface to plant control system

- Help function available at any given point to any given topic.

- Find the complete operating manual in the control panel.

BÜHLER

Comfortable Operation.
Operating from control room.

Self-explanatory operation via touch screen

Context-sensitive help

Remote operating station

Interface to plant control system

Control room

Local operating

- Observation of the extrusion process from the control room.

- Comfortable definition of recipes with keyboard and mouse.

BÜHLER

Comfortable Operation.
Holistic Integration.

**WinCos®
Plant control**

Line 1　　　　**Line 2**　　　　**Line 3**

Self-explanatory operation via touch screen

Context-sensitive help

Remote operating station

Interface to plant control system

- Extruder connection to upstream and downstream processes.

- Direct transfer of the actual values to the holistic data collection.

BÜHLER

Quality Control.
Tools for conformity.

Change logging recipe
Recipe: hfd16
Period of time: All
User: -----
Number: 28

Time	Description	Old value	New value	User
3/15/2017 10:22:06 AM	Dwell time Conditioner 1	45.0000 s	10.0000 s	admin
3/15/2017 10:22:06 AM	SME barrel Torque	0.0000 %	20.0000 %	admin
3/15/2017 10:22:06 AM	SME barrel SME	0.0000 Wh/kg	6.0000 Wh/kg	admin
3/15/2017 10:11:47 AM	Max. cutter torque for message	30.0000 %	0.0000 %	admin
3/8/2017 1:57:21 PM	Feeding rate Start Feeder 2	5.0000 %	10.0000 %	admin
3/8/2017 1:56:39 PM	Feeding rate Start Feeder 2	10.0000 %	5.0000 %	admin
3/8/2017 12:11:26 PM	Feeding rate Production Feeder 6	0.0000 %	15.0000 %	admin
3/8/2017 12:11:26 PM	Feeding rate Start Feeder 6	0.0000 %	15.0000 %	admin

Readiness for FDA21 CFR part 11

Trending of historical data

Useful production statistic

Product density regulation

- User management with freely definable user accounts.

- Displayed errors and messages as well as user interactions are archived.

- Changes in product recipes and in the machine configuration are recorded.

Quality Control.
Discrepancies detection.

Readiness for FDA21 CFR part 11

Trending of historical data

Useful production statistic

Product density regulation

- Reporting of process-related target as well as actual values.

- Editable chart of actual as well as historian trend data.

- CSV export for external applications.

Quality Control.
Flexible data comparison.

Readiness for FDA21 CFR part 11

Trending of historical data

Useful production statistic

Product density regulation

- Periodical statistics about all configured feeder units and measuring points.

- Two statistics enable different views about the actual or last production (shift, day, etc.).

Quality Control.
Less energy waste.

Barrel pressure control

Opening of vacuum valve	20 %	20 %
Opening of vent valve	10 %	10 %
Opening of steam valve	5 %	5 %

Readiness for FDA21 CFR part 11

Trending of historical data

Useful production statistic

Product density regulation
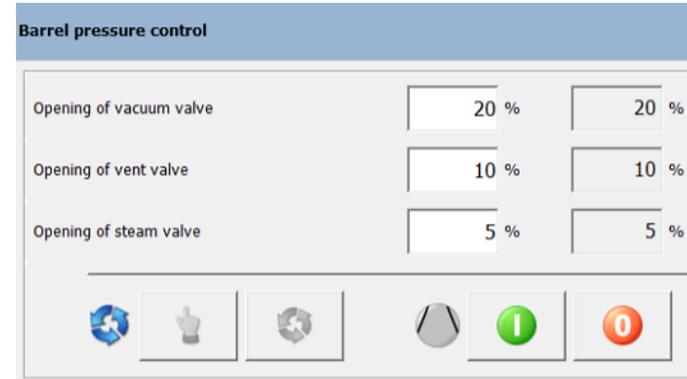
- Full automatic pressure regulation of the barrel to control the expansion degree of the product.

- Energy recuperation by refeeding the steam to the conditioner or preheating of processing water.

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Engineering Customer Success.

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