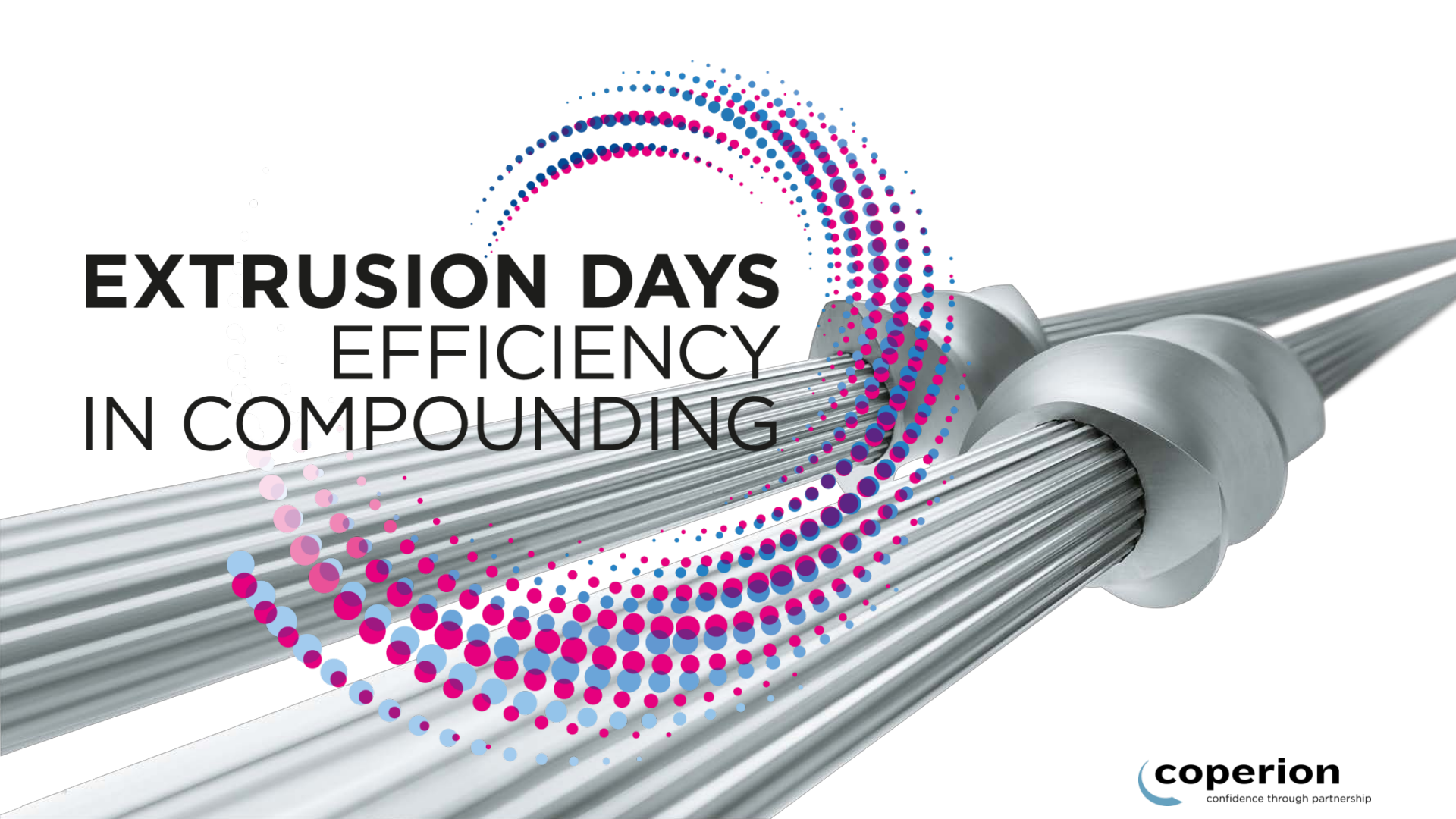
EXTRUSION DAYS
EFFICIENCY IN COMPOUNDING



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Efficiency in Compounding of Engineering Plastics - Advantages of ZSK Mc^{18}

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Efficiency in Compounding of Engineering Plastics
Advantages of ZSK Mc^{18}

Content

- ZSK Mc^{18} review
- Technical advantages
- Commercial benefits
- Summary

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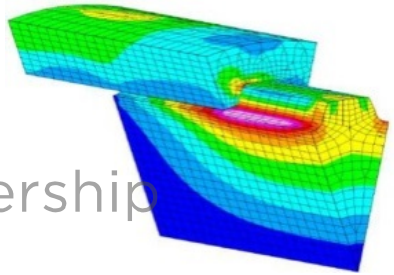
ZSK Mc^{18} – Review

- Introduced into the market in 2010 (K fair)

- First years after introduction Mc PLUS and Mc^{18} machine series sold

- More than 600 ZSK Mc^{18} sold, including new sizes ZSK 45 Mc^{18} & ZSK 82 Mc^{18}
- More than 300 ZSK Mc^{18} sold with torque level > 15 Nm/cm³
- More than 150 ZSK Mc^{18} sold with full torque 18 Nm/cm³



- High technical availability due to reliable and robust machine technology

- ZSK Mc^{18} for testing in the test labs in Stuttgart, Pitman and Nanjing

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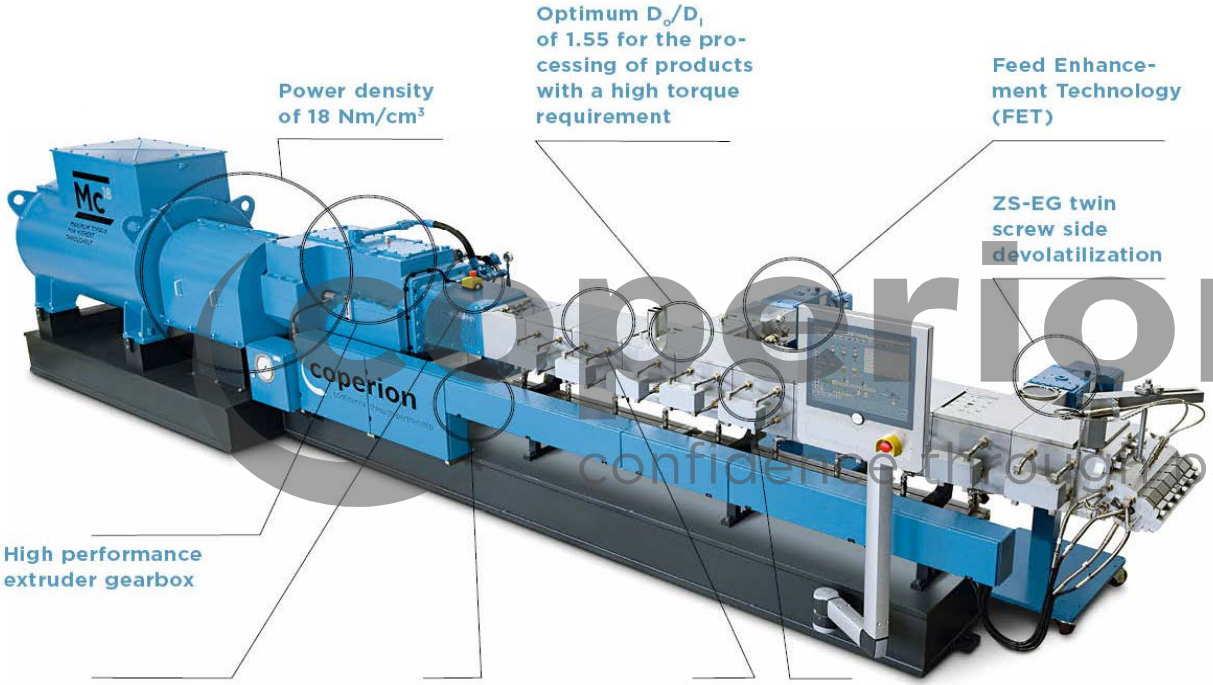
ZSK Mc^{18} – Review



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ZSK Mc^{18} – Technical Data

ZSK	Max. torque per shaft [Nm]	Specific torque Md/a^3 [Nm/cm^3]	Max. screw speed [min^{-1}]	Max. drive power N [kW]	Screw diameter [mm]
18 MEGAlab*	38	11.3	1,200	10	18
26 Mc^{18}**	140	15	1,200	37	26
32 Mc^{18}	315	18	1,200	83	32
45 Mc^{18}	930	18	1,200	246	45
58 Mc^{18}	2,000	18	1,200	529	58
70 Mc^{18}	3,500	18	1,200	926	70
82 Mc^{18}	5,700	18	1,200	1,508	82
92 Mc^{18}	7,500	17	1,000	1,654	92
119 Mc^{18}	15,300	17	1,000	3,373	119
133 Mc PLUS	20.000	15	1,000	4,390	133

* Laboratory extruder | ** max. 1,800 min^{-1} at reduced torque | ZSK 32 - ZSK 82 available in compact version

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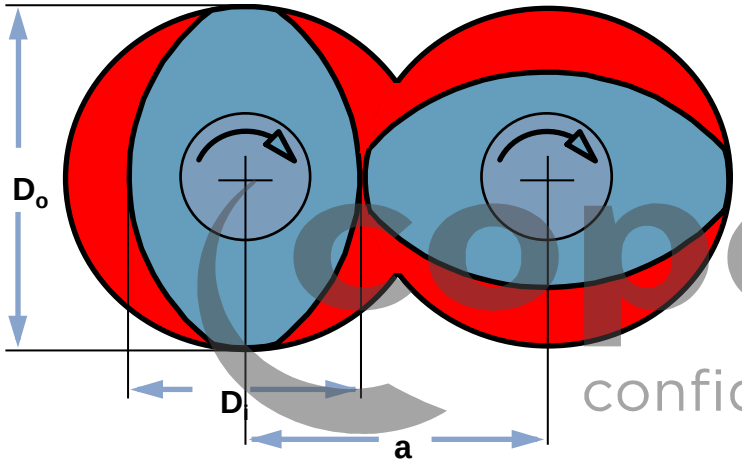
ZSK Mc^{18} – Design Criteria



D_o = Outer diameter
D_i = Inner diameter
a = Centerline distance

D_o / D_i = Diameter ratio
determines shear, degassing and powder intake

M_d / a^3 = Specific torque
determines power density and filling degree

n = Screw speed
determines shear and mixing

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ZSK Mc^{18} – Advantages

Optimal D_o/D_i of 1.55

The shafts reliably withstand the high mechanical stress and the screw elements feature high wear resistance
D_o/D_i of 1,55 enables reliable scale-up within the whole Mc^{18} series
D_o/D_i of 1,55 enables scale-up and modernization of ZSK Mc PLUS to the ZSK Mc^{18} series

Increase in torque of 30%

Increase in throughput from up to 30% to 100%
Improved compounding quality by gentle processing with a higher filling degree
Maximum flexibility due to broader operating window
Reduced melt temperature at higher output
Increased energy efficiency by reduced specific energy input
Significantly improved productivity
Proven high ZSK safety enabled by new designs and developments

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ZSK Mc^{18} – Possibilities - Sold

ZSK Standard
D_o / D_i = 1,22
M_d / a^3 = 5,0 Nm/cm^3 / n = 150 rpm

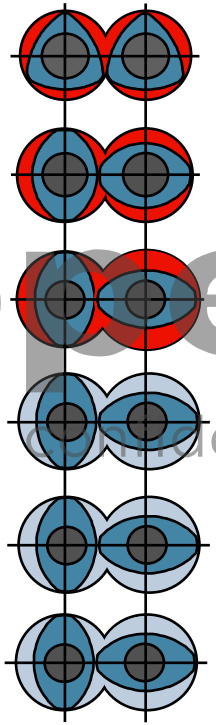
ZSK variable
D_o / D_i = 1,44
M_d / a^3 = 5,0 Nm/cm^3 / n = 300 rpm

ZSK Supercompounder
D_o / D_i = 1,55
M_d / a^3 = 8,7 Nm/cm^3 / n = 600 rpm

ZSK MEGAcompounder
D_o / D_i = 1,55
M_d / a^3 = 11,3 Nm/cm^3 / n = 1200 rpm

ZSK MEGAcompounder PLUS
D_o / D_i = 1,55
M_d / a^3 = 13,5 Nm/cm^3 / n = 1200 rpm

ZSK Mc^{18}
D_o / D_i = 1,55
M_d / a^3 = 18 Nm/cm^3 / n = 1200 rpm



ZSK Supercompounder* **5%: Chemical Applications**
D_o / D_i = 1,55 / n = 1200rpm
M_d / a^3 = 8,7 Nm/cm^3

ZSK MEGAcompounder **20 %: Chemical Applications Masterbatch, PVC, DP, some EP**
D_o / D_i = 1,55 / n = 1200rpm
M_d / a^3 = 11,3 Nm/cm^3

ZSK MEGAcompounder PLUS **25 %: EP and MB, some CA, PVC**
D_o / D_i = 1,55 / n = 1200rpm
M_d / a^3 = 13,5 Nm/cm^3

ZSK Mc^{18} **50 %: EP and DP, some MB lab**
D_o / D_i = 1,55 / n = 1200rpm
M_d / a^3 = 15 Nm/cm^3, 2/3: EP and DP, some MB lab
M_d / a^3 = 18 Nm/cm^3 1/3: EP only

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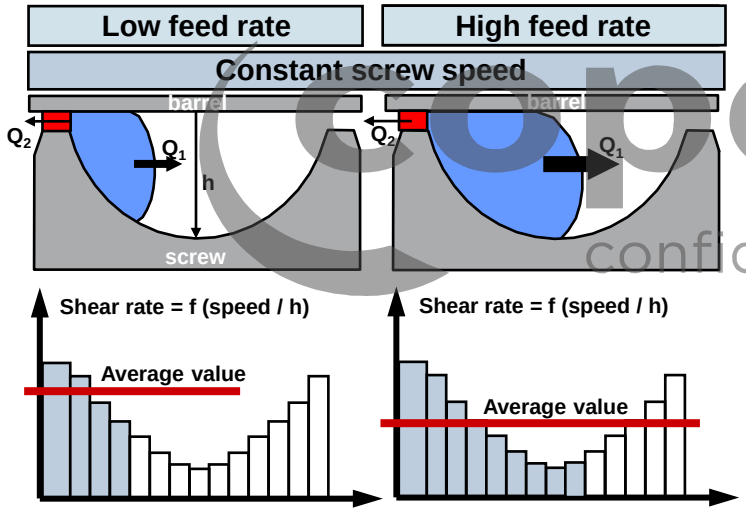
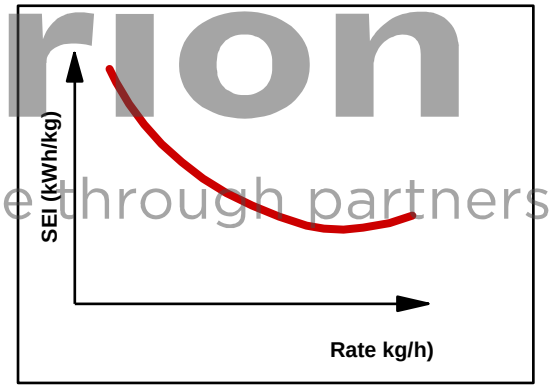
ZSK Mc^{18} – Technical Advantages

$$\frac{\text{Consumed power [kW]}}{\text{Throughput rate [kg/h]}} = \text{Specific Energy Input (SEI)}$$





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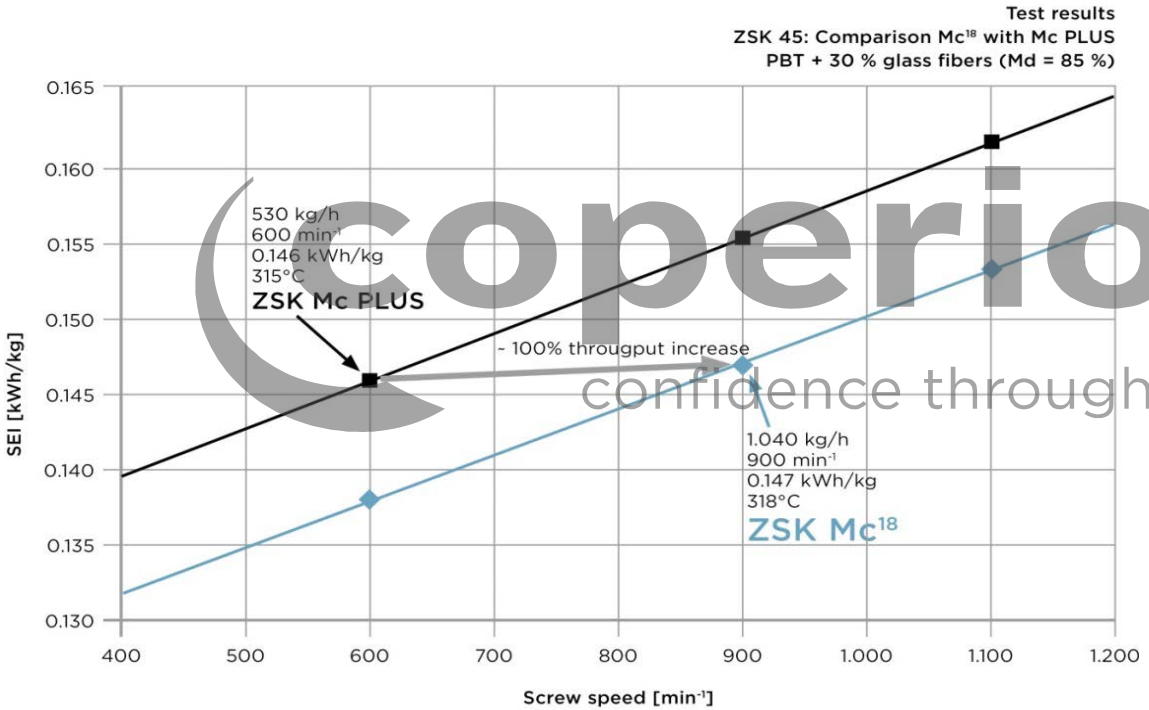
ZSK Mc^{18} – Technical Advantages

Throughput increase of up to 100% for constant specific energy input (SEI)



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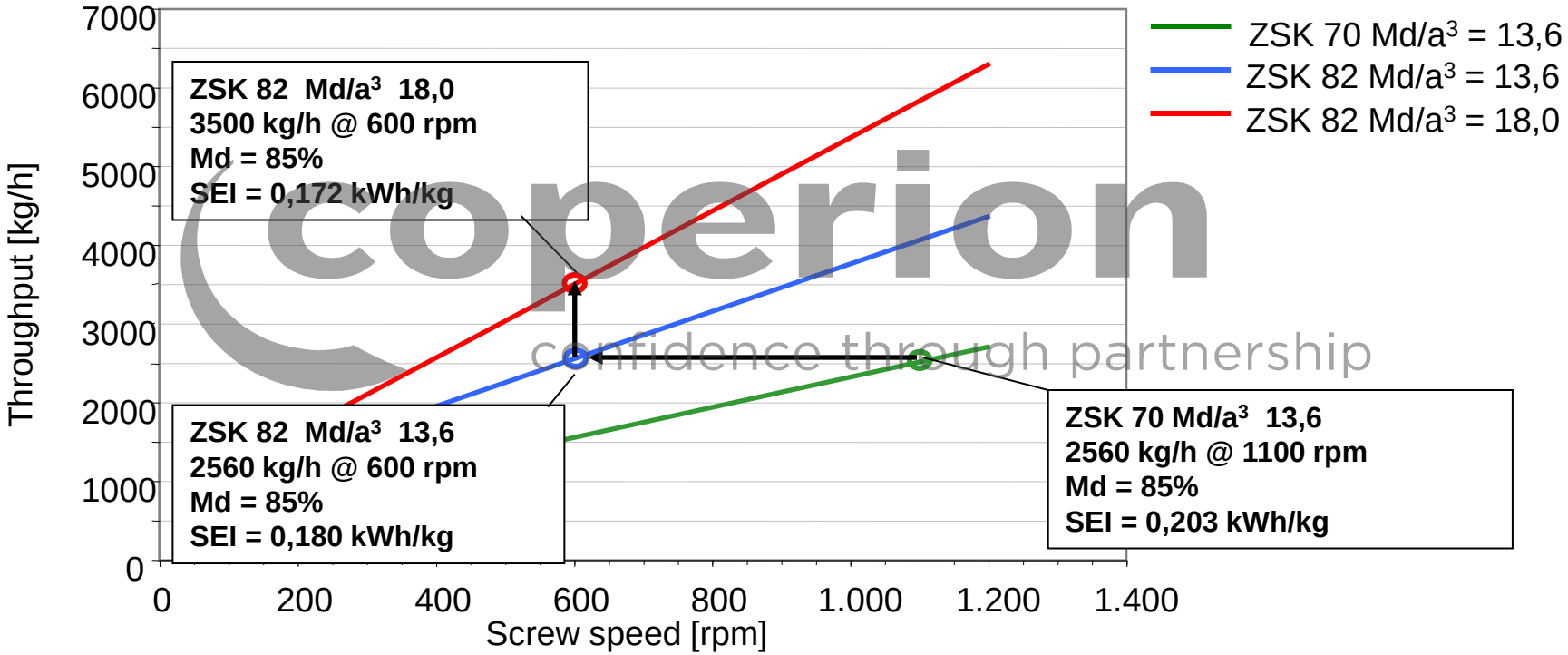
ZSK Mc^{18} – Technical Advantages

Reinforcing of polyamid with 30% glassfibres



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Cost Benefit – ZSK 82 – Different Torque Level

Machine	Type	ZSK 82 Mc^{18}	ZSK 82 Mc^{18}	ZSK 82 Mc^{18}
Operation hours	h	7,000	7,000	7,000
Capacity	kg/h	2,560	3,500	3,900
Md/a3	Nm/cm3	**13.6**	18.0	18.0
Torque	%	85	**85**	**95**
Total amount per year	kt	17.92	24.50	27.30
Energy cost / kWh	€	0.15	0.15	0.15
Energy savings per year	€	-	21,504	26,880
Specific Energy Input	kWh/kg	**0.180**	**0.172**	**0.170**
Profit per kg	€	0.30	0.30	0.30
Cost benefit per year	€	-	1.995.504	2.840.880

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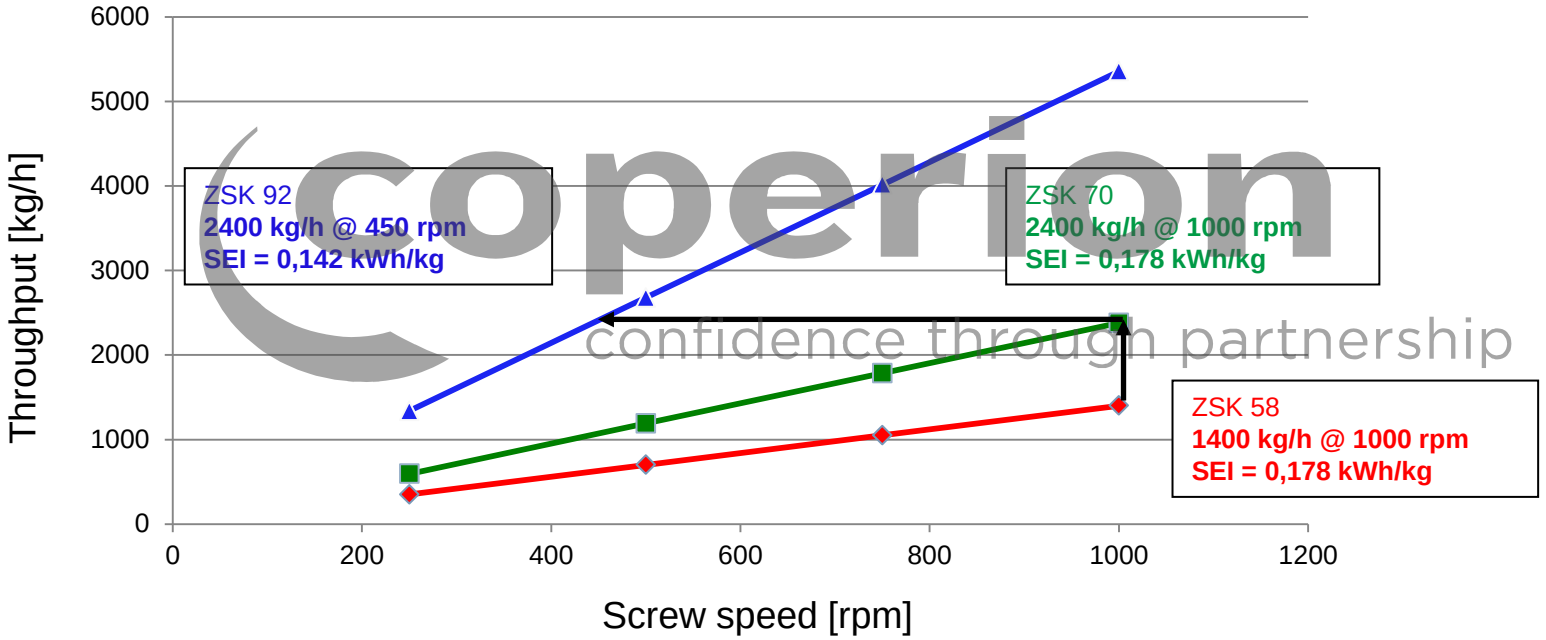
ZSK Mc^{18} – Technical Advantages

Fiber reinforced PP + 20% GF



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Cost Benefit – Different Machine Sizes

Machine	Type	ZSK 58Mc^{18}	ZSK 70 Mc^{18}	ZSK 92 Mc^{18}
Operation hours	h	7,000	7,000	7,000
Capacity	kg/h	**1400**	2400	2400
Total amount per year	kt	9.80	16.80	16.80
Energy cost / kWh	€	0.15	0.15	0.15
Energy savings per year	€	-		**52.900**
Specific Energy Input	kWh/kg	0.178	**0.178**	**0.142**
Profit per kg	€	0.30	0.30	0.30
Cost benefit per year	€	-	2.100.000	2.152.920

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Remark: ZSK 92 – investment cost approx. 70.000 Euro higher

Efficiency in Compounding of Engineering Plastics
Advantages of ZSK Mc^{18}

EXTRUSION DAYS
EFFICIENCY
IN COMPOUNDING

Summary

- ZSK Mc^{18} series offers different options –> adjusted/optimized machine for specific applications with high efficiency
- ZSK Mc^{18} machines – proven technology since 8 years, over 600 machines sold
- ZSK Mc^{18} is the benchmark / market leader in Coumpounding of Engineering Plastics

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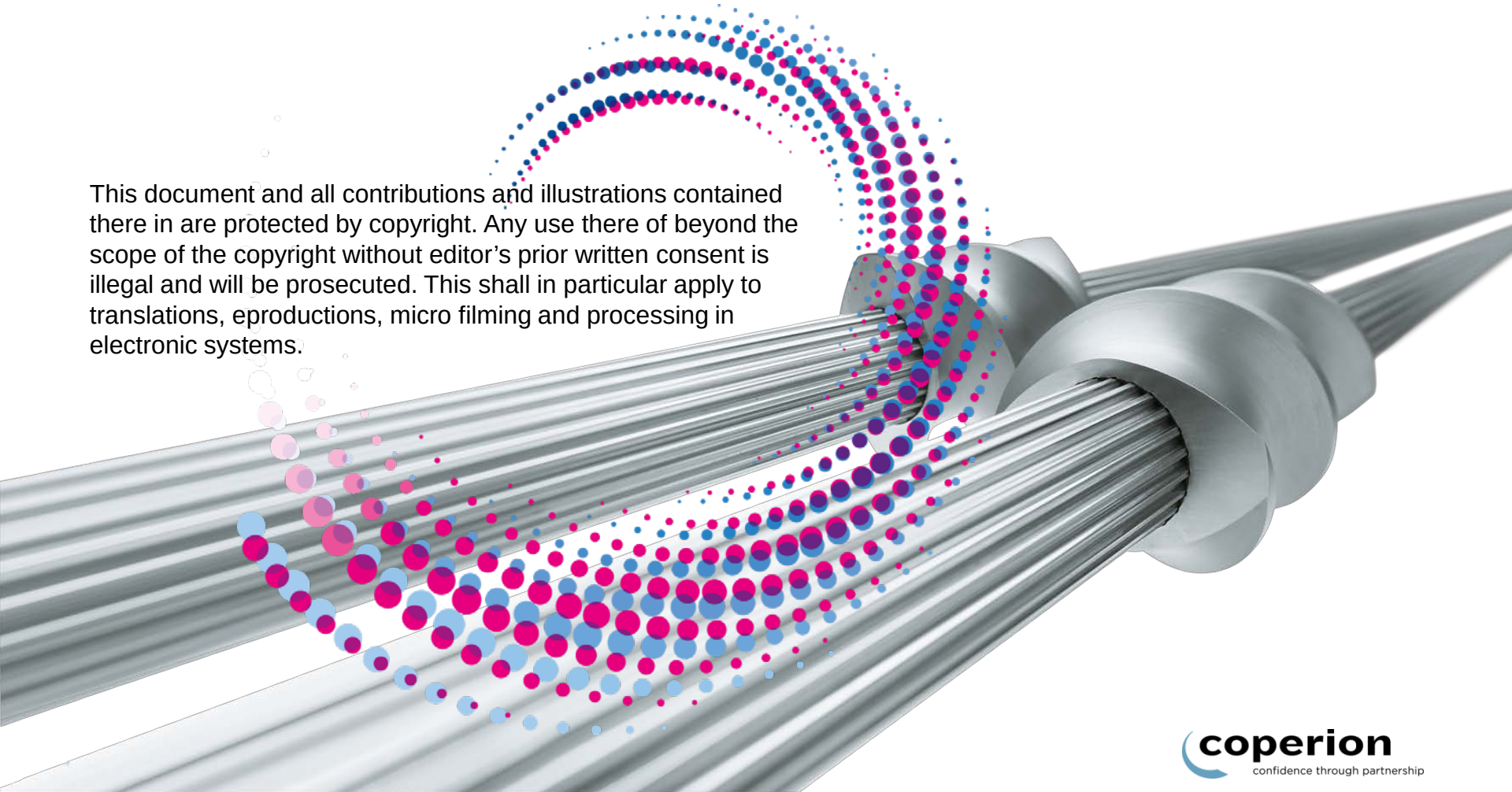

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