



Energy Consumption Reduction in Extrusion Systems: Latest Developments

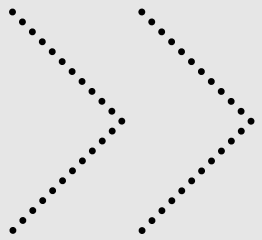
Claus Hermann – General Manager Extrusion Systems Large



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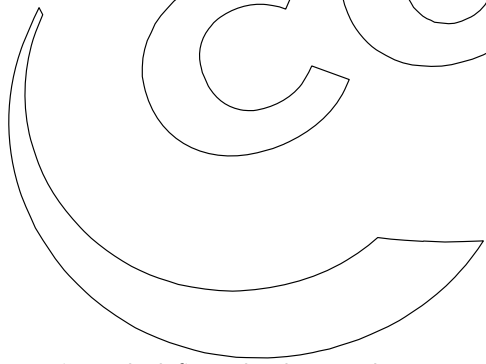
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Energy Saving – Overview



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Energy Saving – Practical Approach



Significance of Energy Reduction Potential

Extruder process is usually highest energy consumer in a dry reactor (gas phase/slurry) process



9 MW Extruder train for 350 kt/a
PO production (8,000 h/y)
Yearly power consumption: 72 GWh
Costs: 4.68 Mio EUR/year

24,000 Households (3000 kWh/yr)

CO₂ emission equivalent of
25,715 cars per year
(1.4t CO₂/car/year)

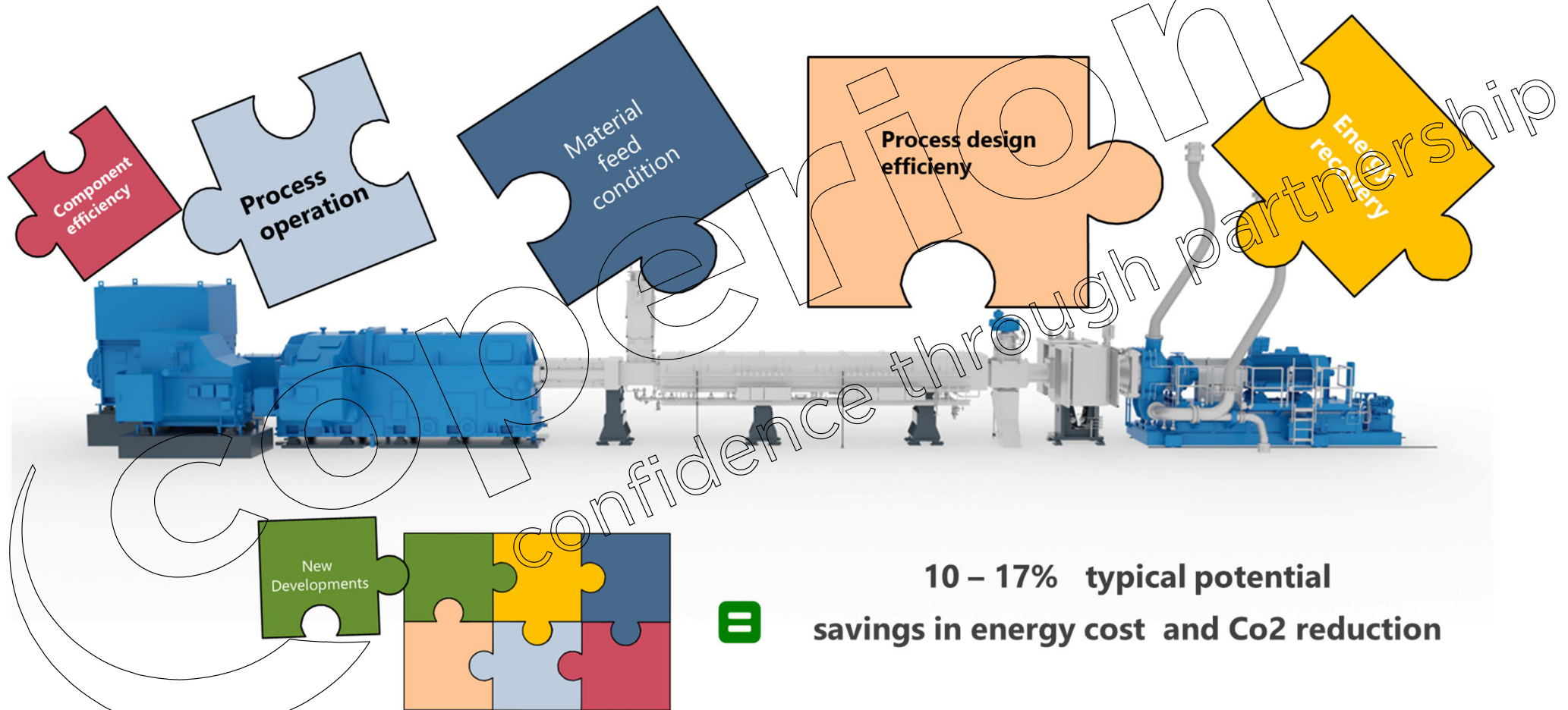
Energy reduction of 10% is equivalent to:

0.5 Mio EUR saving power cost = 2,400 household power consumption = 2572 car CO₂ emission equivalent

Reference: Electrical power cost KSA 2022 = 0,065 EUR/kWh - CO₂ = 500 g/kWh

Extrusion System Energy Reduction

Systematic review of plant components required



Energy Reduction – Areas of Improvement

Process design provides usually biggest potential for energy reduction

Component efficiency:

- Electrical main drive efficiency
- Main extruder gearbox exchange low torque with high torque
- Auxilliary motor efficiency
- Pump efficiency

Process design efficiency:

- Process design torque
- Extruder screw design melting/mixing
- Extruder screw design pressure build-up
- Extruder discharge component pressure consumption
- Melt pressure generation melt pump/extruder
- Ecoblue pellet conveying

Process operation:

- Screw speed selection
- Temperature profile setting
- High rate production (avoid long operation period on low rate)
- Reactor product feed temperature

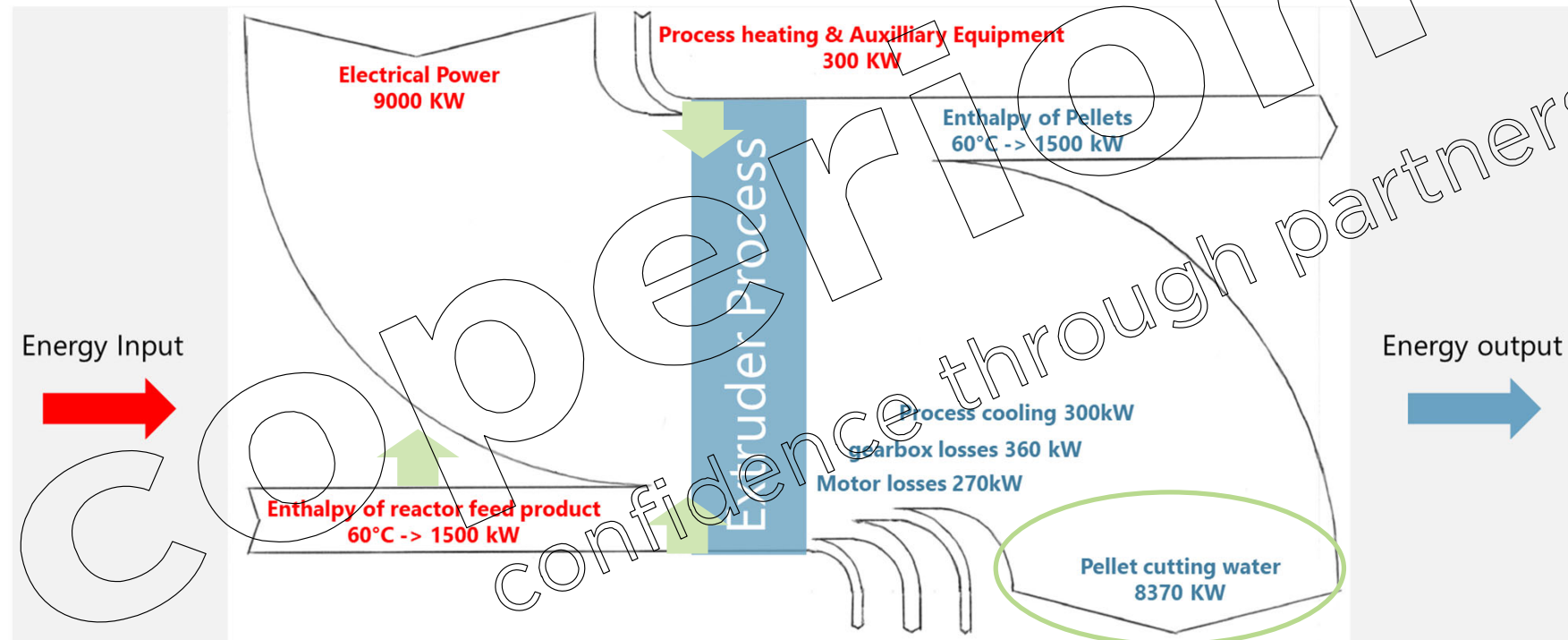
General operation philosophy:

- Direct additive feed vs. masterbatch
- Plant layout – vertical product lift

Rating of potential has a high variance in existing plant comparison → individual evaluations are of essence

Typical Energy Balance of 350 kt/a PP Extruder System (45t/h)

Based on process specific energy consumption of 0,2 kWh/kg



Reduction of electrical power consumption required reduction of extruder process power demand **and / or** increase of product feed temperature

Energy Recovery – Areas of Improvement

Future potentials with plant modification requirements

Elevate extruder material feed temperature

- Thermal insulation to feed bin and gravity pipes
- Purge gas heat exchanger
- Bulk exchange inline for fluff temperature increase with pellet water

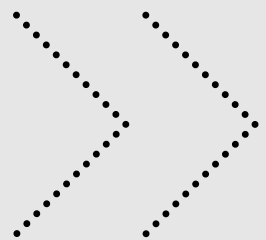
Energy recovery from pellet water loop

- Electrical power generation with Organic Rankin Cycle process (ORC)
- Low pressure steam generation
- Adsorption chiller for cold water generation
- Use water elevation at dryer to operate water turbine

Extruder process section:

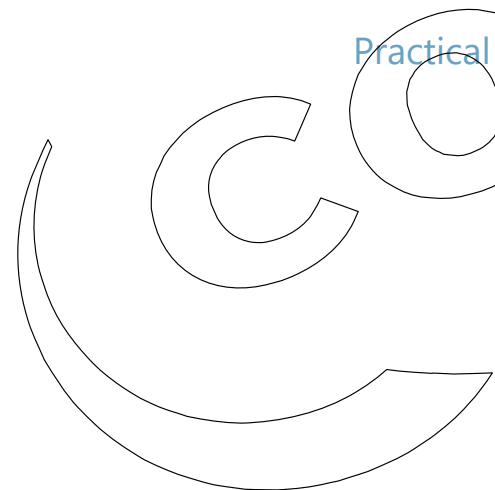
- Generate low pressure steam with barrel cooling water loop.
- Use cooling of „hot“ operated barrels for heating of heat demanding components

Energy recovery potentials are significant in most cases – especially for all commodity and high capacity Polyolefin production lines.



Energy Saving

Practical approach



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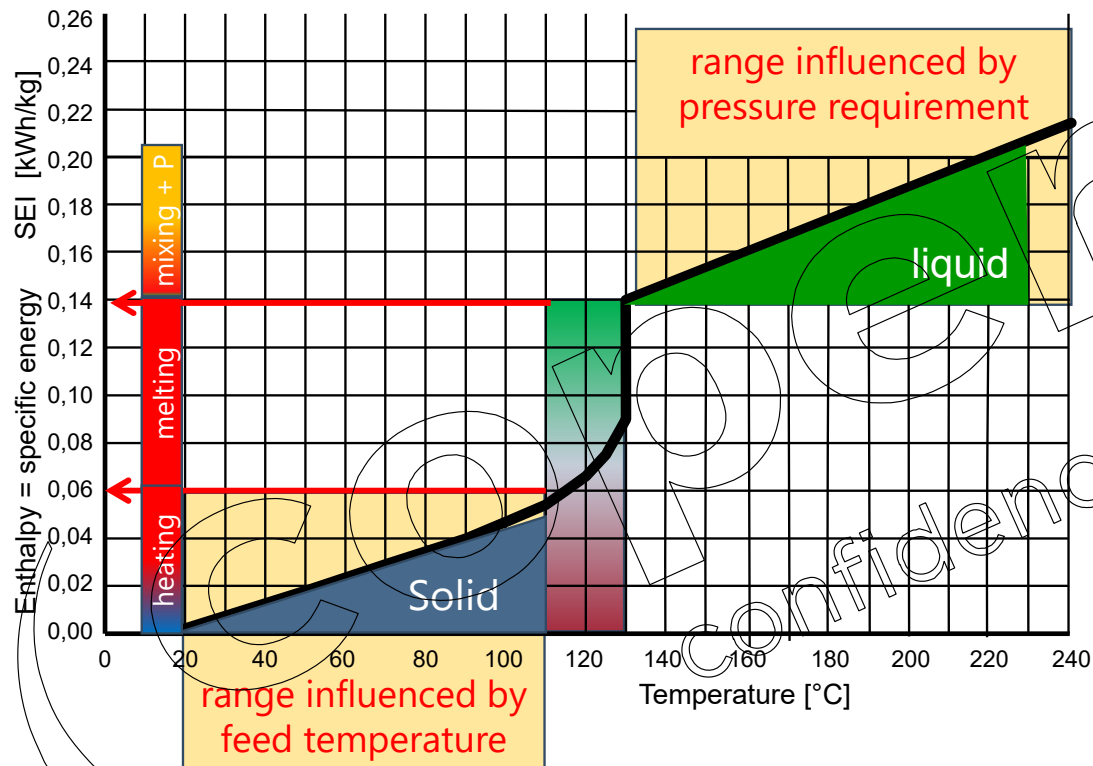


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confidence through partnership

Energy Saving – Potentials and Savings

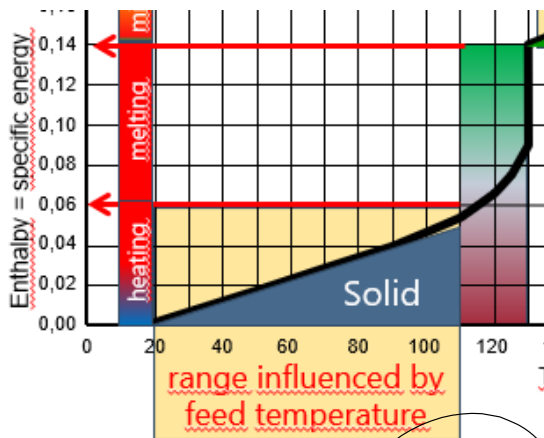
Polymer feed temperature – influence on extrusion



- Every polymer has its specific energy „demand“
- This demand varies with process requirements, viscosity and quality
- The diagram shows a general behaviour for an HD-PE
- Energy necessary for melting the polymer is fixed
- Energy required for treatment in liquid state varies

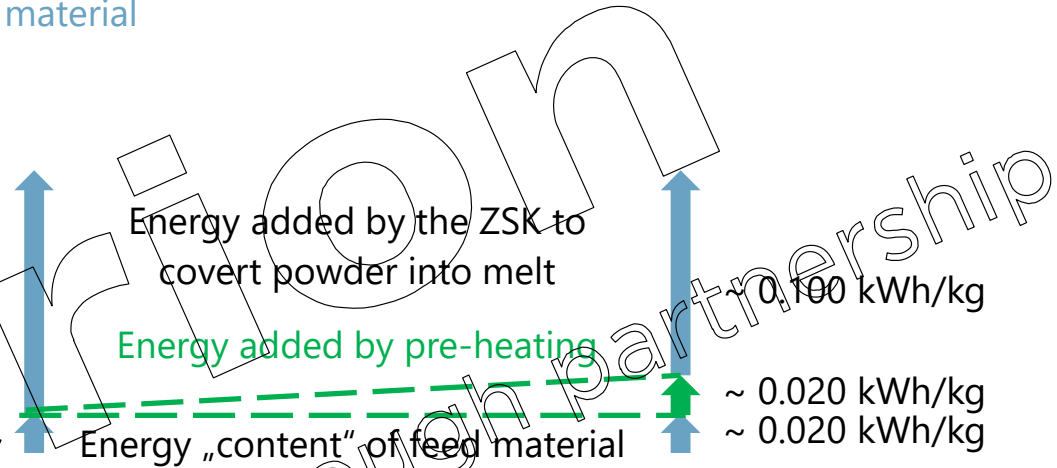
Energy Saving – Potentials and Savings

Further potential in extrusion – Bulk X-Change, preheat feed material



~ 0.120 kWh/kg

~ 0.020 kWh/kg



- Example based on HDPE with a normal feed temperature of 60°C.
- Bulk X-Change use to lift the feed temperature to 90°C by using „secondary or waste“ energy sources available on a petrochemical plant.
- Electrical energy saved would be the same for all HDPE grades.

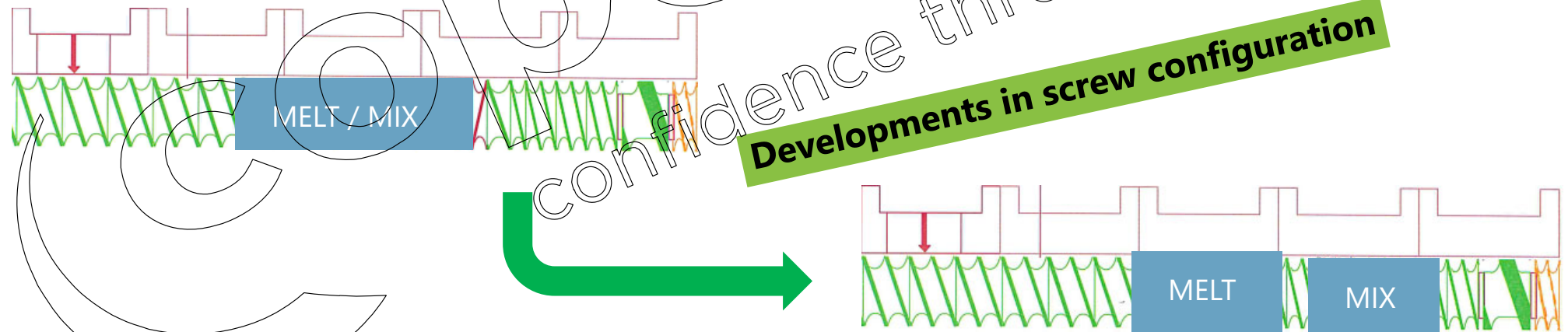
Example: 45t/h HDPE plant; availability: 8000h/year; total annual production: 360.000.000kg; electricity rate (assumed): 0.065€/kWh

Energy saved: 0.020kWh/kg * 360.000.000kg = **7.200.000kWh**

Money saved: 7.200.000kWh * 0.065€/kWh = **468.000€/year**

Energy Saving – Potentials and Savings

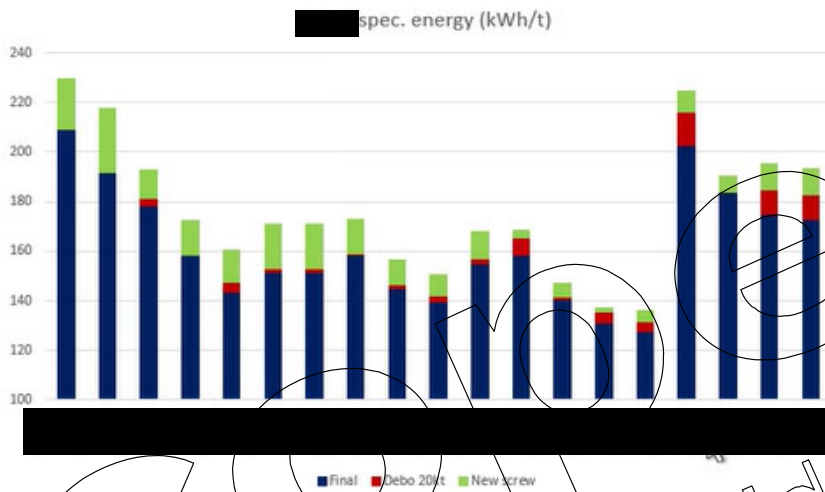
Screw configuration



Energy Saving – Potentials and Savings

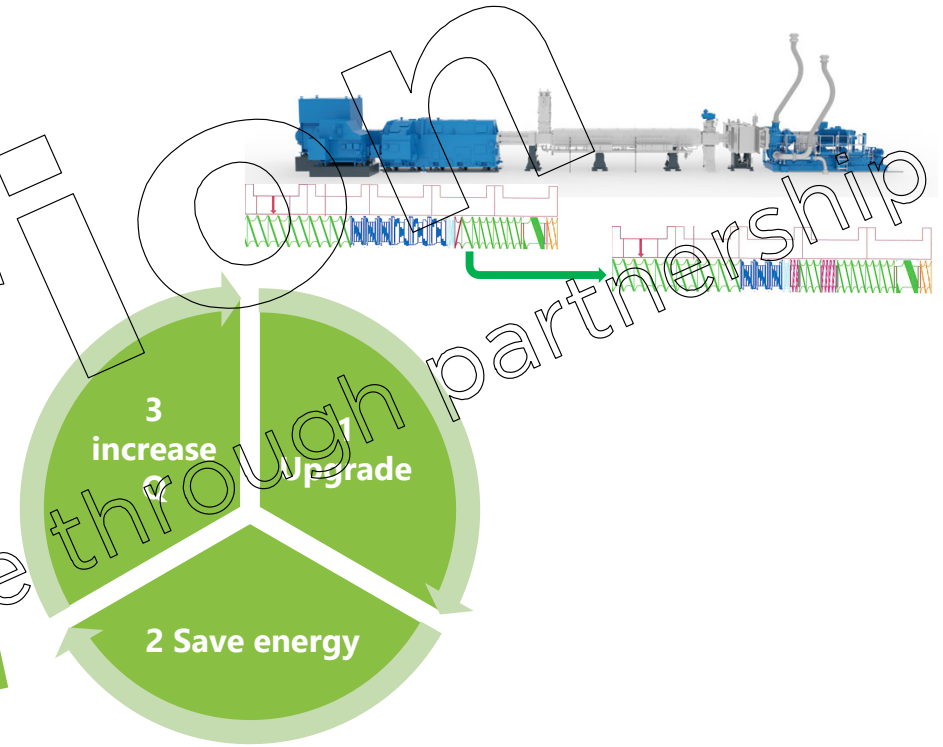
Screw configuration

Energy savings – Results



For the 2nd half of 2021: 1,4 GWh were saved* because of the new screw configuration, which corresponds to 200 k€ or 800 t eq.

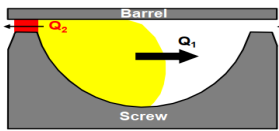
Customer data



Throughput old (t/h)	26,1	30,6	28,6	30,6	30,7	30,2	30,2	30,5	29,0	29,7	29,2
Throughput new (t/h)	26,1	30,7	29,1	30,1	31,2	30,2	30,2	30,1	29,0	29,2	29,1
BASE CASE (kWh/t)	229,67	217,40	189,86	172,27	156,24	169,11	169,11	172,55	154,86	148,10	165,86
CASE 1 (kWh/t)	209,00	191,89	178,30	158,52	143,43	151,34	151,34	158,52	144,85	139,62	155,07
Savings (%)	9,00	11,73	6,09	7,98	8,20	10,50	10,50	8,13	6,47	5,72	6,50

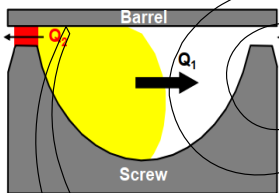
Energy Saving – Potentials and Savings

Highest potential in extrusion – how to save energy in polymer processing?



Average shear rate
(SEI equivalent)
determined by:

- *Flight depth*
- *Filling (torque)*
- *Screw speed*



Upgrade CUSTOMER in USA:

ZSK300 → ZSK320

HDPE: 80.000lb/h → 100.000lb/h

LLDPE: 53.000lb/h → 93.000lb/h

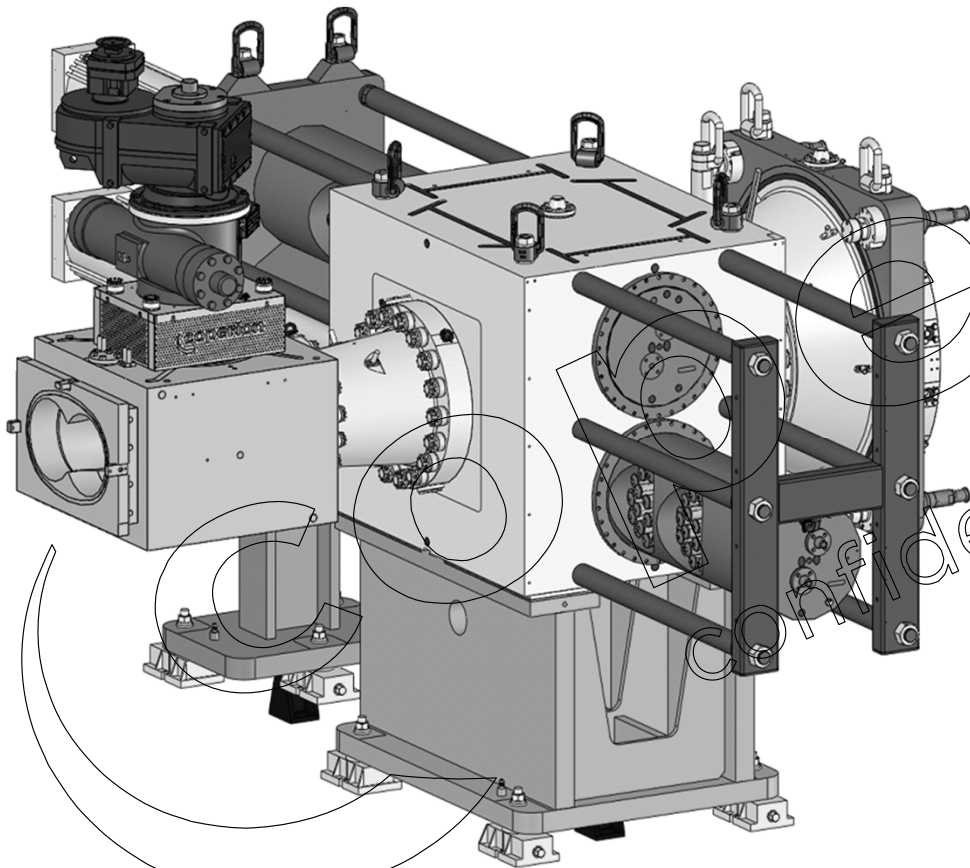
SEI Reduction: ~5%

ROI < 2years

Modernization and upgrades in vertical lines (same shaft axial distance) is possible and most effective
Both – Volume and Torque increase. If I/D is kept the same, all retrofits are within the same extruder footprint.

Energy Saving – Potentials and Savings

Further potential in extrusion – Reduce pressure consumption in the discharge



- New Design DAV -> reduce pressure losses
- New design SWZ -> reduce pressure losses
- New design GKG -> reduce pressure losses
- With new components 30 barg or more can be saved
- 30 barg pressure build up by ZSK is ~ 0.01kWh/kg
- Appr. 720.000€/year (@90t/h @0.10€/kWh)
- New screen/basket combination for low dp is available

Energy Saving – Potentials and Savings

Process conditions – Process excellence

- Modernize production lines with higher efficiency equipment
- Reduce losses (product/utility transfer)
- For MH savings, consider proper design in engineering phase and EcoBlue and Bulk Exchange also for modernization
- Heating/cooling philosophy
- High torque
- Optimize processing, screw design update
- Implement Process Excellence



Thank you very much for your attention.

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