EXTRUSION DAYS
BATCH-TO-CONTI

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confidence through partnership

Over 60 Years of ZSK: Process related Modularity and Flexibility Meets High Quality and Efficiency

Frank Lechner
Process Technology, Compounding & Extrusion

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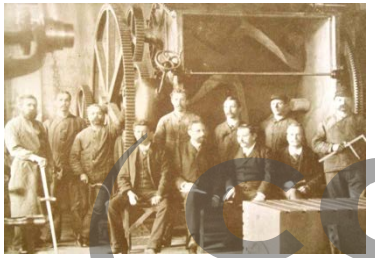
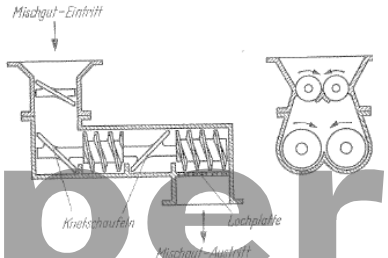
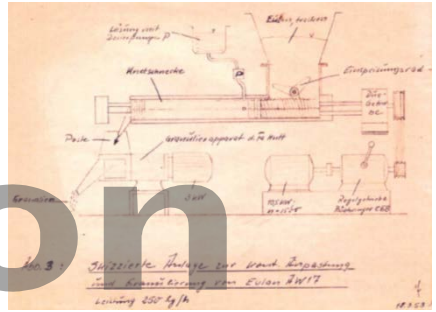
confidence through partnership

History of Kneading and Compounding

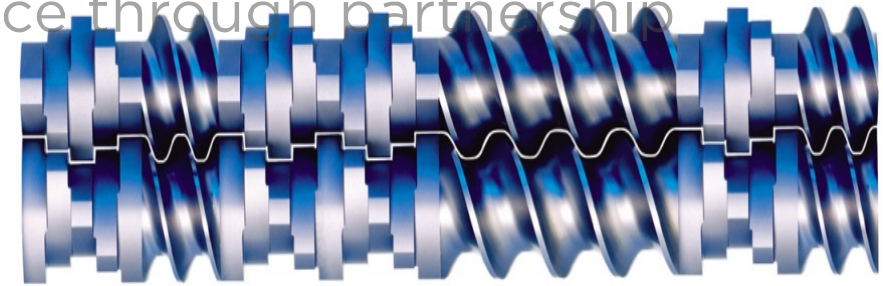
1879 Paul Pfleiderer founded the company in Stuttgart and Hermann Werner started the production of Universal Kneaders UK.







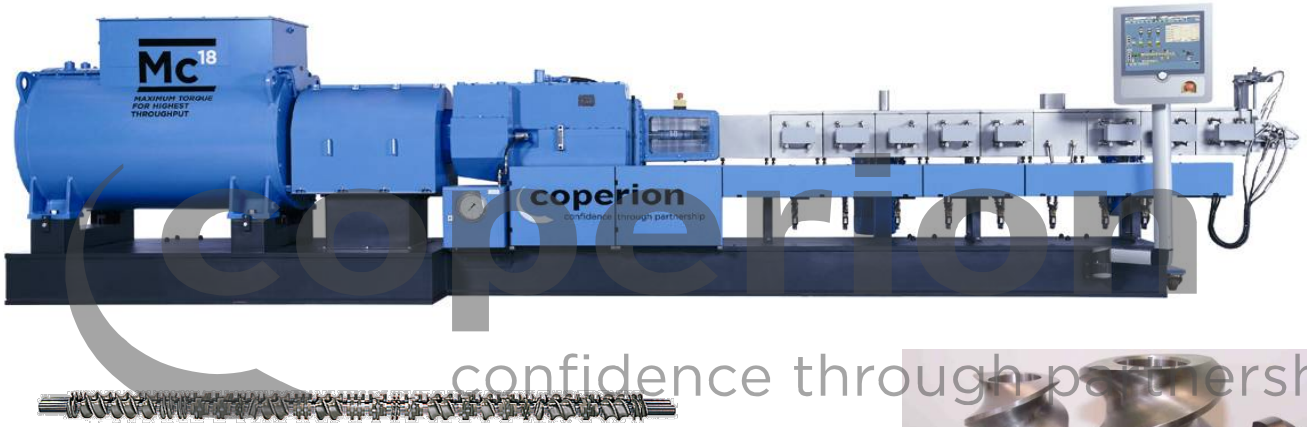
1953 License from Bayer (Erdmenger) was taken for the continuous Twin Screw Kneader ZSK.

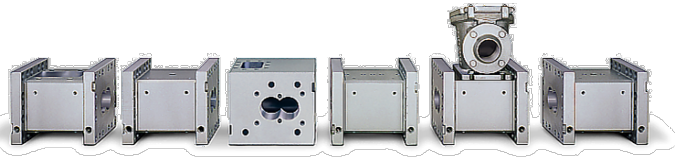


➡ **2010** Constant increase of volume and torque

Modular Design

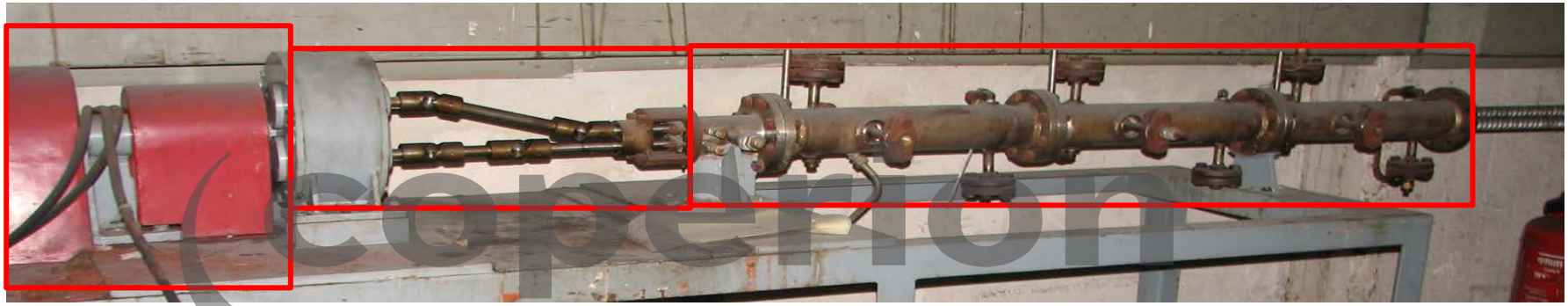
Motor Coupling Gear box Processing section Discharge





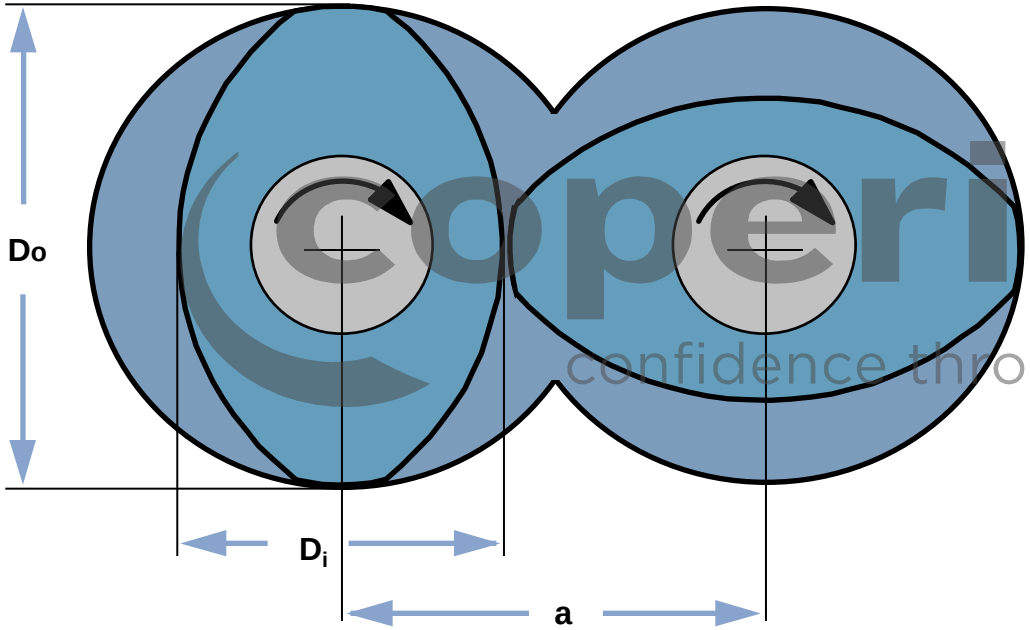
Modular design for screw elements and barrels

Modular Design: Early Twin Screw Lab Extruder



Lab Extruder 1940's, R. Erdmenger

Design Criteria for ZSK



D_o = Outer diameter

D_i = Inner diameter

a = Centerline distance

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

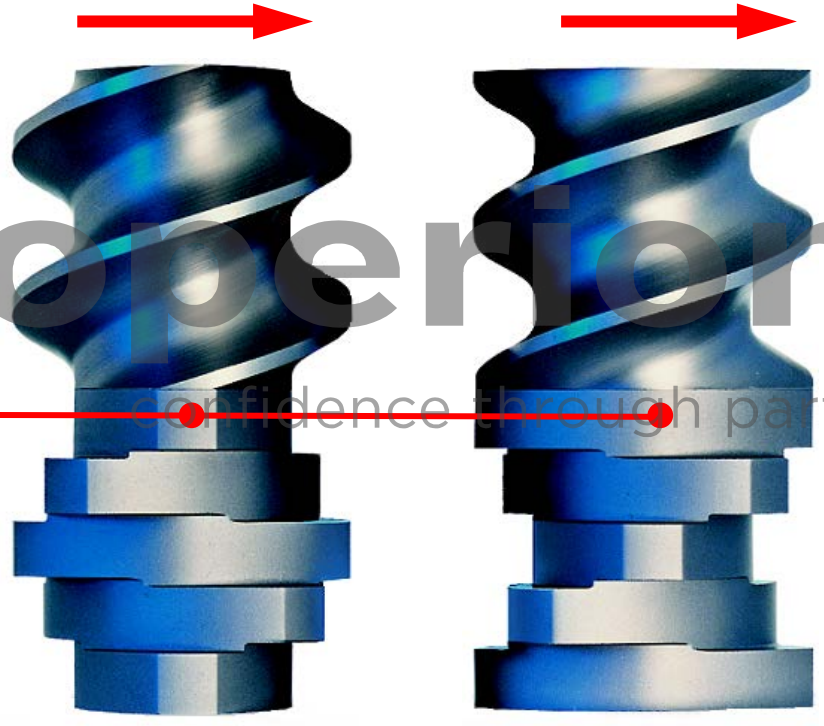
M_d / a^3 = Specific torque
determines power density and filling degree

n = Screw speed
determines shear and mixing

Self-Cleaning Screw Profile

Co-rotating

2 Screw shafts



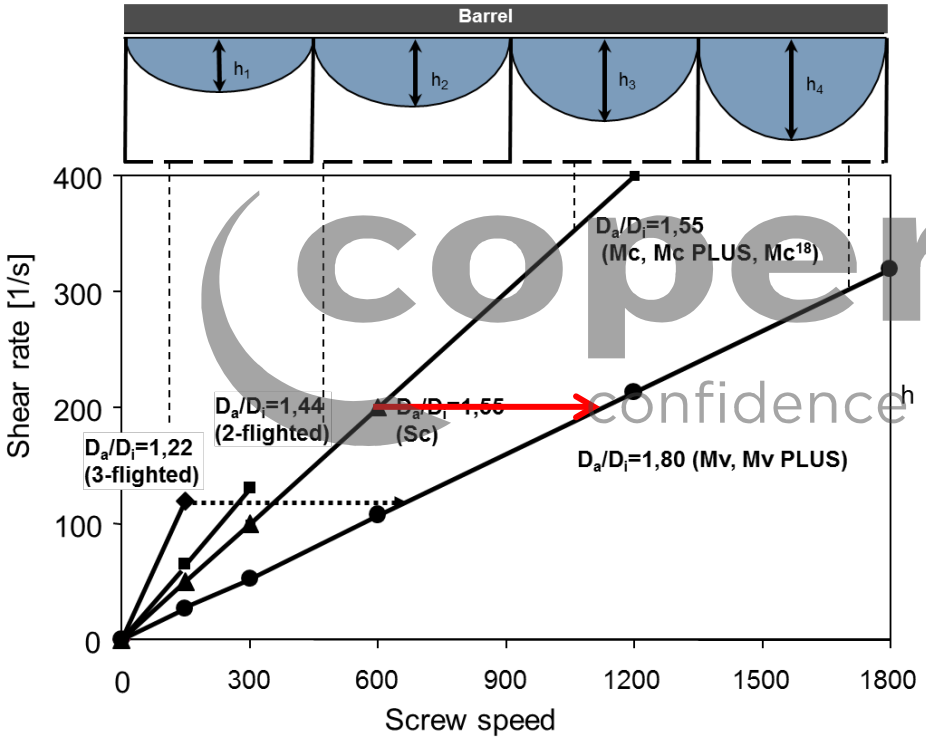
Self-Cleaning Screw Profile

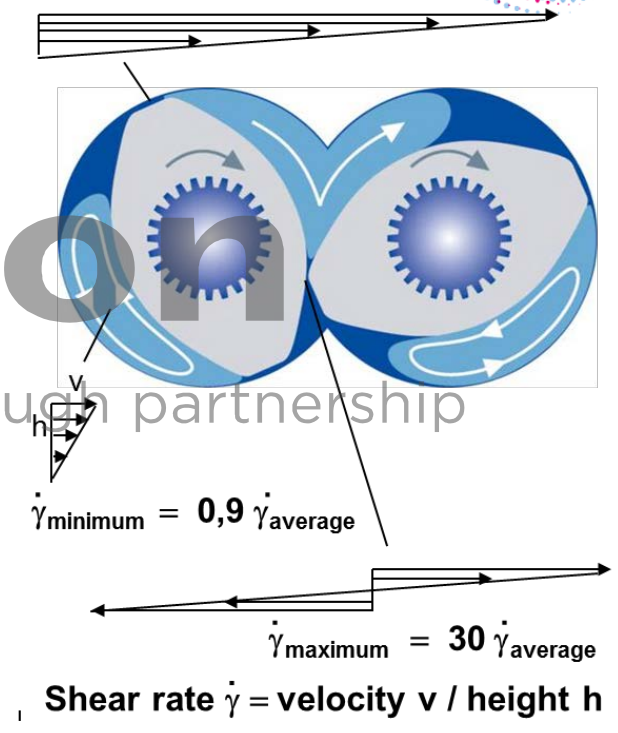
Co-rotating

Intermeshing
=> narrow gap
=> self cleaning

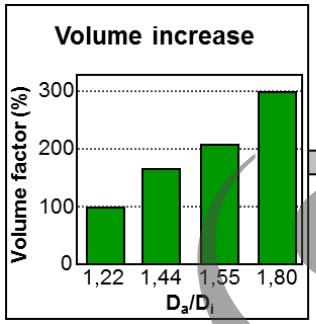
2 Screw shafts

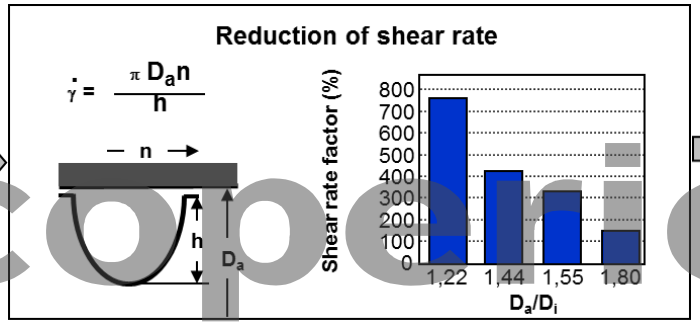
Capacity Limits – Torque and Volume

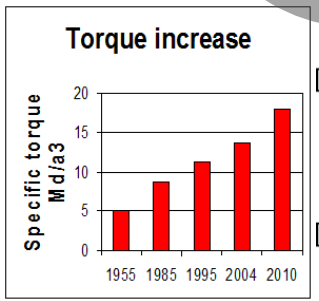




Feed Rate and Quality Relating Parameters

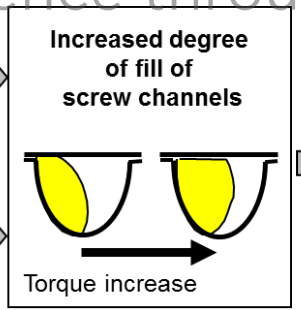






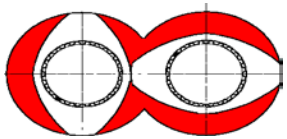
Capacity increase at constant screw speed

Speed reduction at constant capacity



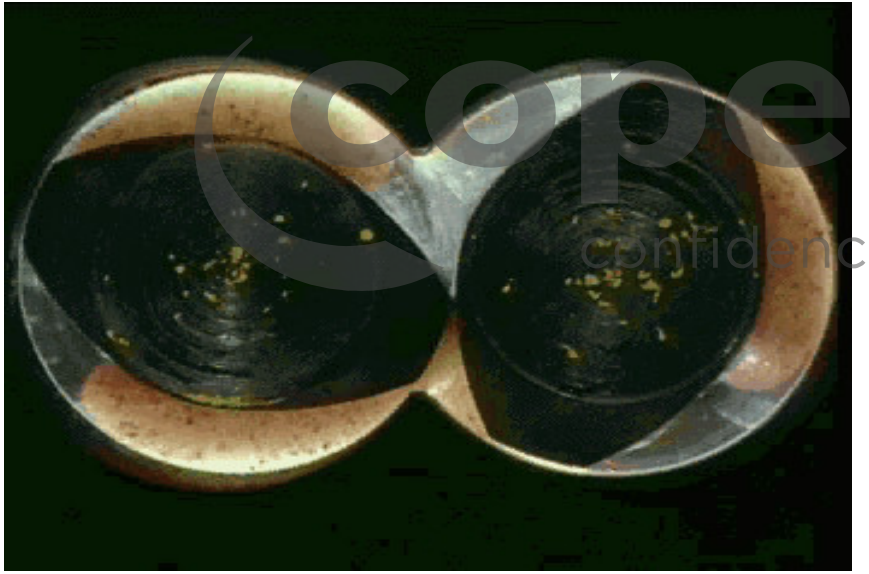
- Reduction of specific energy
- Reduction of product temperature
- Product sensitive Compounding
- Improved product quality
- Increase of capacity
- .....

Working Principle of ZSK

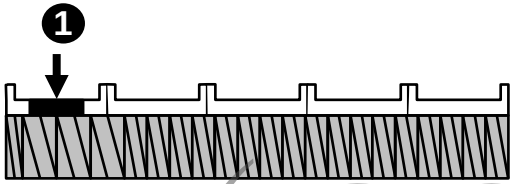


2-flighted, D_o / D_i = 1.55

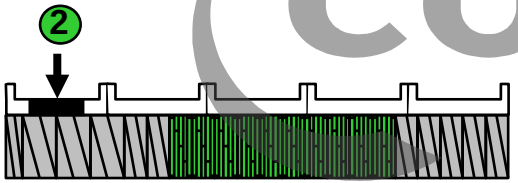
3-flighted, D_o / D_i = 1.22



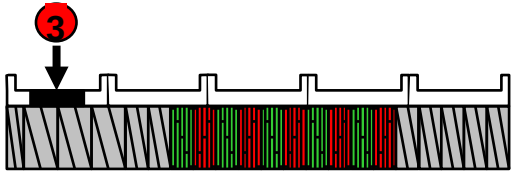
Residence Time and Self-Cleaning



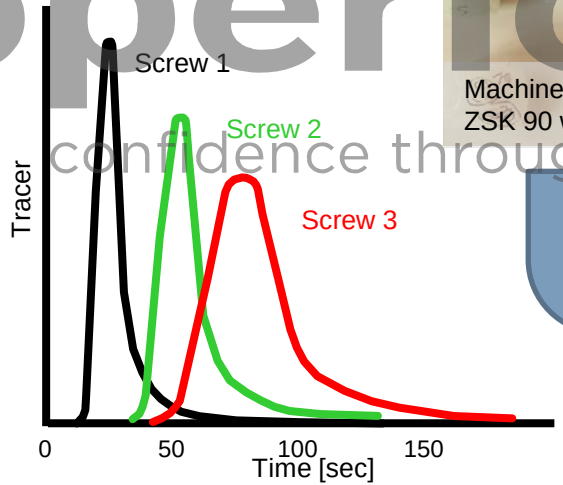
Conveying elements only



Right handed KB‘s only

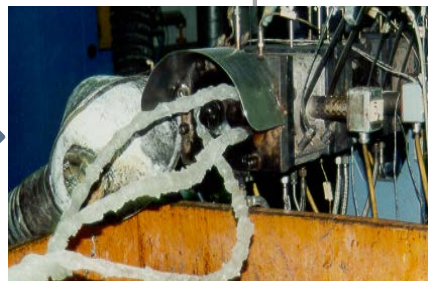


Right/left handed KB combinations

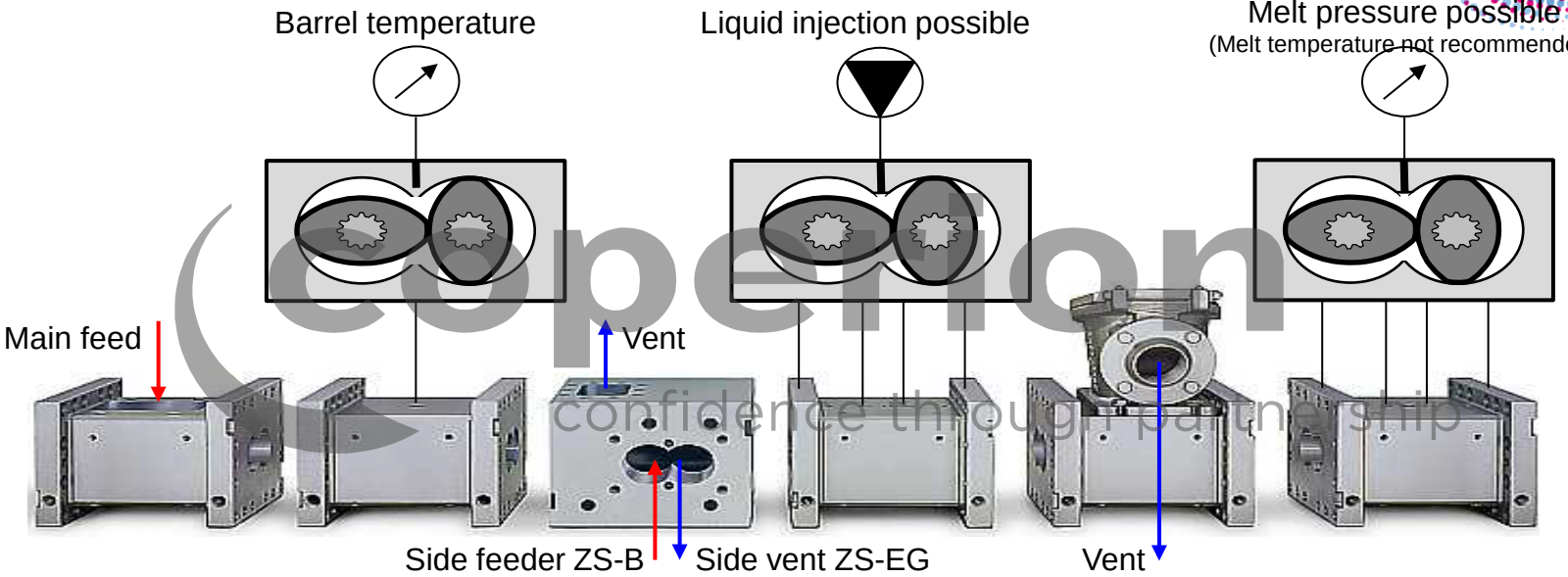


Machine:
ZSK 90 with free discharge

after 15 min



Modular Design



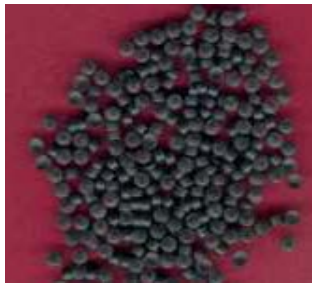
Barrel length L/D approx. 4:
- D_o/D_i = 1.55 all sizes smaller than ZSK 250
- D_o/D_i = 1.80 all sizes

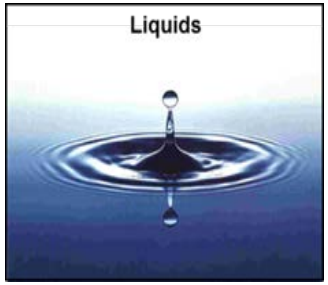
Barrel length L/D approx. 3:
- D_o/D_i = 1.22 and 1.44 all sizes
- D_o/D_i = 1.55 ZSK 250 - ZSK 420

Materials to be Handled



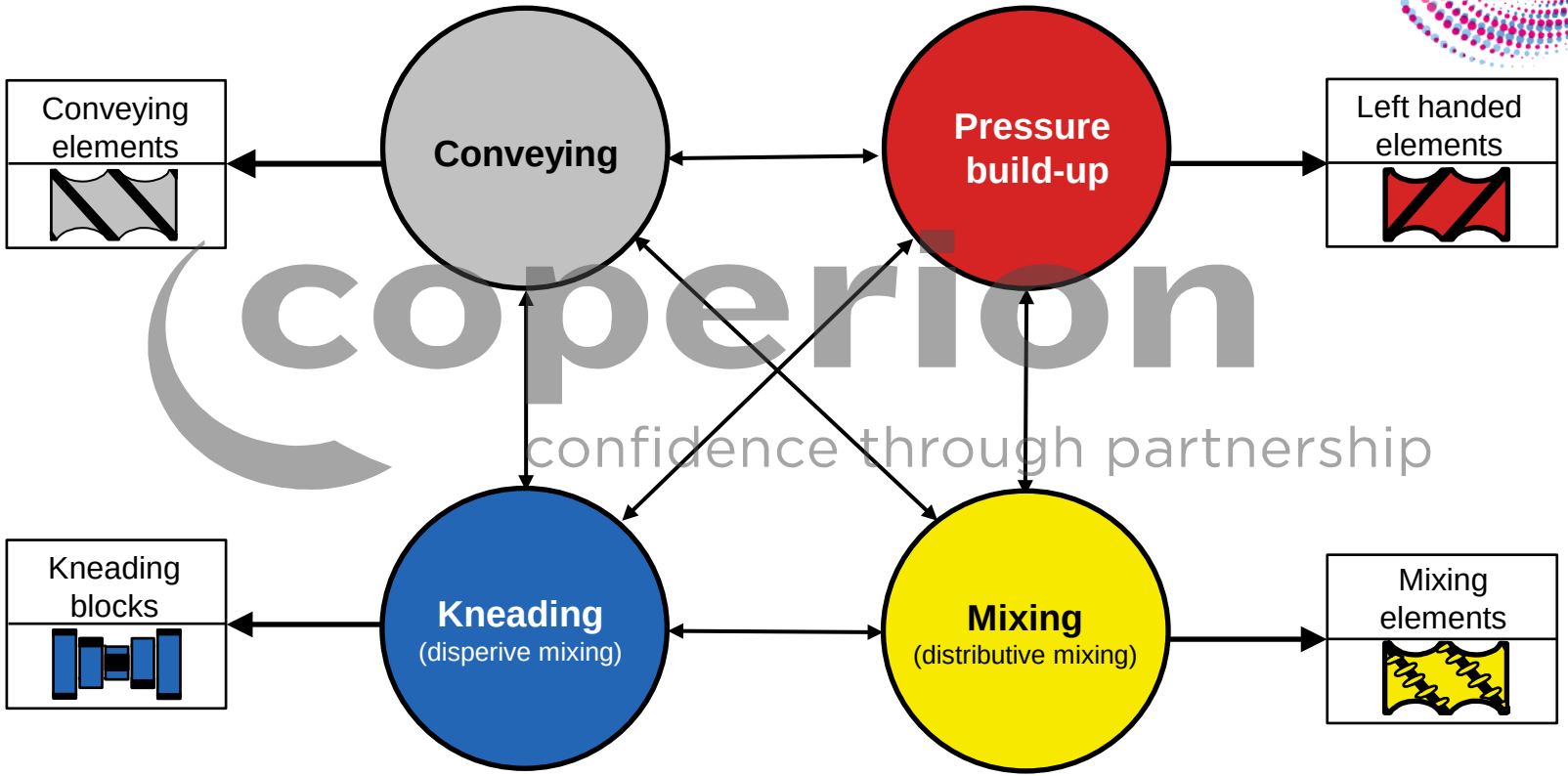


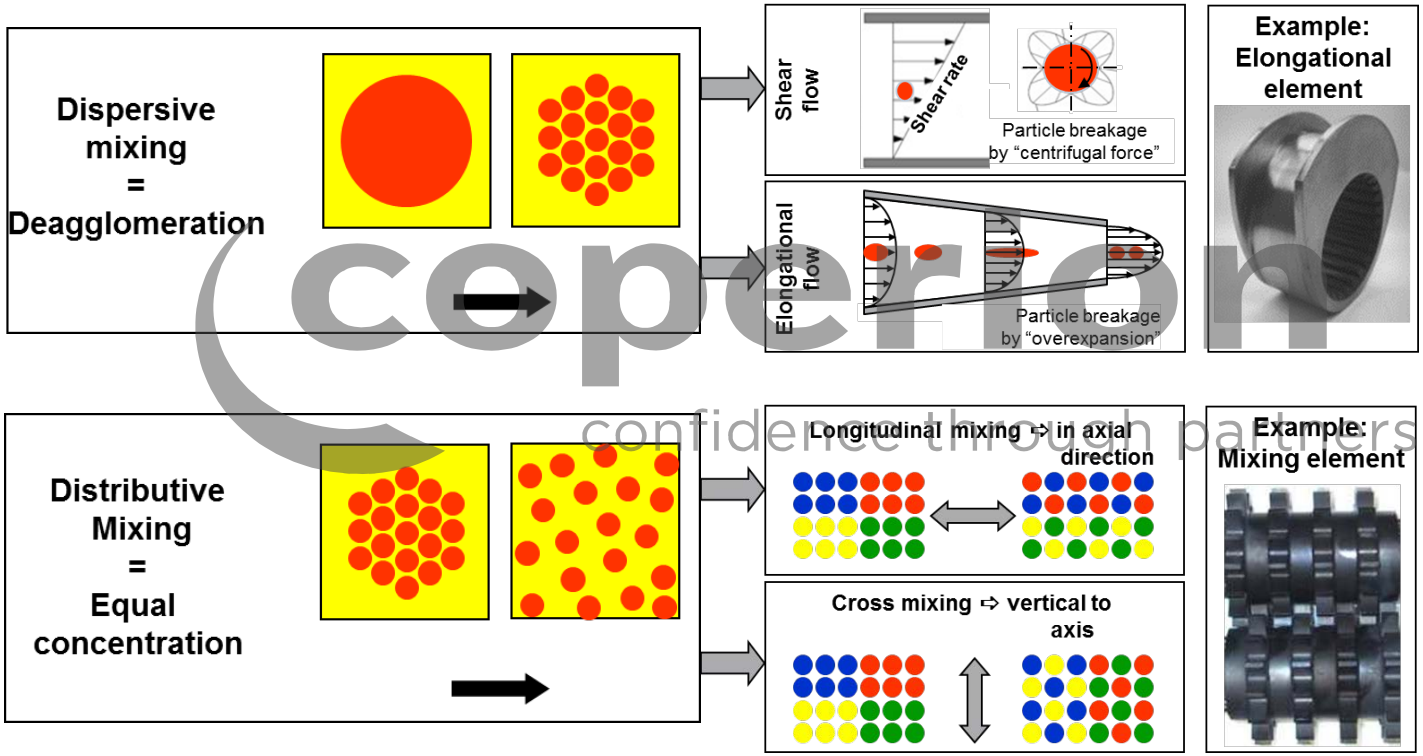



Pellets
Powder
Flakes
Liquids
Bales
...

Screw Elements

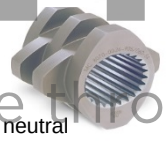


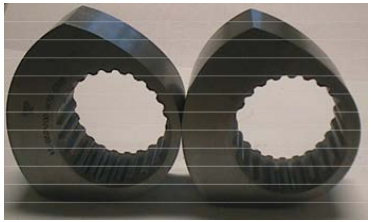
Dispersive and Distributive Mixing

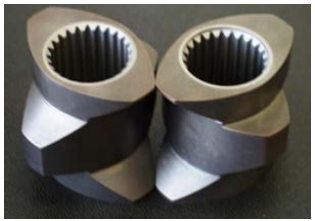


Kneading Blocks for Dispersive Mixing: Working Principle

Type of element	Mixing effect	Shearing
 X°  90°		
 X°  90°		

Type of element	Mixing effect	Shearing	Efficiency of conveying
 standard			
 neutral			





Mixing Elements for Distributive Mixing: Working Principle

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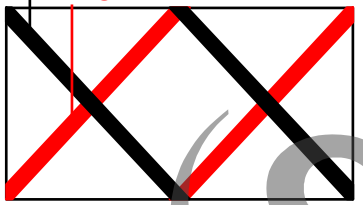
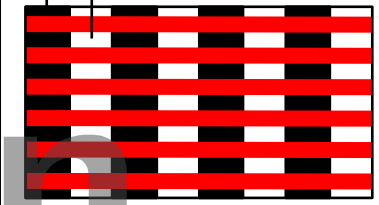
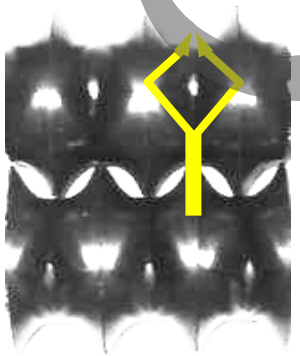
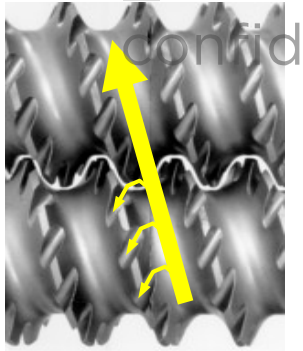
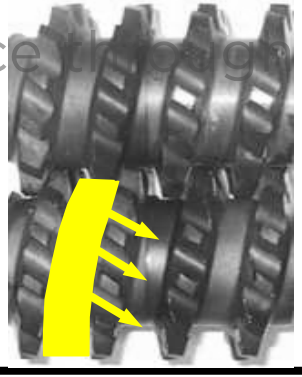
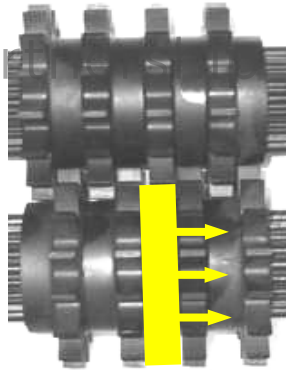
Igel - element	SME - element	ZME - element	TME - element
2-flights, right handed 2-flights, left handed	2-flights, right handed 8-flights, left handed	16-flights, right handed 1-flight, left handed	„Gear“ disc Cylindrical disc
			
No active conveying	Direction of conveying	Direction of conveying	No active conveying
			

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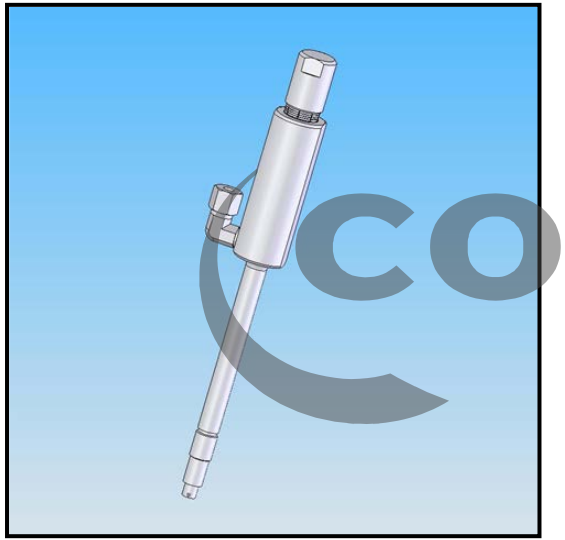
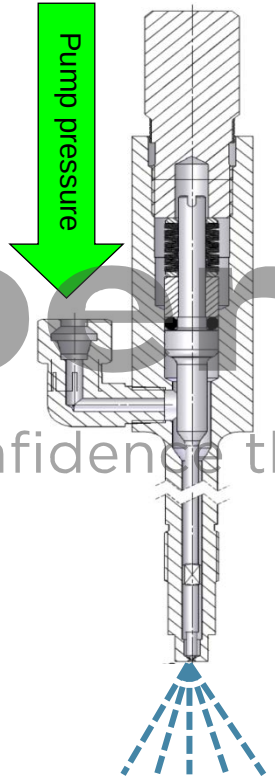
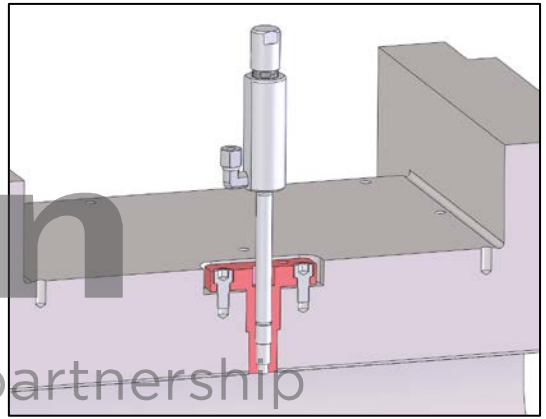
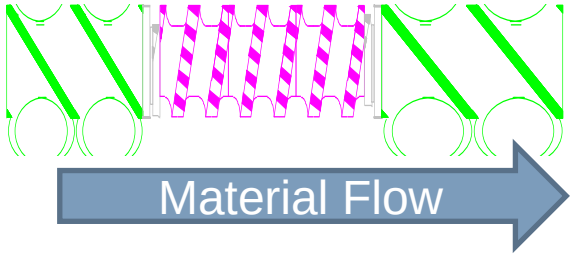
Feeding of Liquids



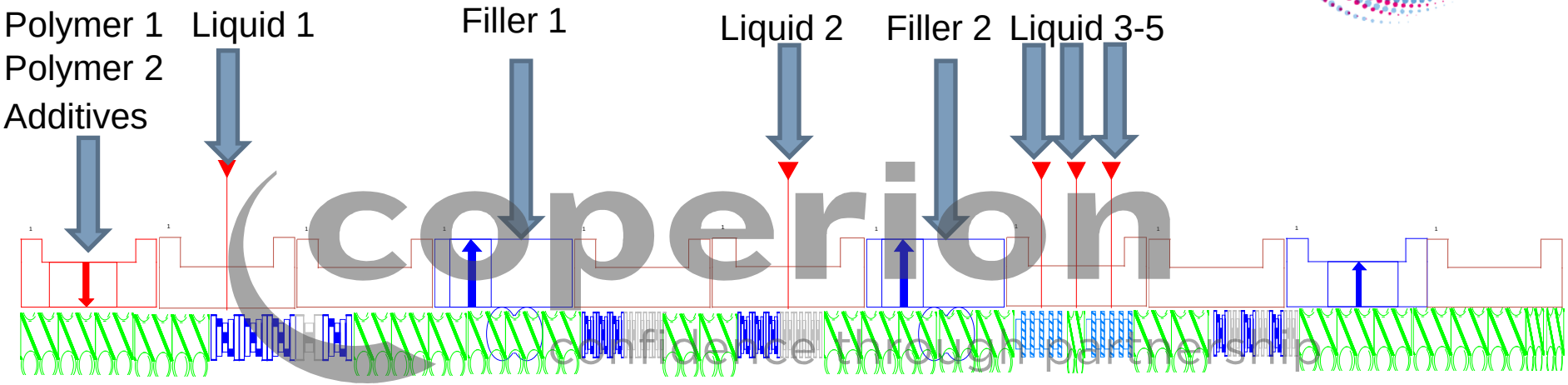
Spring preload







Flexibility Based on Modular System



- Feeding of solids and Liquids on defined process sections.
- Viscosities from low mPas up 100.000Pas.
- Kneading, mixing or homogenisation of different materials can be done by screw profile continuosly.

Over 60 Years of ZSK: Process related Modularity and Flexibility Meets High Quality and Efficiency

- Different material (solids, pellets, powders, bales and liquids of different viscosities) can be contiuously fed and homogenously mixed by using a ZSK.
- Distributive and dispersive mixing can be applied depending on the recipe and process requirements.
- Temperature control is given by the machine set-up, process parameters and feeding sequence.

Thank you very much for your attention!

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