HOW TO PROCESS MASTERBATCH
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IMPORTANT FACTS ON LEISTRITZ

- established in 1905
- privately owned, independent company
- employees ~ 2,000
- sales p.a. ~ 300 Mio. EUR
FOUR BUSINESS UNITS – ONE MOTION: ROTATION

TURBINE TECHNOLOGY

PUMP TECHNOLOGY

EXTRUSION TECHNOLOGY

PRODUCTION TECHNOLOGY
BUSINESS UNIT
EXTRUSION TECHNOLOGY

One of the leading manufacturers of co-rotating twin screw extruders

- for the plastics, food and pharmaceutical industry
- from 12 to 260 mm screw diameter
Masterbatch (MB) is a solid or liquid additive for plastics used for coloring plastics (color masterbatch) or imparting other properties to plastics (additive masterbatch). Masterbatch is a concentrated mixture of pigments and/or additives encapsulated during a heat process into a carrier resin which is then cooled and cut into a granular shape.

(source wikipedia.com 18.1.2016)
MASTERBATCH OVERVIEW

- Pigmente
  - organische Pigmente
  - anorganische Pigmente
  - Effektpigmente
  - Monopräparate

- Additive
  - Thermostabilisatoren
  - Lichtschutzstabilisatoren
  - Flammenschutzstabilisatoren
  - Antistatika
  - Antiblocksubstanzen
  - Nukleierungsmittel

- Füllstoffe
  - Füller
  - Verstärker

- Extrusion
  - Spritzguss
  - Folienextrusion
  - Faserextrusion
  - Profilextrusion
  - Rohrextrusion

- Rohopolymer
  - > 10%

- Masterbatch 20-90%
CHALLENGE MASTERBATCH

- Low bulk density powders
- Low melting points of additives
- Low viscosity of additives
- Addition of liquids
- Dispersion
- Shear sensitive products
Example:
Anti-blocking additives containing natural or synthetic silica. Some silica grades have a bulk density far < 300 g/l!

Formulation:
20% (+) Silica in a polyolefin carrier

Problematic properties and effects in processing:
Volume limitation in side feed port
PROCESSING LOW BULK DENSITY

- Side feeder with a high free volume

Example: Leistritz LSB XX with an OD/ID = 2.0
PROCESSING LOW BULK DENSITY

- Extruder with high OD/ID provide a high free volume, but still enough mixing effect for high level dispersion grades
- OD/ID = 1.66, torque factor = 15 Nm/cm³
Venting strategy/extruder setup

Forward venting for best filler intake and lowest disturbance of dosed filler at side feed position (reverse flow).
**PROCESSING LOW MELTING POINT**

**LOW VISCOSITY / LIQUIDS**

- **Example:** Slip additive MB containing higher amounts of wax like Atmer, UV stabilizer containing HALS

- **Formulation:** 10-30 % additives in a polyolefin matrix

- **Problematic properties and effects in processing:** Blocking of side feeder after a certain time (sometimes only some minutes) due to additive melting. After melting, the additive is quite slippery which makes feeding via side feeder impossible. Migration of additive during storage of the final product. Additive is not 100% stable blended to polymer matrix.

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**PROCESSING LOW MELTING POINT**

- Side feeder with cooled screws and barrel

- The extruder barrel at side feed position should also be as cool as possible.
**PROCESSING LOW VISCOITY**

- Improved mixing by using special mixing elements

- Residence time for additives to migrate in the matrix ➔ 48-60 L/D length of extruder
PROCESSING DISPERSION

↗ Example: Color Masterbatch

↗ Quality depends on many factors:
   ↗ Formulation (polymer, pigment, wax)
   ↗ Process setup (mixing, premix/split-feed, screw design)
   ↗ Process settings (screw-speed, filling rate)
Filter value: 1.2 bar/g  
magnification: 1 : 50

Filter value: 2.6 bar/g  
magnification: 1 : 50
SHAPE OF PIGMENT PARTICLES

Primary particles (size from 0.01 µm to 1 µm)
- Single crystals
- Crystallites
- Coherent net
- Aggregates – surface linking (indivisible)
- Agglomerates – linked by edges and endings - divisible
  causing stains in end product when compacted!
**IMPACT OF THE POLYMER ON PRODUCT QUALITY**

**EXTRUDER:**
ZSE 27 MAXX 44 L/D

**Formulation:**
1.) 40% **LLDPE**-powder
   - 40% pigments blue 15:1
   - 20% wax
2.) 40% **PP**-powder
   - 40% pigments blue 15:1
   - 20% wax
**IMPACT OF THE PIGMENT ON PRODUCT QUALITY**

EXTRUDER: ZSE 50 MAXX – 44 L/D

Formulation
1.) 40% LLDPE-powder
20% wax

**Filter pressure value [bar/g]**

- **Pigments**
  - K 6902: 2.6
  - K 6911: 1.0

1200 rpm, 200 kg/h
IMPACT OF THE WAX TYPE ON PRODUCT QUALITY

EXTRUDER:
ZSE 27 MAXX – 44 L/D

Formulation:
1.) 40% PP-powder
   40% pigment blue 15:3
   20% wax

Filter pressure value [bar/g]

- Wax A
- Wax B

600 (33 kg/h)
900 (52 kg/h)
1200 (72 kg/h)
QUALITY DEPENDING ON THE WAX PORTION

EXTRUDER:
ZSE 27 MAXX - 44 L/D

Formulation:
70% - 30% PP-granulate
30% pigment yellow 155
0% - 40% wax

throughput: 13 kg/h
speed: 800 RPM
wax and pigment dispensed separately in Sidefeeder
MASTERBATCH IN PREMIX:
COMPARISON OF HOT AND COLD PREMIXES

EXTRUDER:
ZSE 50 MAXX - 44 D

Formulation:
40% LLDPE-powder
40% pigment blue 15:3
20% wax

cold premixing
hot premixing
SETUP PREMIX VS. SPLIT-FEED

 Cromophtal Red G in Split-feed opens up a new dimension

 Nearly perfect dispersion (no actual agglomerates visible under microscope)

 Differences in color intensity hints at differences in color depth.

 Split-feed is the preferred processing method for pigments with a great tendency to compaction and great calendering effect (potential for color development).

**IMPACT OF SCREW GEOMETRY ON WETTING**

**EXTRUDER:**
ZSE 27 MAXX - 44 L/D

**Formulation:**
1.) 40% PP-powder
   40% pigment blue 15:1
   20% wax

<table>
<thead>
<tr>
<th>Screw rpm</th>
<th>Filter pressure value [bar/g]</th>
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<tbody>
<tr>
<td>600 rpm (20 kg/h)</td>
<td>1,0</td>
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<tr>
<td>900 rpm (39 kg/h)</td>
<td>1,6</td>
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<tr>
<td>1200 rpm (59 kg/h)</td>
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**Screw Geometry**

- **Lobal pool capture (dispersive)**
- **Splitting of melt pools (distributive)**
  - Wider disc = higher extensional flow
  - Smaller disc = more melting units
IMPACT OF SCREW SPEED ON WETTING WITH CONSTANT THROUGHPUT

EXTRUDER:
ZSE 27 MAXX - 44 L/D

Formulation:
1.) 40% PP-powder
   40% pigment blau 15:1
   20% wax

Constant improvement of filter pressure value with rising screw speed

400 rpm (30 kg/h)  
800 rpm (30 kg/h)  
1200 rpm (30 kg/h)
Example: Effect pigment masterbatch. Project with KUNCAI.

Formulation:
- 65-70 % PS
- 0-5 % wax
- 30 % effect pigment (2 different types: standard / wax preparation)

Problematic properties and effects in processing: Effect pigments break due to high shear – pearlecent effect gets lost.
**PROCESSING SHEAR SENSITIVE**

- Soft extruder screw with gentle distributive mixing

- Extruder needs to be as short as possible after adding the effect pigment, but long enough for good dispersion

- Low screw speed
PROCESSING SHEAR SENSITIVE

Vacuum

Wax Pigment Atm. venting

Polystyrene
PROCESSING SHEAR SENSITIVE

High OD/ID ratio for gentle handling of products with economic throughputs
PROCESSING SHEAR SENSITIVE

- Screw speed: 400 rpm vs. 200 rpm

- Side feeder speed: 100 rpm vs. 200 rpm
PROCESSING SHEAR SENSITIVE

Original D95 = 182μm
before extrusion

after extrusion
THANK YOU!!!

For questions please contact me:

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