Optimization of the injection molding process

MOLDFLOW® SIMULATIONS

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Agenda

• Pezy Group – Accelerating innovation
• Introduction injection molding simulation software
• Necessity of injection molding simulation
• Examples
Accelerating innovation

20+
Years of customer relations

100+
Specialists
Accelerating innovation

400+ Clients

20+ Years of customer relations

100+ Specialists
Accelerating innovation

300+ Patents
400+ Clients
20+ Years of customer relations
100+ Specialists
Accelerating innovation

- International network of partners and suppliers

- Groningen
- Houten
- Amsterdam
- Eindhoven
- Singapore

- 5 offices
- 300+ Patents
- 400+ Clients
- 20+ Years of customer relations
- 100+ Specialists
From design to small series production
Offering expertise in all aspects
Agenda

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- Necessity of injection molding simulation
- Examples
Injection molding simulation – History

1978

1980

1990

2000

2008

Cadmould

FillCalc

G-MOLD®

AC Technology

moldflow®

autodesk

1-DEAC for Plastics

SIGMA Engineering GmbH

Cadmould

Moldex3D®

Simpoe-Mold
Injection molding simulation – Overview

- Filling
- Pressure
- Temperature
- Air traps
- Fiber Orientation

- Shear rates
- Frozen layers
- Shrinkage
- Warpage
- Etc….

IMPORT CAD MODEL

FIX FEM MODEL

Finite Element Model

BOUNDARY CONDITION

START ANALYSIS

RESULTS & INTERPRETATION
Injection molding simulation – Overview

DEMO
Injection molding simulation – Overview

- **IMPORT CAD MODEL**
  - Finite Element Model

- **FIX FEM MODEL**
  - Filling
  - Pressure
  - Temperature
  - Air traps
  - Fiber Orientation

- **BOUNDARY CONDITION**
  - Shear rates
  - Frozen layers
  - Shrinkage
  - Warpage
  - Etc....

- **START ANALYSIS**

- **RESULTS & INTERPRETATION**
Finite element modelling

Moldflow Dual Domain™ Technology
Finite element modelling

Moldflow Dual Domain™ Technology
Finite element modelling

Moldflow Dual Domain™ Technology
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Why simulation?

Industrial design
Product design

Mold design
Mold making

Production
Why simulation?

Industrial design
Product design

Mold design
Mold making

Production
Simulation for industrial / product design

- Can I fill this part?
- Where is the best gate position?
- What happens if I change the material?
- Position weld lines?
- Location air traps?
- Is there a risk of sink marks?
- Are the wall thicknesses okay?
- Deformation of the product (warpage) and / or tolerance issues?
Simulation for mold design

- Position & dimensions of cooling channels?
- Conformal cooling?
- Highly conductive mold inserts?
- Cycle time?
- Hot or cold runner?
- Runner balancing?
- Deformation of the product (warpage) and / or tolerance issues?
Simulation for production

- Injection time and injection profile?
- Switch over point?
- Packing time and packing profile?
- Process window?
  - Stable process?
- Decrease cycle time?
- Deformation of the product (warpage) and/or tolerance issues?
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Example 1 – Filling
Filling

Weld line
Filling

Weld line
Filling
Filling
Filling
Filling
Good filling pattern through living hinge: Straight
Filling
Filling
Filling
Filling
Filling
Filling
Filling
Filling
Filling
Filling
Filling
Filling
Filling
End of filling - Product 100% filled

Good filling pattern through living hinge: Straight

Weld line
Volumetric shrinkage

Sink marks
Volumetric shrinkage and Sink marks
“Plastic System”

- “Plastic System” is complex
- Simulation helps
- But... Simulation is always based on assumptions and simplifications
“Plastic System”

• Mathematical models vs. reality
  • Models are limited
• Simplifications by user
  • Conscious or not
• User errors
  • No training
  • Interpretation errors
• Finite Element Model
  • Element size
  • Type of model

• Numerical tolerances
  • Convergence criteria
• Changing material behaviour
• Reliability IM machine
• ...

Part design — Mold design — Processing conditions — Material
“Plastic System”

- **IF** the user understands the assumptions and simplifications
- **THEN** the user has a perfect tool to unravel the Plastic System...
- **AND** the user can virtually optimize the system in a reliable manner
Example 2

- Part design
- Mold design
- Processing conditions
- Material
Example 2
Example 2  Runner balancing

AMA filling simulation
• 3 different parts
• Initially Ø = 5.0 mm
• Goal: Balanced flow
Example 2  Runner balancing

Filling pattern not balanced
Example 2  Runner balancing

Optimized runner design
• Runner diameters adapted
• Runner lengths adapted
• (Less runner scrap)
Example 2  Runner balancing

Filled

ø 4.3 mm

Filled

ø 5.0 mm

Filled

ø 5.0 mm

Filled

Filled pattern balanced
Example 3

Part design → Mold design

Processing conditions → Material
Example 3  Gate location

Automotive headlight frame
- Warpage is critical
- PA GF30
Example 3  Gate location

Initial gate location
Example 3  Gate location

Deflection in Z-direction for initial gate
- Too high, out of spec
Example 3  Gate location

Glass fiber orientation for initial gate
• Not uniform
Example 3  Gate location

Original gate

Central gate

2 x 3 gates

Edge gate
Example 3  Gate location

- Original gate
- Central gate
- 2 x 3 gates
- Edge gate

Smallest deformation
Example 4

Part design

Mold design

Processing conditions

Material
Example 4  Injection pressure versus time

![Image of a container of butter](image-url)

**Graph:**
- **X-axis:** Injection time (s)
- **Y-axis:** Injection pressure (MPa)

Data points showing a decrease in injection pressure over time, with a notable increase in pressure around the 0.5 to 0.7 second mark.
Questions...?
More...?

Contact Pezy Group if you like to know more about Moldflow:
• Software
• Consultancy
• Advice & Second Opinion
• Training
• Material data
• Network

Check out presentation of my Pezy Group colleague Eddy Leeuwangh
• Creo Parametric 3.0 Tips & Tricks
• Congresroom 040 Noord
• 16h05 – 16h40