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New process technology for thermoset fiber reinforced composite materials with the D-TSC process.

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Content.

New process technology for thermoset fiber reinforced composites with the D-TSC process.

1. Motivation, idea und targets
2. D-LFT process
3. Working principle of co-rotating twin screw extruder ZSK
4. Processing of thermoset fiber reinforced composite materials on a ZSK
5. Summary

Motivation.

- In automotive applications thermoset materials have to compete with thermoplastic composite materials which are processed continuously.
- ⇒ The **DaimlerChrysler AG** together with the machine and plant manufacturer **Coperion Werner & Pfleiderer** and **DSM Composite Resins** as manufacturer of thermoset resins have faced up to this challenge

Idea.

Idea of the project:

Development of a material and process where thermoset composite materials can be extruded in a cost-effective and stable process and where they can be molded directly into parts.

The advantage in quality and price by using a continuous process should benefit also in thermoset fiber reinforced composite materials.

⇒ **ETAA** (*Ex*trusion of *T*hermosets for *A*utomotive *A*pplications)

Idea.

- Use of a co-rotating twin screw extruder (ZSK) for compounding of the composite material.
- Feeding of all components via feeding systems (gravimetric feeders, pumps, ZSB, etc).
- Impregnation of the glass fibers in the ZSK.
- Areal and temporal combination of extrusion and molding.
- Option: production of storable semi-finished parts
- Use of compression molding and injection molding process.

Targets.

- Development of a continuous process for production of thermoset composite materials which is competitive to the efficiency of thermoplastic composite materials.
- Reduction of many single process steps (mixing of the paste, knife application, sprinkling of glass fibers, fulling, thickening, etc.) and reduction of the complexity of the different interfering process parameters of the production process.

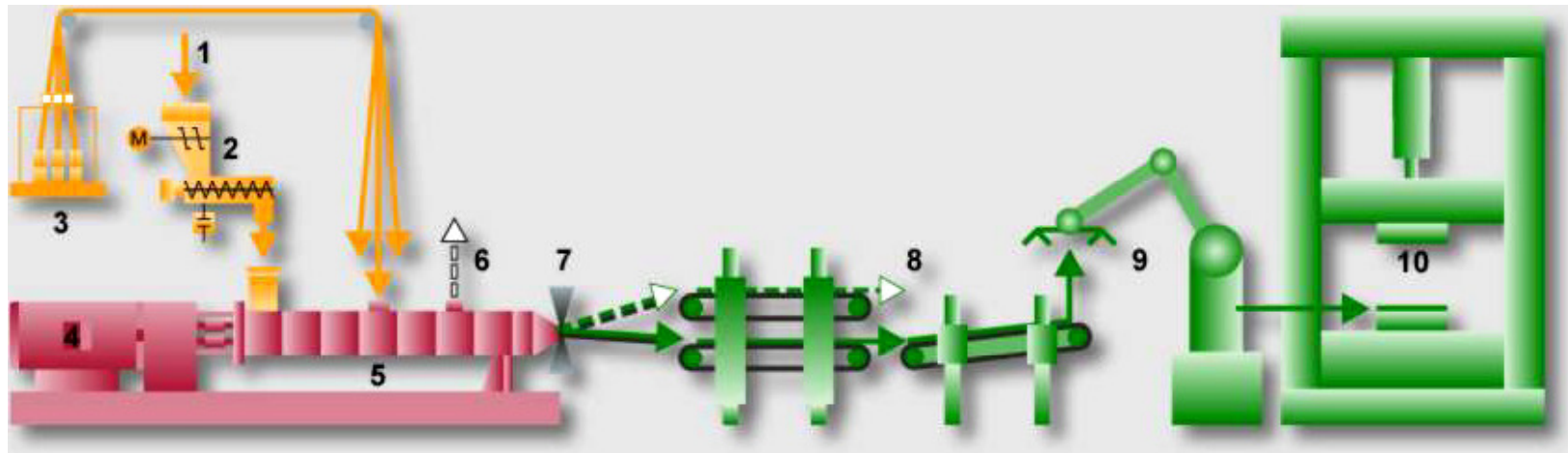
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D-LFT-process.

- | | | | |
|---|-------------------------------------|----|-----------------|
| 1 | Polymer | 6 | Degassing |
| 2 | Gravimetric feeder | 7 | Cutting unit |
| 3 | Glass fiber roving | 8 | Seperation unit |
| 4 | Maindrive | 9 | Handling system |
| 5 | Co-rotating twin screw extruder ZSK | 10 | Mold |

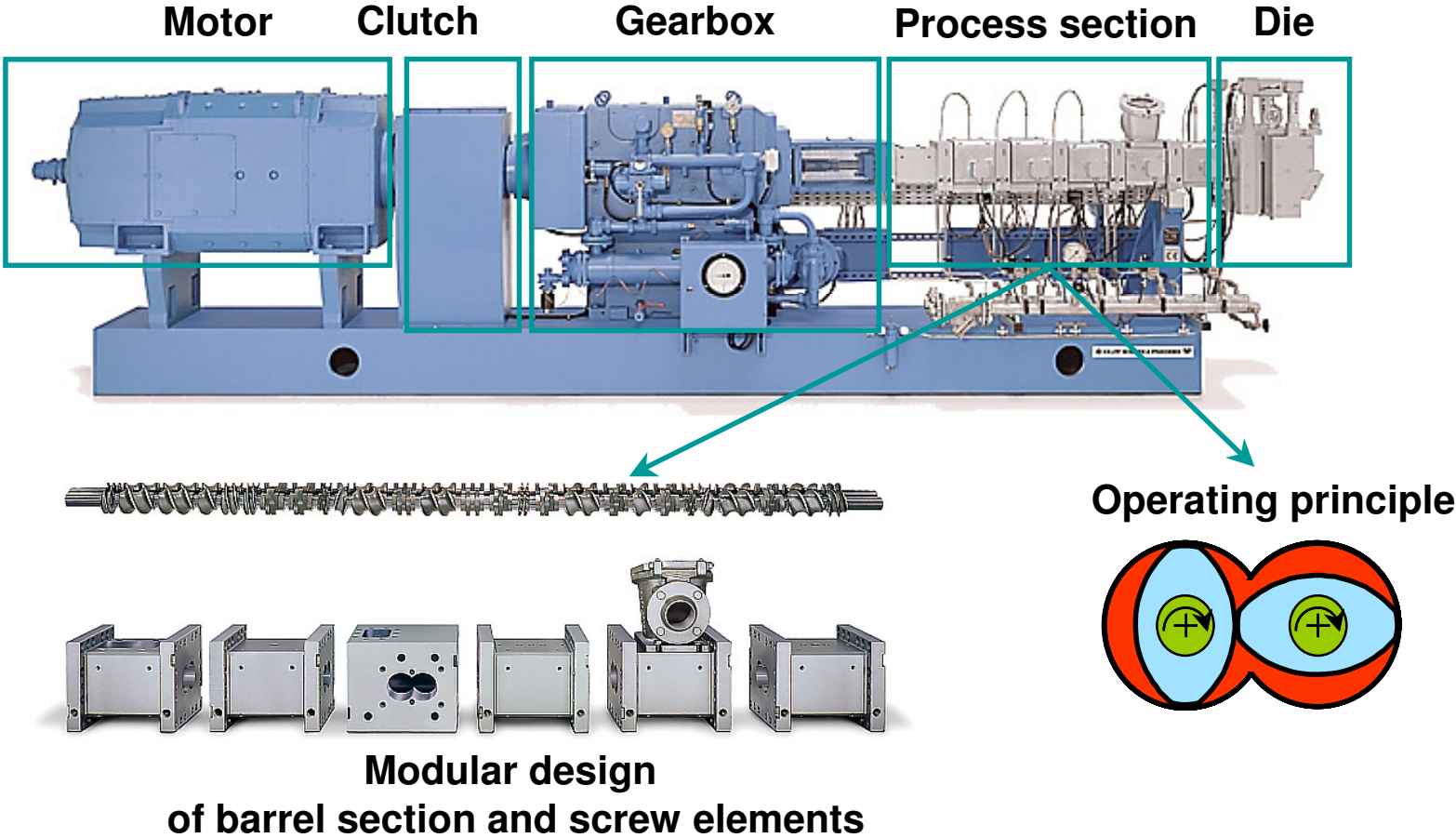


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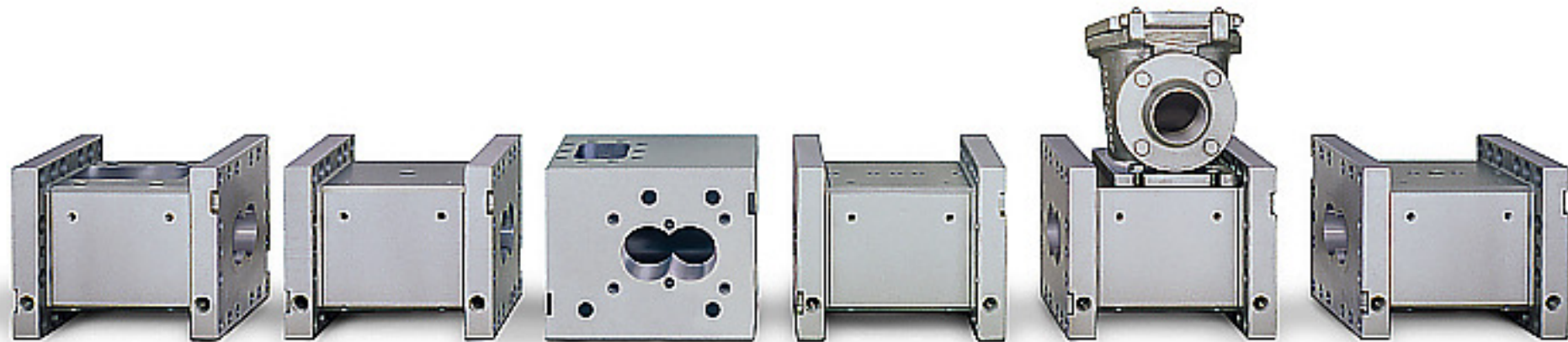
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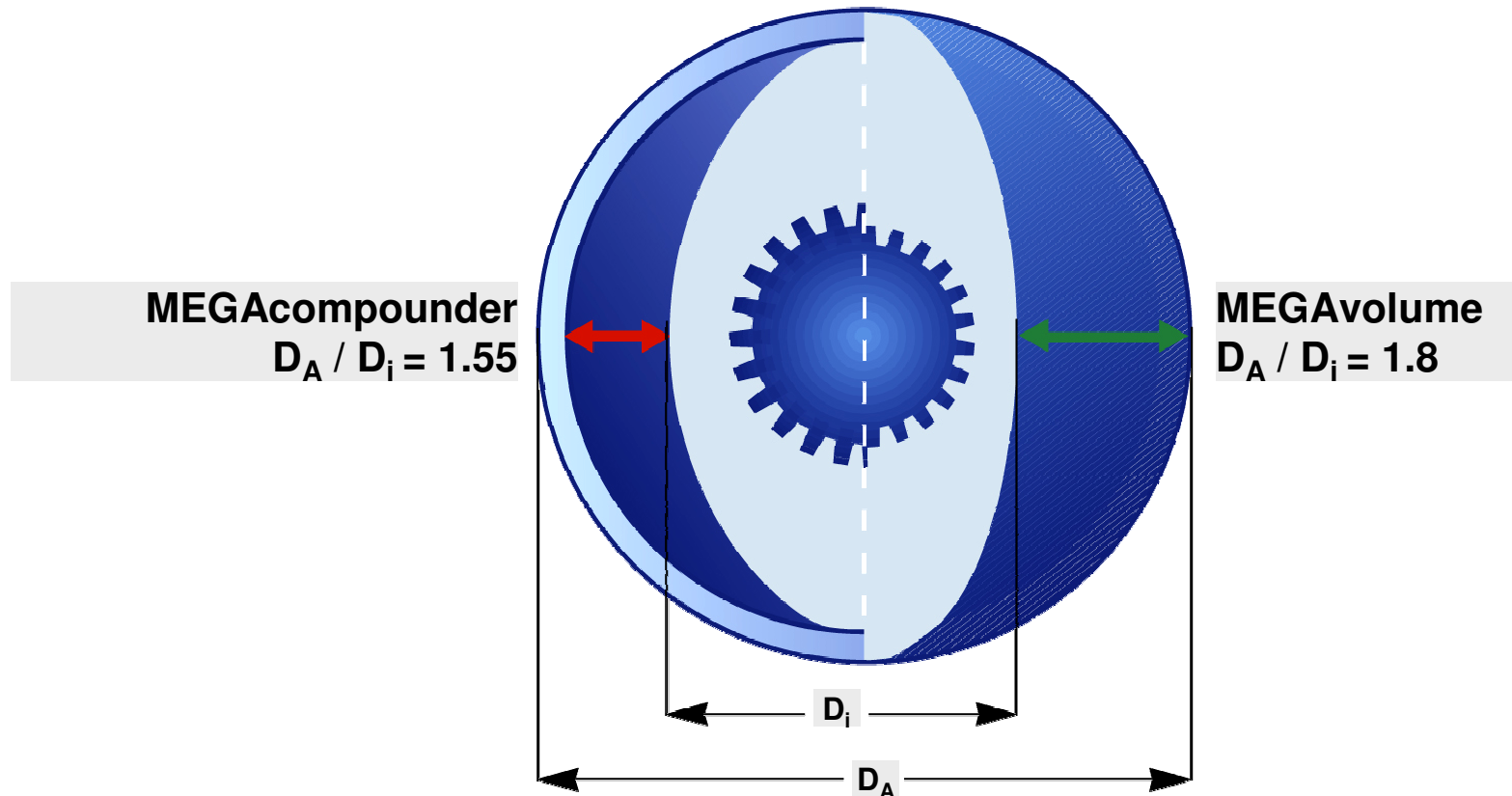
Working principle of a co-rotating twin screw extruder ZSK.



Modular design of barrel section and screw elements.



Diameter ratio. Flight depth and free volume.

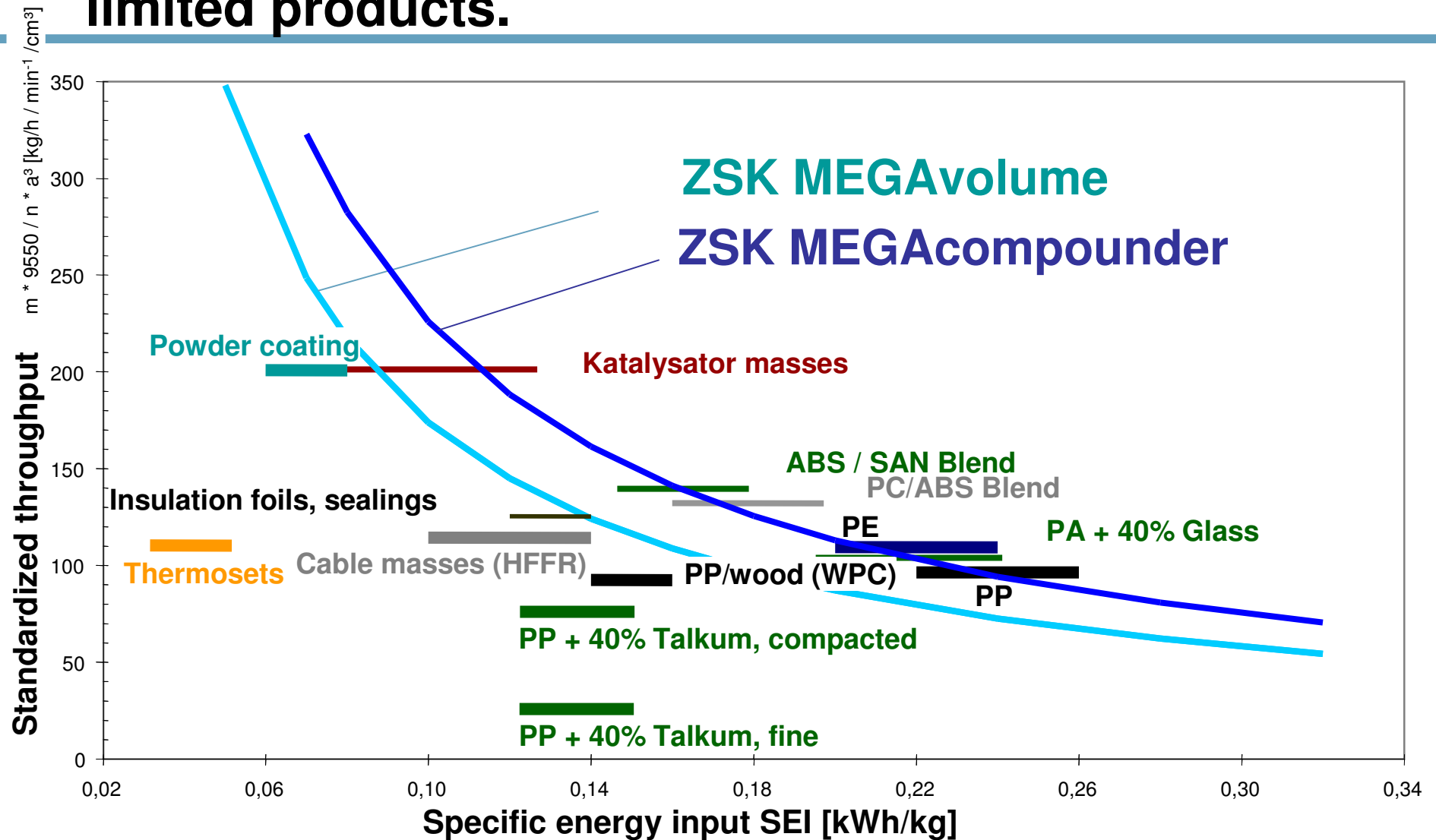


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ZSK-working areas: torque limited and intake limited products.



Requirements to the ZSK.

D-LFT (Direct-Longfiber Thermoplast)

- Melting of PP
- Homogenization und dispersing of the additives in the melt
- Glass fiber intake
- Cutting, dispersing and impregnating of the fibers with melt

→ Torque necessary

→ Mc-machines

D-TSC (Direct-Thermoset Compounding)

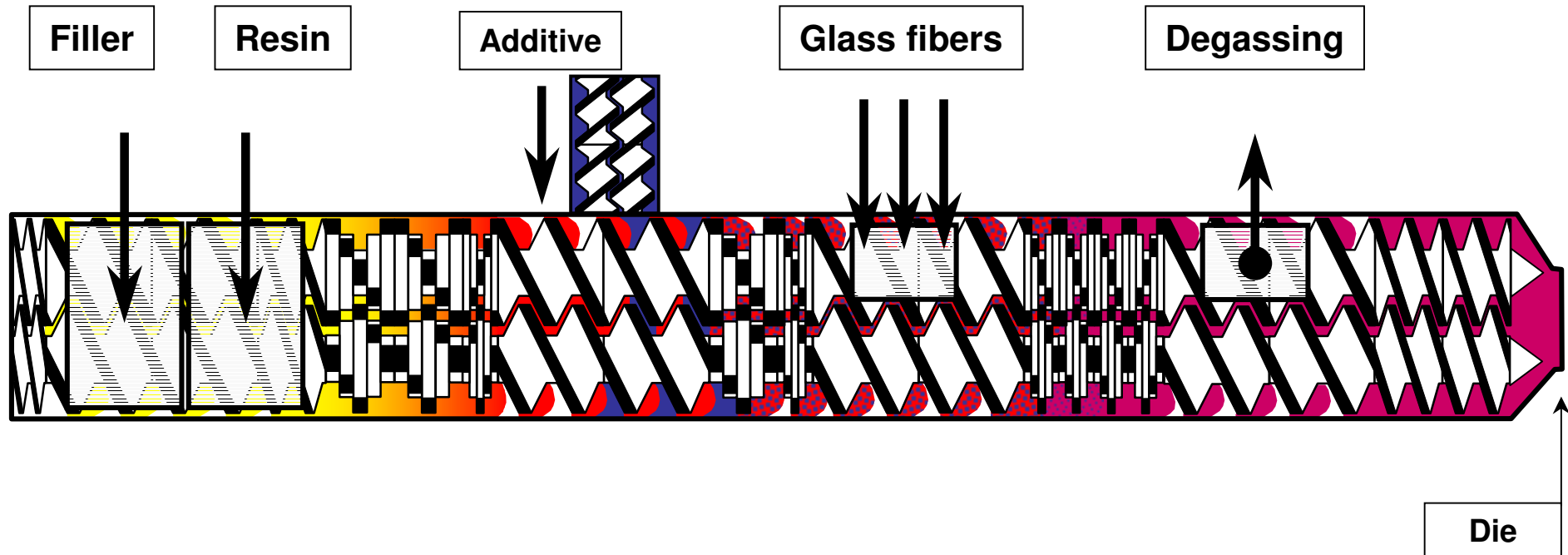
- Homogenization und dispersing of high amounts of fillers and mold release agent with resin
- Glass fiber intake
- Cutting, dispersing and impregnating of the fibers with melt

→ Volume necessary

→ Mv-machines

It is necessary to adapt the process to the homogenization and dispersing of the filler and mold release agent in the resin to get a homogeneous paste.

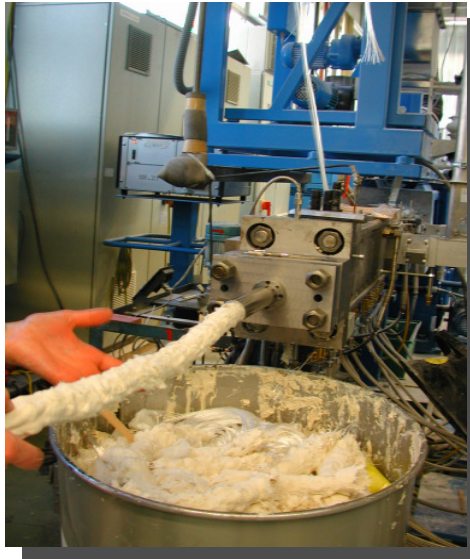
Order of feeding the raw materials.



Process sections

Feeding, conveying	Mixing, Homo- genization	Conveying, Feeding	Mixing	Feeding of glass fibers	Cutting Dispersing Impregnating	Degassing	Discharge pressure built up
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Different dies and discharge forms.



Tube die



Slit die (100mm)



Slit die (200mm)

Experimental tool.

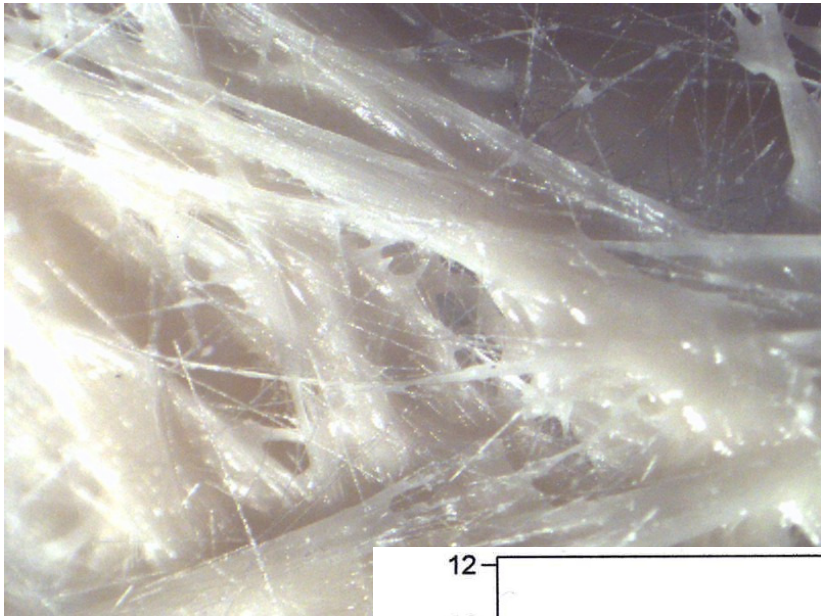


Experimental tool

Detail view

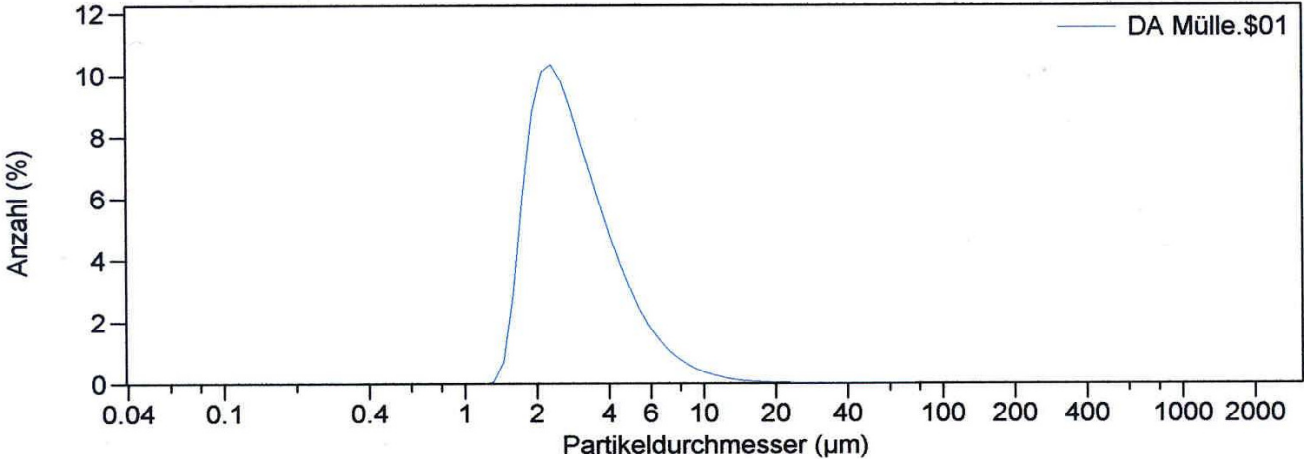


Fiber impregnation and homogeneity.



Microscopy of the fiber impregnation

Measurement of homogeneity of the paste



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Summary.

- Series of experiments for processing thermoset fiber reinforced composite materials on the ZSK.
- Adapting of a twin screw extruder on the process of thermoset materials. Feeding of the raw materials with continuous gravimetric feeders.
- Impregnation of the glass fibers in the extruder, discharge of a fiber reinforced composite material.
- Pilot plant for the process chain at the OEM.
- Areal and temporal combination of extrusion and molding process was realized.

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[Thank you for your attention!](#)

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