Bucheon International mold conference

New Processing Technology

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Injection compression moulding (coinmelt)

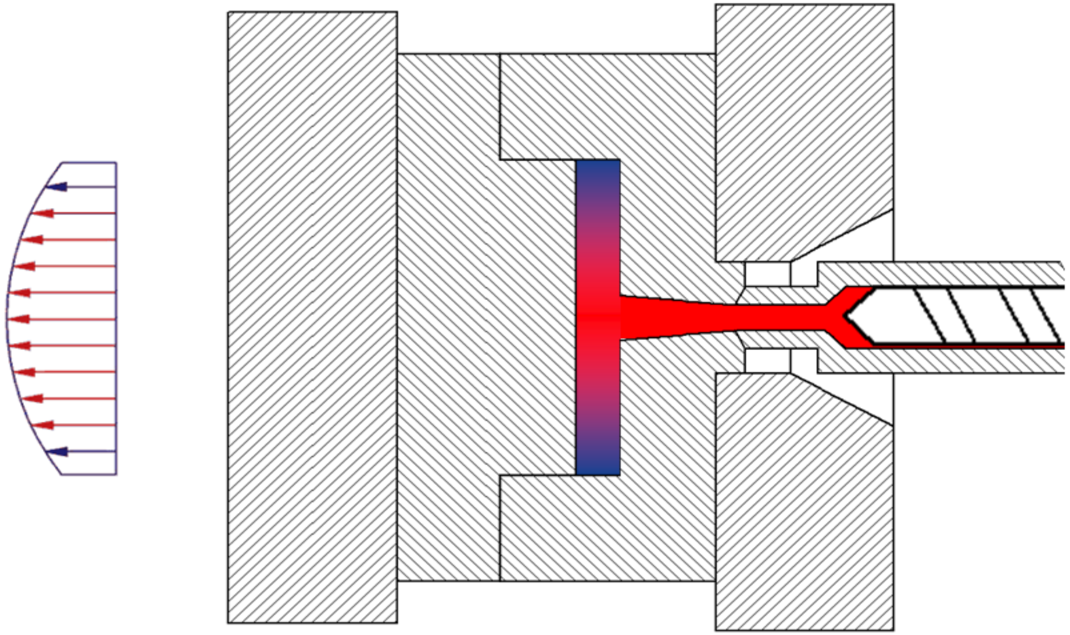
Sandwich molding + iQ weight control (skinmelt)

coinmelt

Injection compression molding (ICM)

coinmelt
introduction

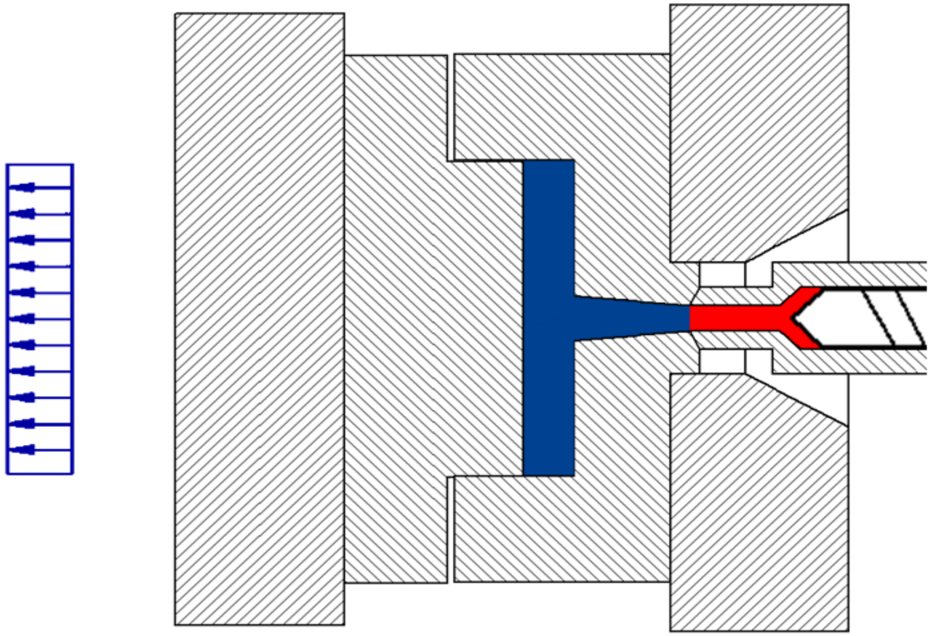
standard injection moulding process



- inhomogeneous pressure distribution
- residual stresses

injection compression moulding (ICM)

the volume of the cavity is decreased or increased during or after melt injection



- homogeneous pressure distribution
- lower shear stress
- reduced injection pressure

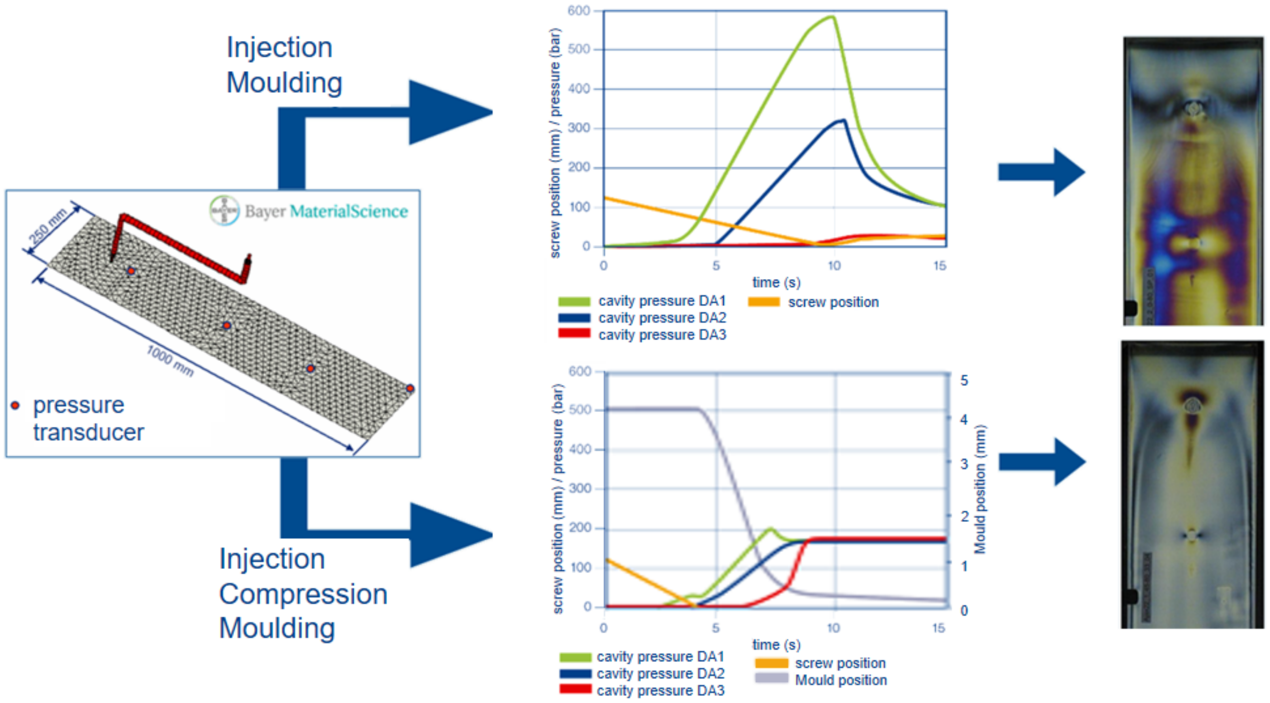
coinmelt
introduction

advantages of injection compression moulding:

- lower injection pressure compared to standard injection moulding
  - wall thickness can be reduced – lower material consumption
  - reduced clamping force
- lower shear stress with the same final part‘s wall thickness
  - lower induced stress prevents damage of foils/textiles during direct back moulding
  - shear-sensitive materials – reduced fibre fracture
- lower inner stress
  - less warpage even after heat treatment
  - for (semi-)transparent parts this is an important prerequisite to fulfil quality requirements in the field of optics
- homogenous replication of surface structures

coinmelt
introduction

lower and more homogenous pressure distribution



material: PC, stress level distribution in a part shown with polarized light

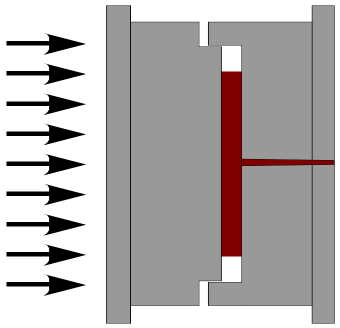
coinmelt

mold

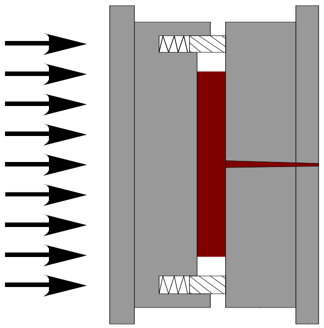
mould concepts for injection compression moulding:

<u>compression by machine movement</u>

- often used for compression of the whole part surface
- mould with vertical flash face or spring loaded frame (mechanic or hydraulic)
- prevent melt from getting pressed back by shut-off nozzle or mechanical shut-off device inside the mould
- restriction in applicability by part geometry



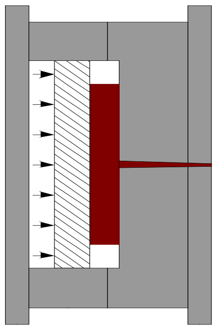
mould with vertical flash face



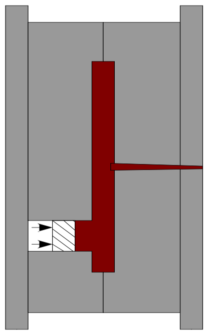
spring loaded frame

<u>compression by mould movement</u>

- often used for smaller compression zones
- compression movement by core puller (hydraulic or electric) or by ejector movement
- prevent melt from getting pressed back by shut-off nozzle or mechanical shut-off device inside the mould
- restriction in applicability by part geometry



core full area

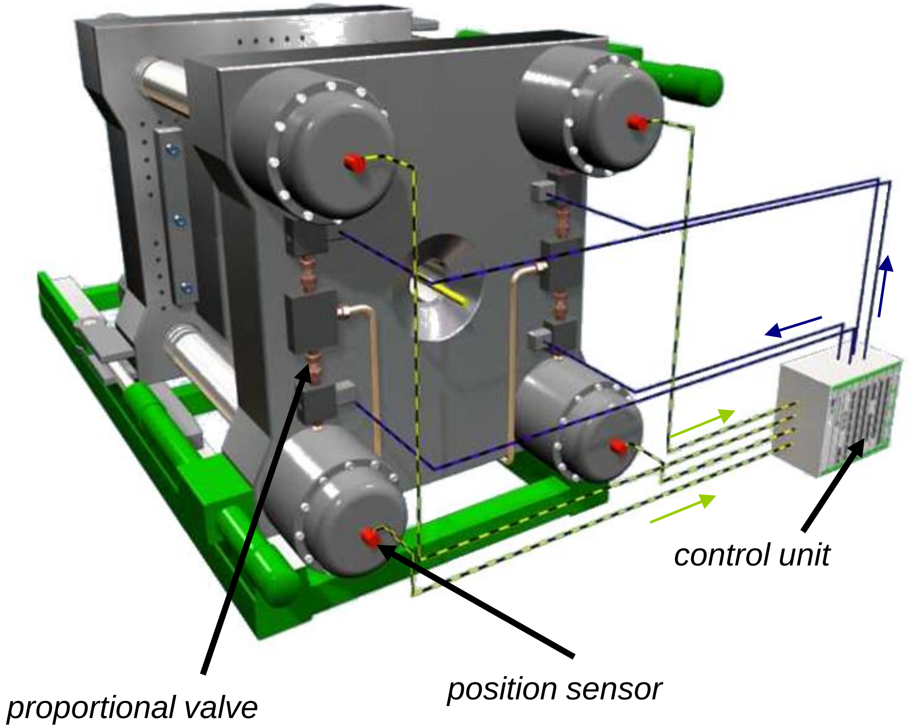


core partial area

coinmelt
machine

parallelism control – tie-bar extension compensation

- if different forces are acting on each tie-bar, the tie-bar‘s elongation would affects the platen parallelism
- the actual clamping force for each tie-bar is measured by pressure transducers
- each tie-bar’s extension is compensated by the control unit

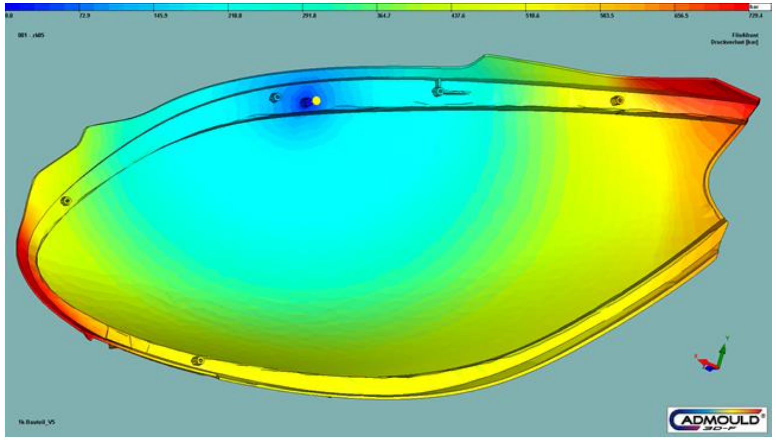


frequency of closed loop control: 6 ms
accuracy: 50 µm

Injection compression molding
Lowest internal stress

- 2K injection compression molding for glazing
- lowest internal pressures enabling
- lowest internal stresses - reduced deformation after heat treatment

technical data	
clamping force	15000 kN
injection unit	11050H, 4550M
screw	Ø 120 mm, Ø 90 mm
product	Outer Lens for Headlamp Porsche Macan
cycle time	73 sec.
shot weight	1150g + 180 g
cavities	1+1
material	Sabic
automation	Viper 120
control unit	ENGEL CC300
mold	Summerer Technologies
technology	Injection compression



Injection compression molding

Reduced injection & holding pressure

- Light weighting for interior thin wall application
- lowest internal pressures and pack and hold by injection compression molding
- final thickness 2mm, starting at 2,5mm without sink marks, ribs up to 1:1 ratio

technical data (1)	
clamping force	17000 kN
injection unit	11050
screw	Ø 120 mm
product	Tail gate trim Daimler GLK
cycle time	59 sec.
shot weight	1600g
cavities	1
material	Borealis
automation	Viper 60
control unit	ENGEL CC300
mold	GK tools
technology	Injection compression

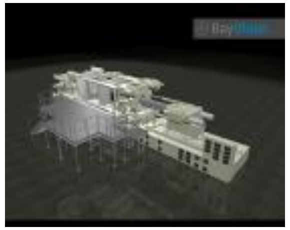
Daimler GLK

Injection compression molding

Less inner stress, smaller machine

glazing sunroof

- Injection compression molding for both shot
- PC for both shot
- small compression gap
- deviations from parallelism are compensated
- prevented jetting with coinmelt EXPERT (black)
- large-area injection moulded part with low inner stress by using coinmelt technology



Injection compression molding
Parallelism control

Decorative part (U-shape)

- Material: PC
- Highest optical requirements (Class-A Optics)
- Parts are coated (less internal stress)
- Parallelism control
- Injection compression moulding for low inner stress

Injection compression molding
Less damage on insert

laptop cover

- film (PC, PMMA) with PC
- total wall thickness: 1,2 mm
- film thickness: 0,2 mm
- no damage of the film in area of injection point
- reduced deformation
- reduced wall thickness

injection point on rear side of marked area with needle valve nozzle

INMOLD ZoMAZZ

ENGEL

Injection compression molding
Low density with precision opening

foammelt MuCell®

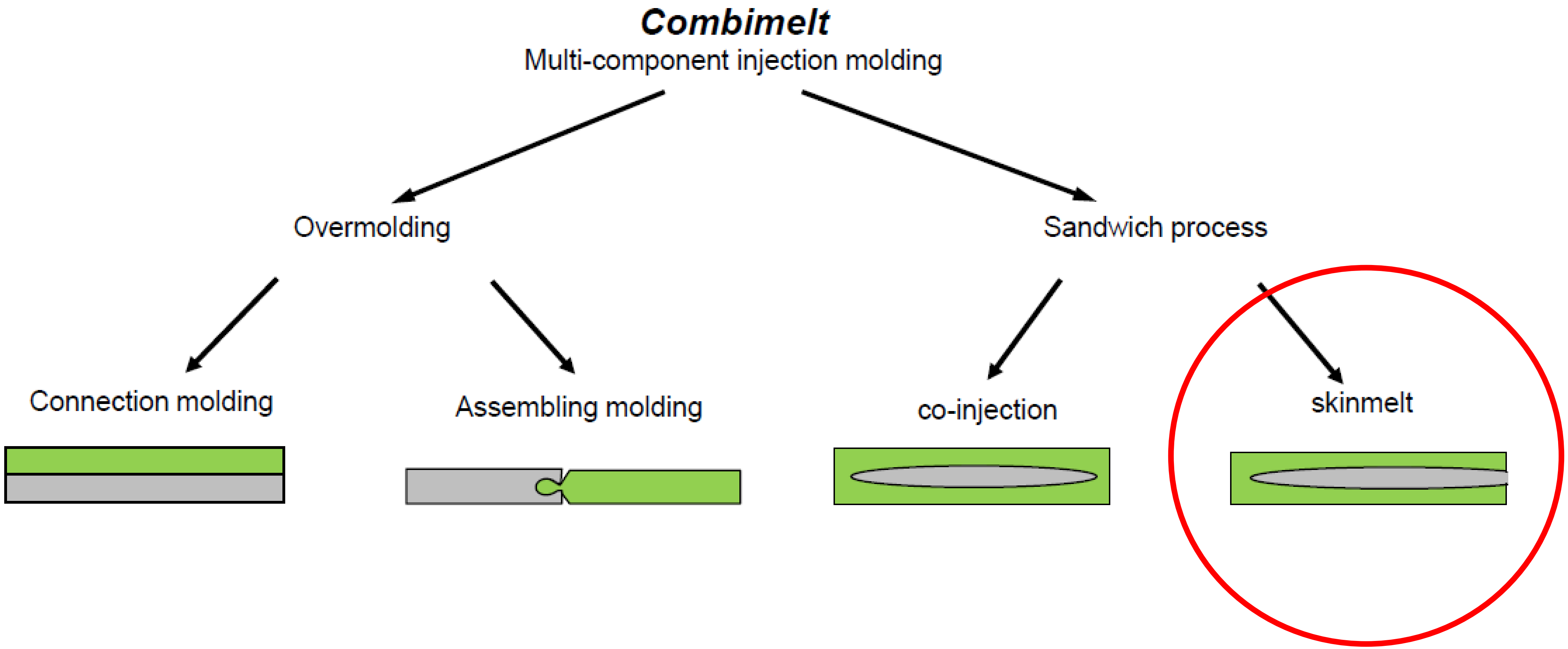
- PP T20
- foaming with negative ICM
- wall thickness injection end: 3mm
- wall thickness compression end: 10mm
- increased bending stiffness with same part weight
- best control of cell size and cell distribution

skinmelt

Sandwich molding

skinmelt

skinmelt is a special part of the multi-component technology



skinmelt
Why skinmelt?

Application field

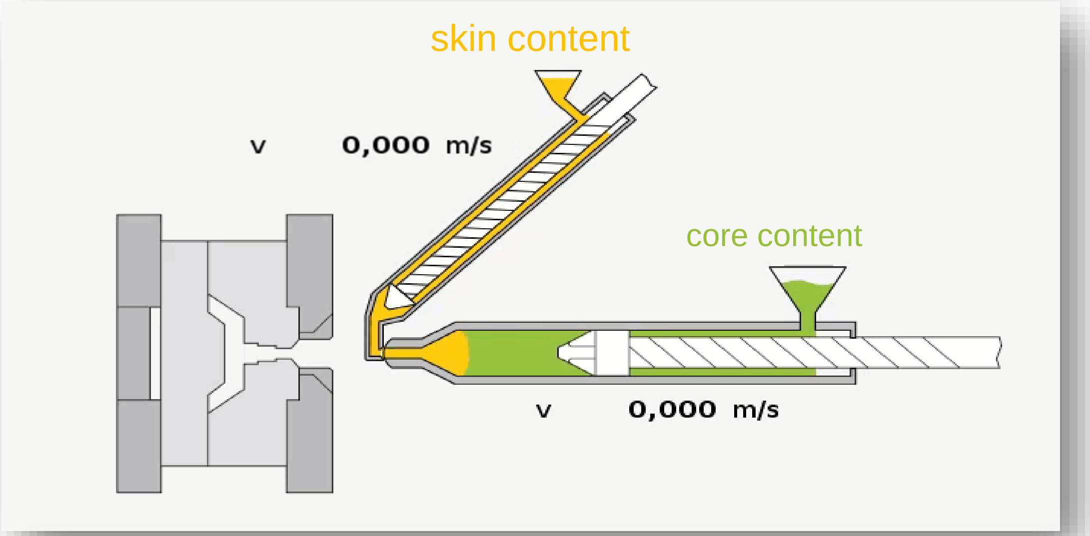
- cost reduction
  - High quality material for the surface andless expensive material for the core component
  - Using of recycled material

- increase of part quality properties
  - Higher mechanical strength in combination with high surface quality
  - Combination of galvanizeable skin- with reinforced core component
  - Avoidance of sinkmarks and reduced weight with foamed core component

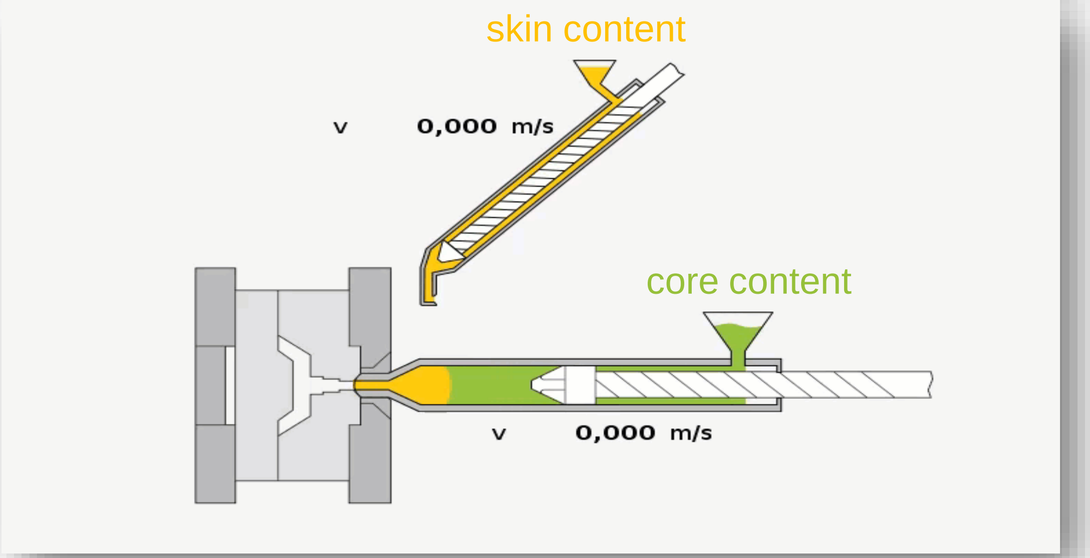
skinmelt

dosing / extrusion

- The core component is first plasticized
- Thereafter the skin component is extruded from the top injection unit into the main unit

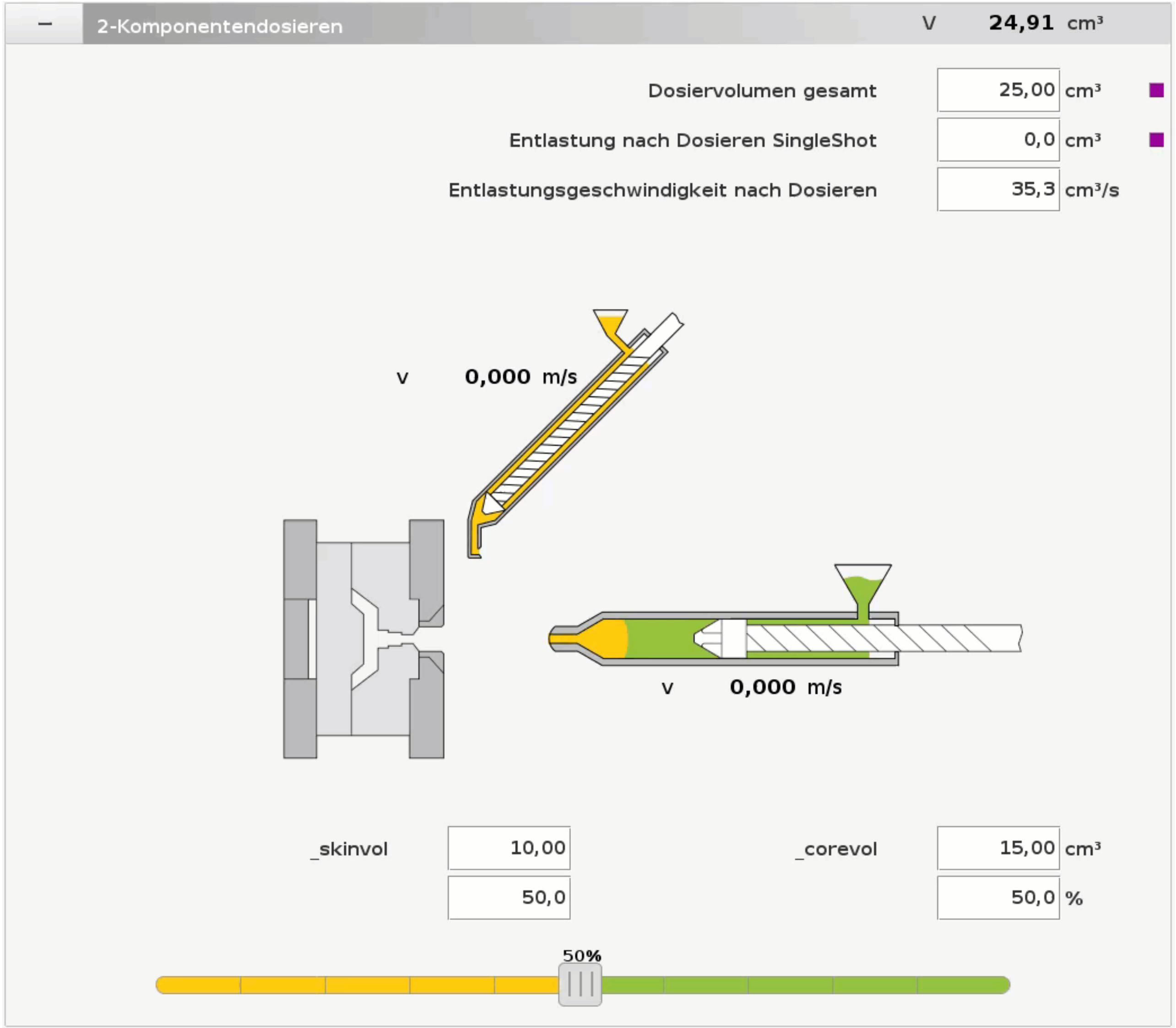


- The complete shot is injected the same way as a conventional one component process



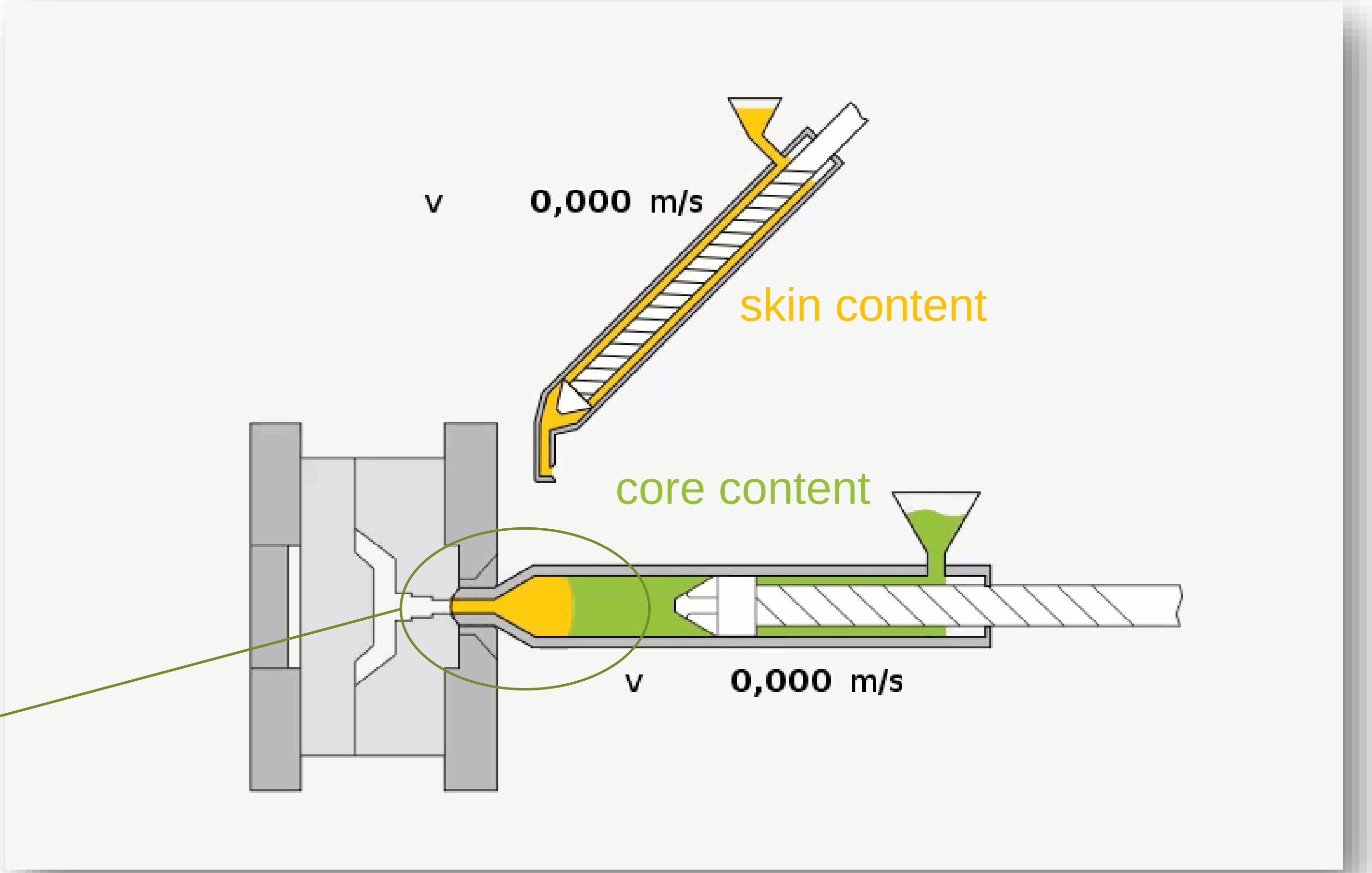
skinmelt

How it works?

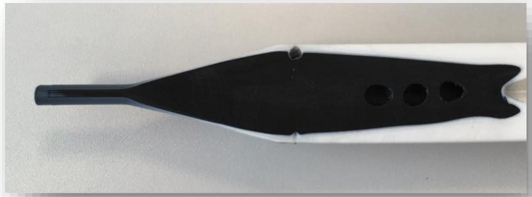


skinmelt
injection

- The skin layer will stay on the outer part surface and the coree will fill the part up from inside



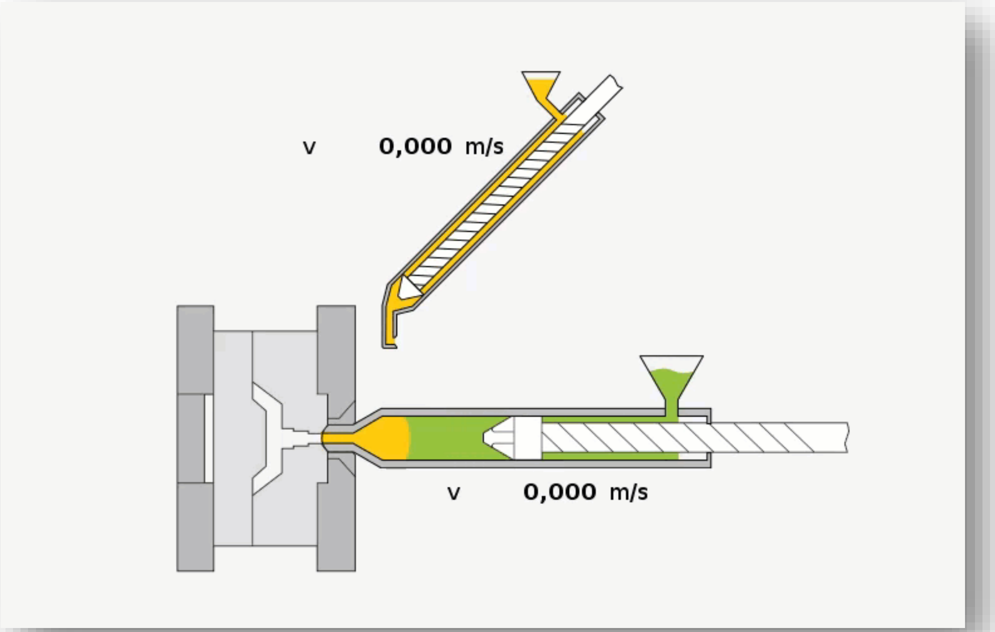
Material distribution
In the front of the screw



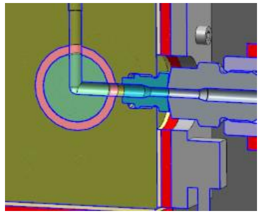
skinmelt

compare to coinjection

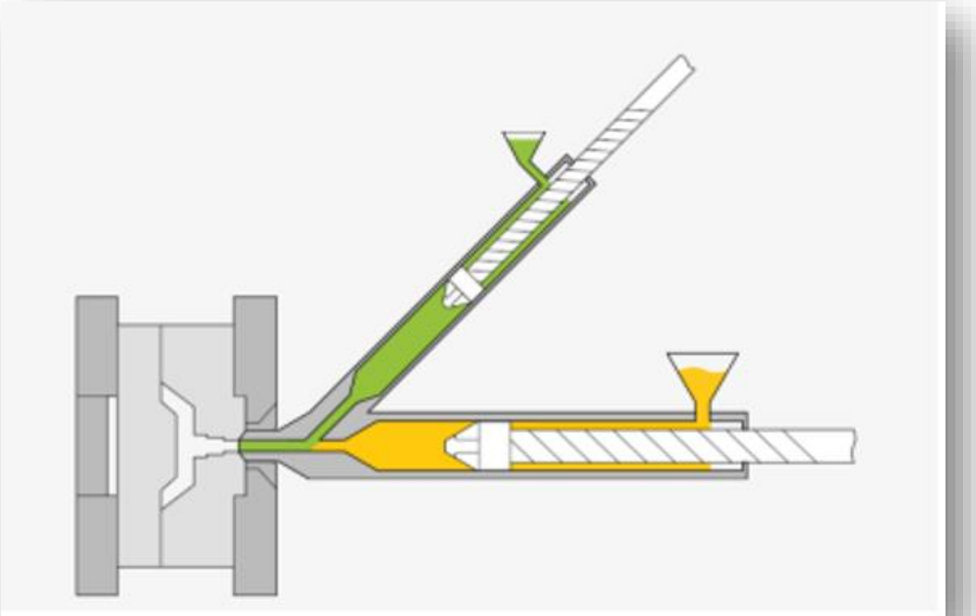
skinmelt



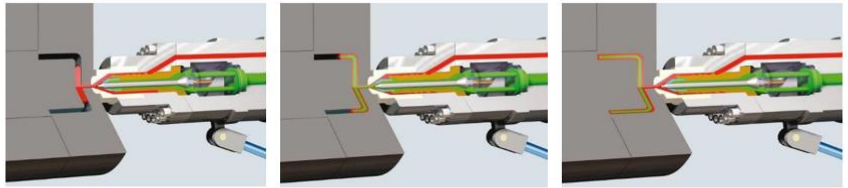
metering prozess



co-injection



sequential injection prozess



advantage
skinmelt vs. co-Injection

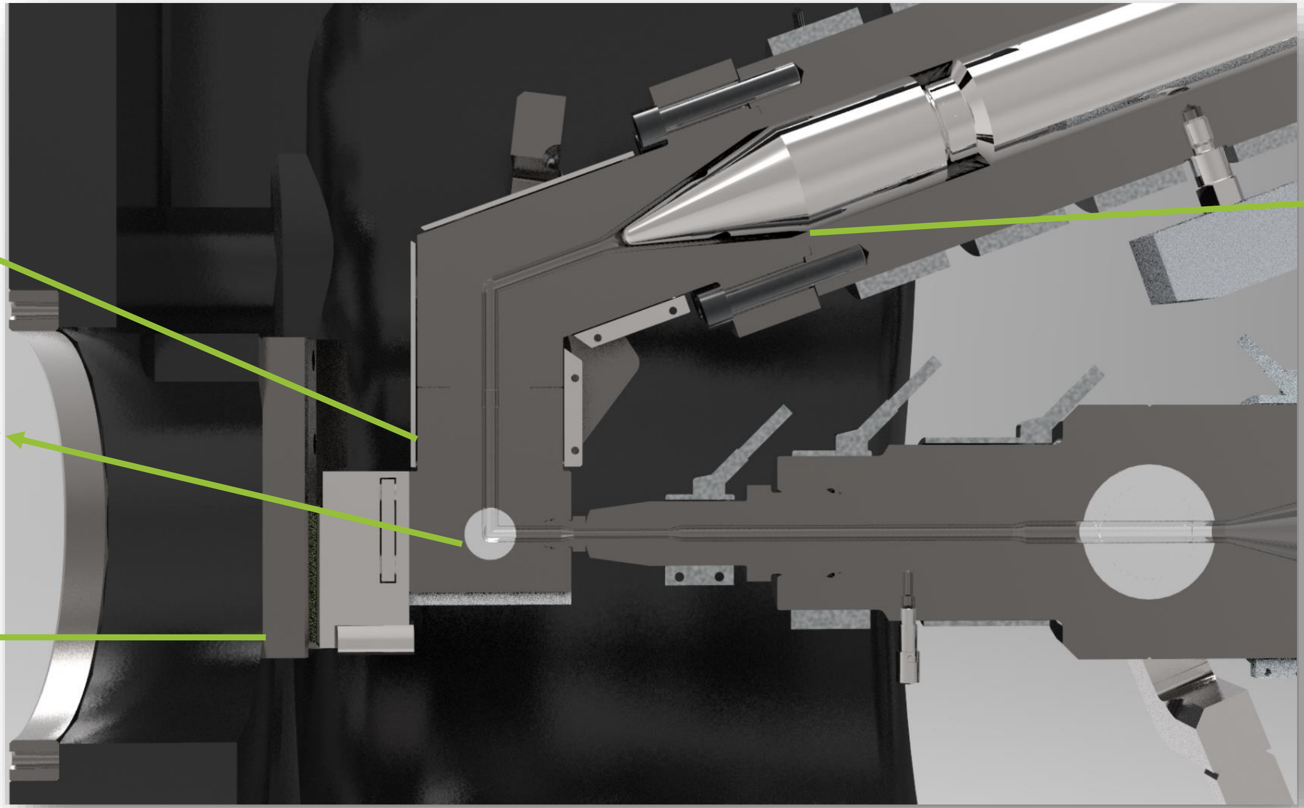
Advantage skinmelt

- faster self-cleaning
- easier operation and handling, similar to conventional injection moulding (one component)
- the injection process concludes with the core component, therefore a higher content is possible
- no switchover marks on the surface

Advantage co-injection

- sealing,part is enclosed with skin material
- sequential injection with 2 injection units, therefore shorter cycle time are possible
- material pairings with different melt temperatures can be processed

skinmelt
function



- skinmelt head
- rotative shut-off nozzle
- linear guide
- 30° flange and screw tip

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skinmelt

material selection – viscosity determines the skin to core wall thickness ratio

Influence of the viscosity on the wall thickness ratio between skin and core

Viscosity of the core component larger than the skin component.

- The viscous core component displaces the skin component - a high core content cannot be achieved

Viskosity of core to skin component quite similar

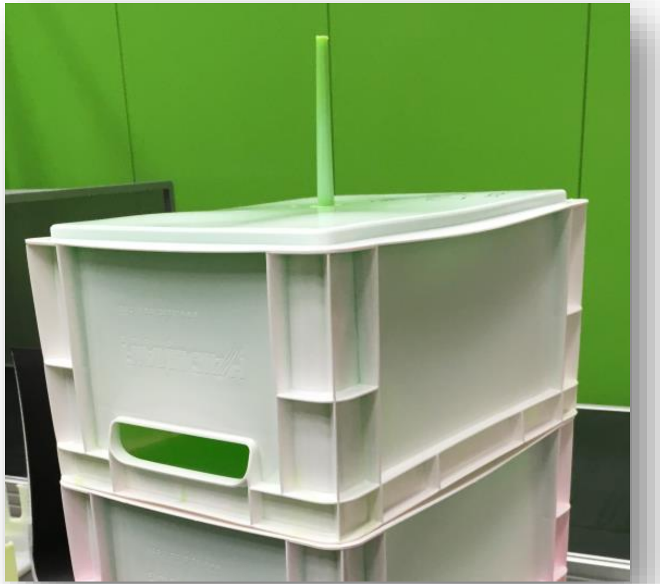
- Perfect for a high percentage of core

Viscosity of the core component lower than of the skin component

- Perfect for a high percentage of core

skinmelt
mould

One component tools can in general be used for the skinmelt process. A cold runner with sprue is required



To avoid longed cycle times due to the sprue dimension, a runner cooling can be used

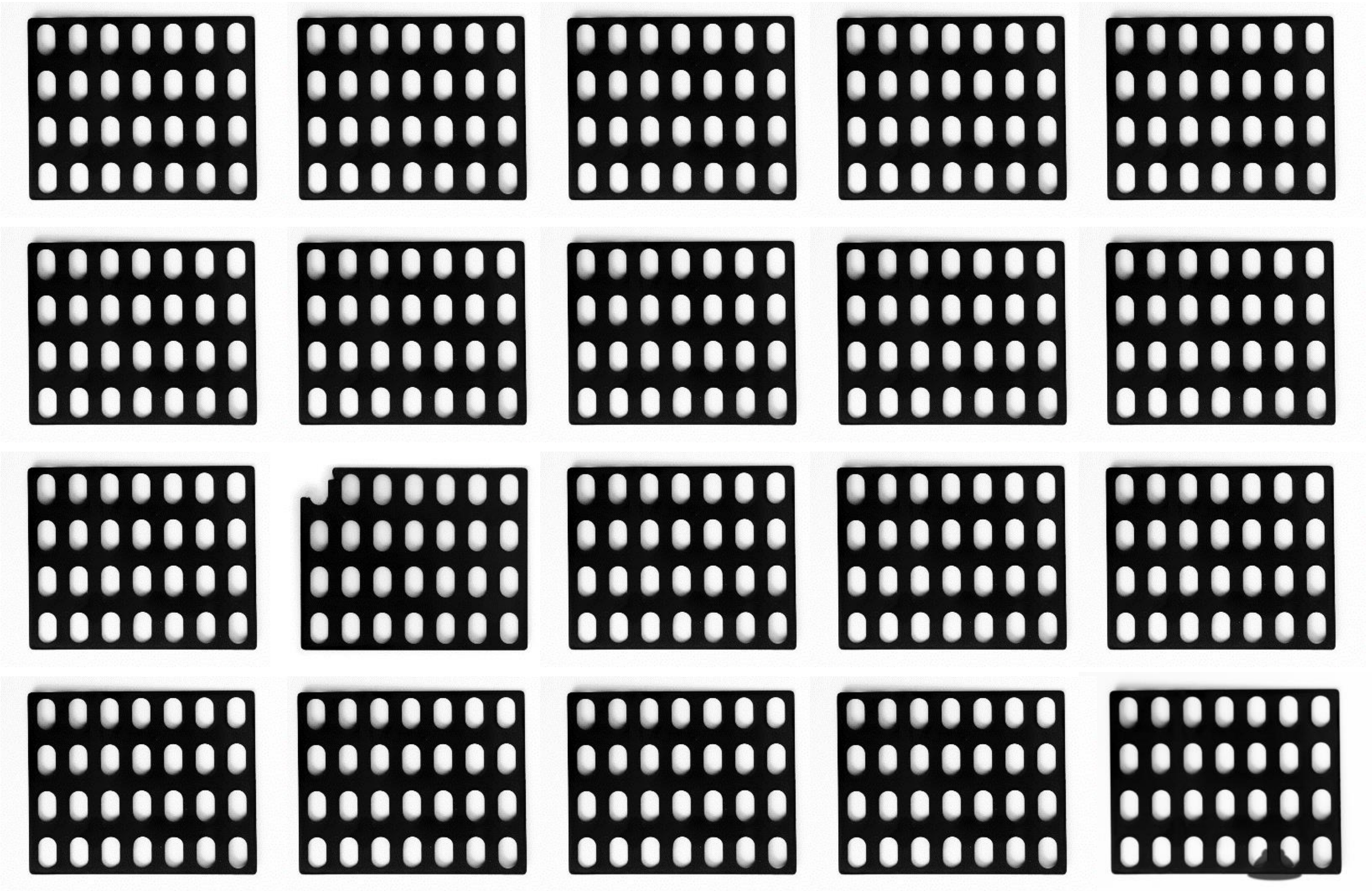
skinmelt
application K 2019 exhibit

Box

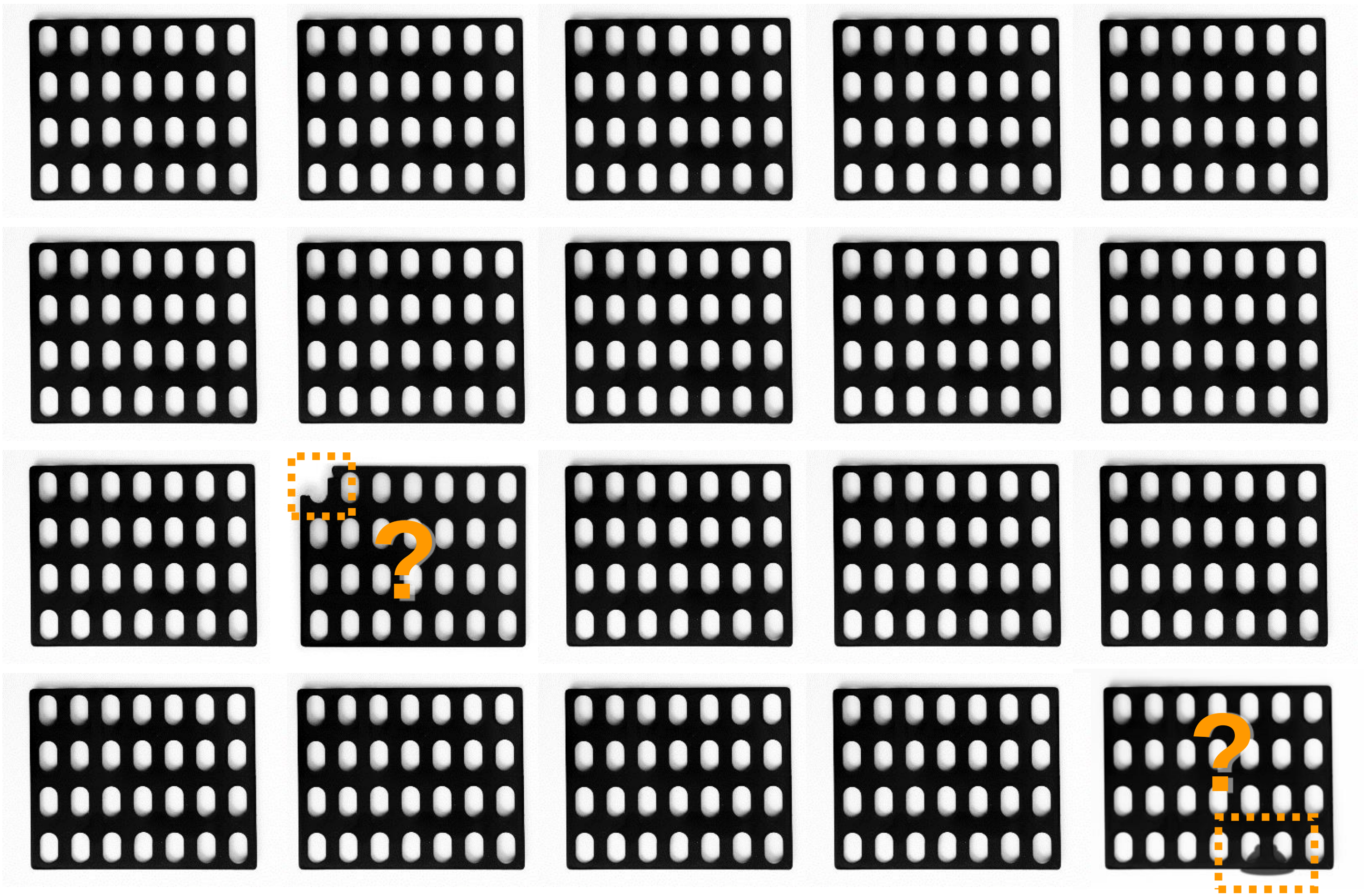
- skin material: PP
- core material: PP, recycled material
- Core portion: 45%

iQ weight control

Introduction
Does this seem familiar?



Introduction
Does this seem familiar?



- Short shot?
- Flash?

The injected melt amount is subject to variations

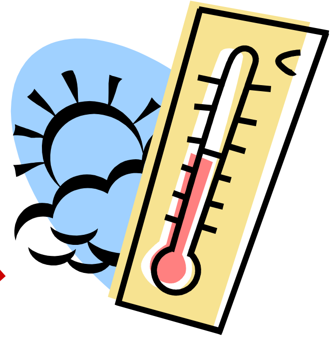
Aren‘t electric injection units doing highly precise and repeatable movements?

iQ wight control
What is the origin of deviations?

- Numerous outside influences affect process and quality
- Often these influences cannot be controlled

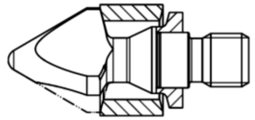
Is there
no solution?

Raw material, drying



Ambience conditions

Temperature control, water supply



Closing behaviour of non-return valve

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iQ weight control
Monitoring

Conventional

- **Time dependent signals** x(t), p(t),…
- Derived **key figures** as process parameters for monitoring, eg.:
  - Cushion
  - Switch-over pressure
  - ...

↓

- **Sometimes limited significance with regard to quality**

iQ weight control

- **Injection pressure vs. screw stroke** p(x)
- **Comparison with reference curve** yields **new process parameters:**
  - Injection volume
  - Change in viscosity
  - Conformance of pressure profile

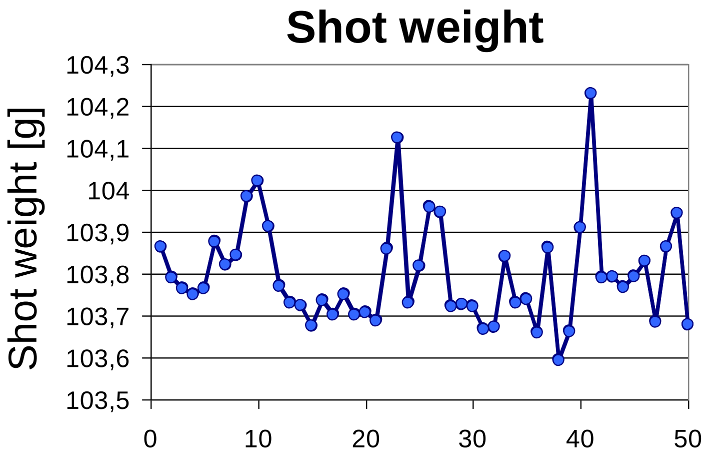
↓

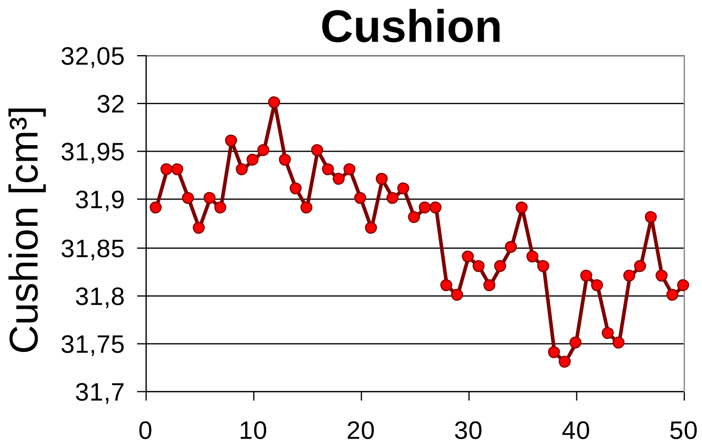
- **Highly significant with regard to quality**

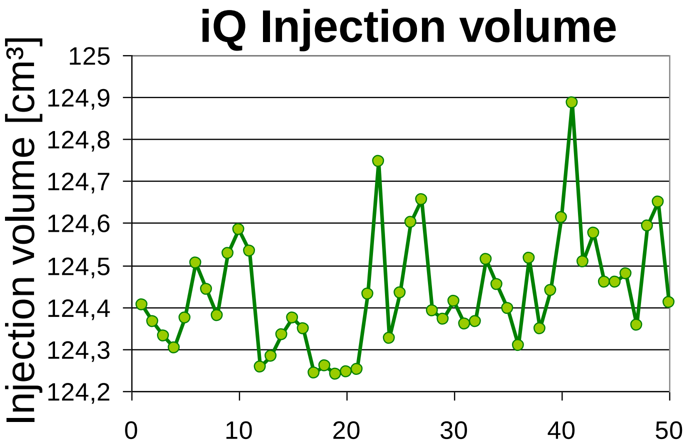
iQ weight control
Injection volume

Example | Engine cover

- 2-cavity hot-runner mould, PA 6.6
- Conventional parameters can‘t explain shot weight variations
- Clear correlation between **injection volume** and shot weight





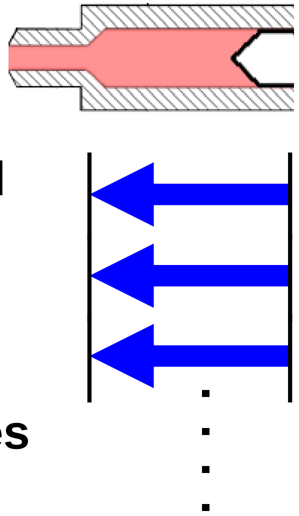


iQ weight control
Injection control

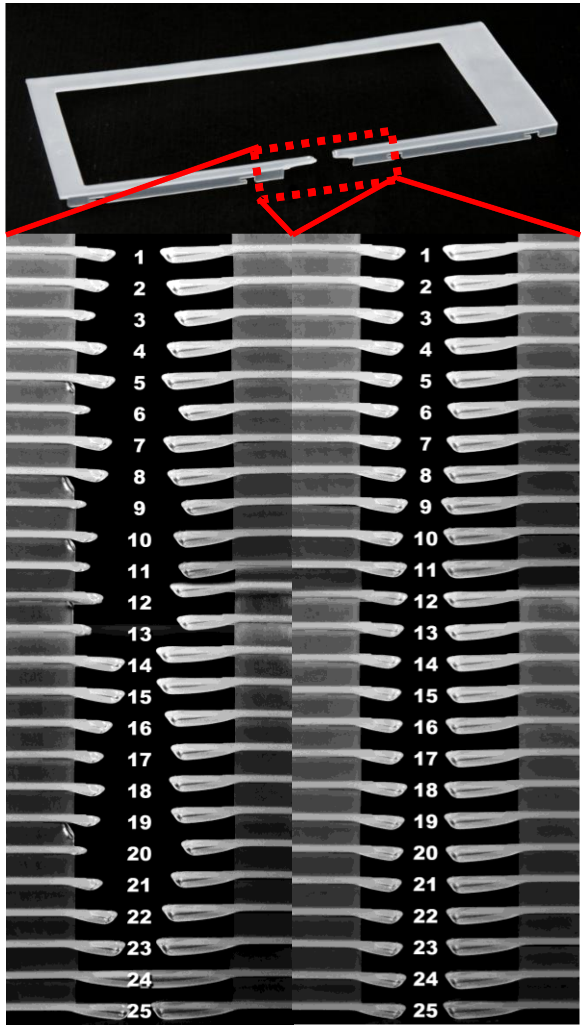
LCD-Bezel (PP)

- 98% partial filling
- No holding pressure

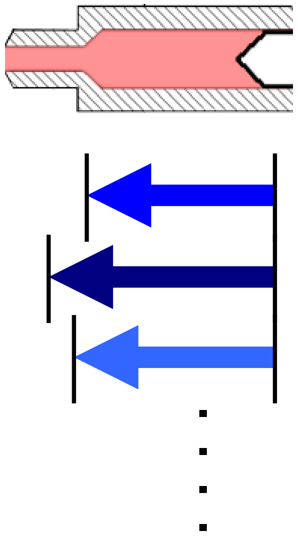
Conventional



- Injection speed and switch-over are the same each cycle
- **External influences affect fill state of cavity**



iQ weight control

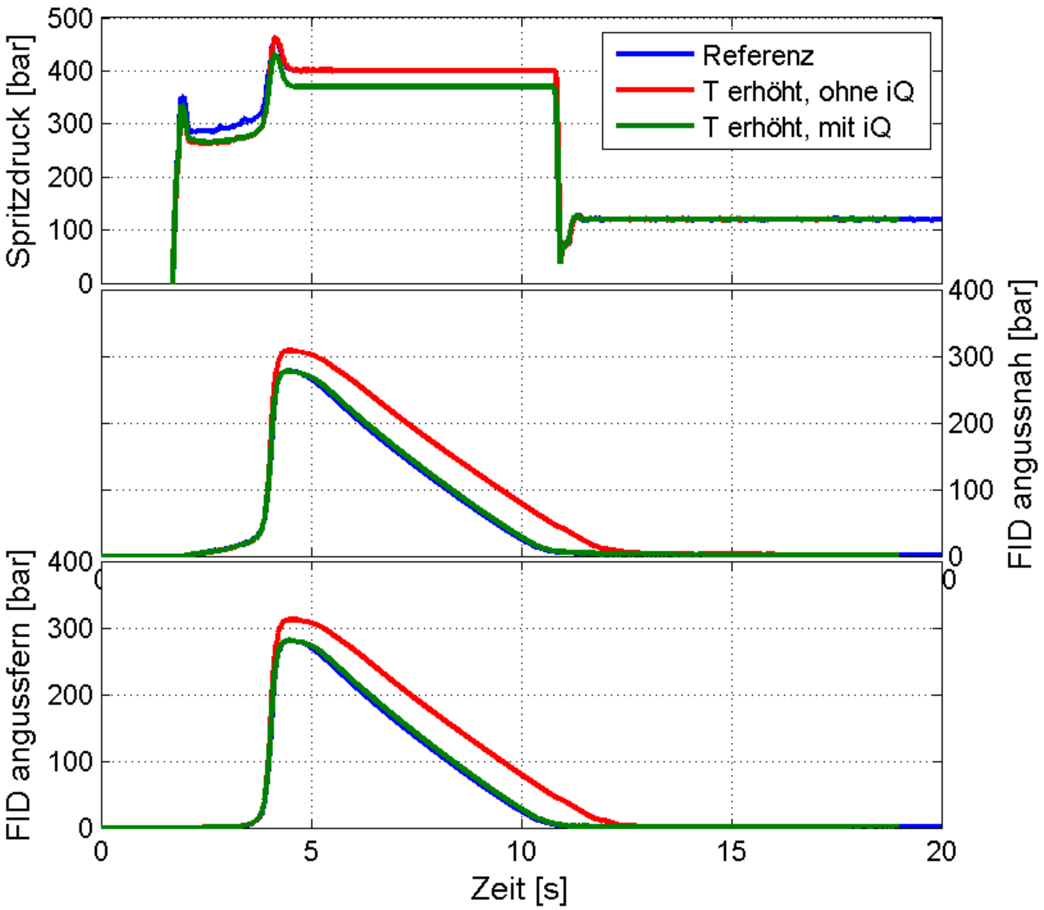


- Injection speed profile and switch-over point are adapted **in each cycle**
- **Deviations due to external influences are compensated for**

iQ weight control
Holding pressure control

Hold pressure profile is automatically adapted when the viscosity changes

- Simulated **viscosity change** by increasing barrel temperature
- **Automatic adaptation of hold pressure profile** based on viscosity change
- **Cavity pressure curves** return to their **original state**

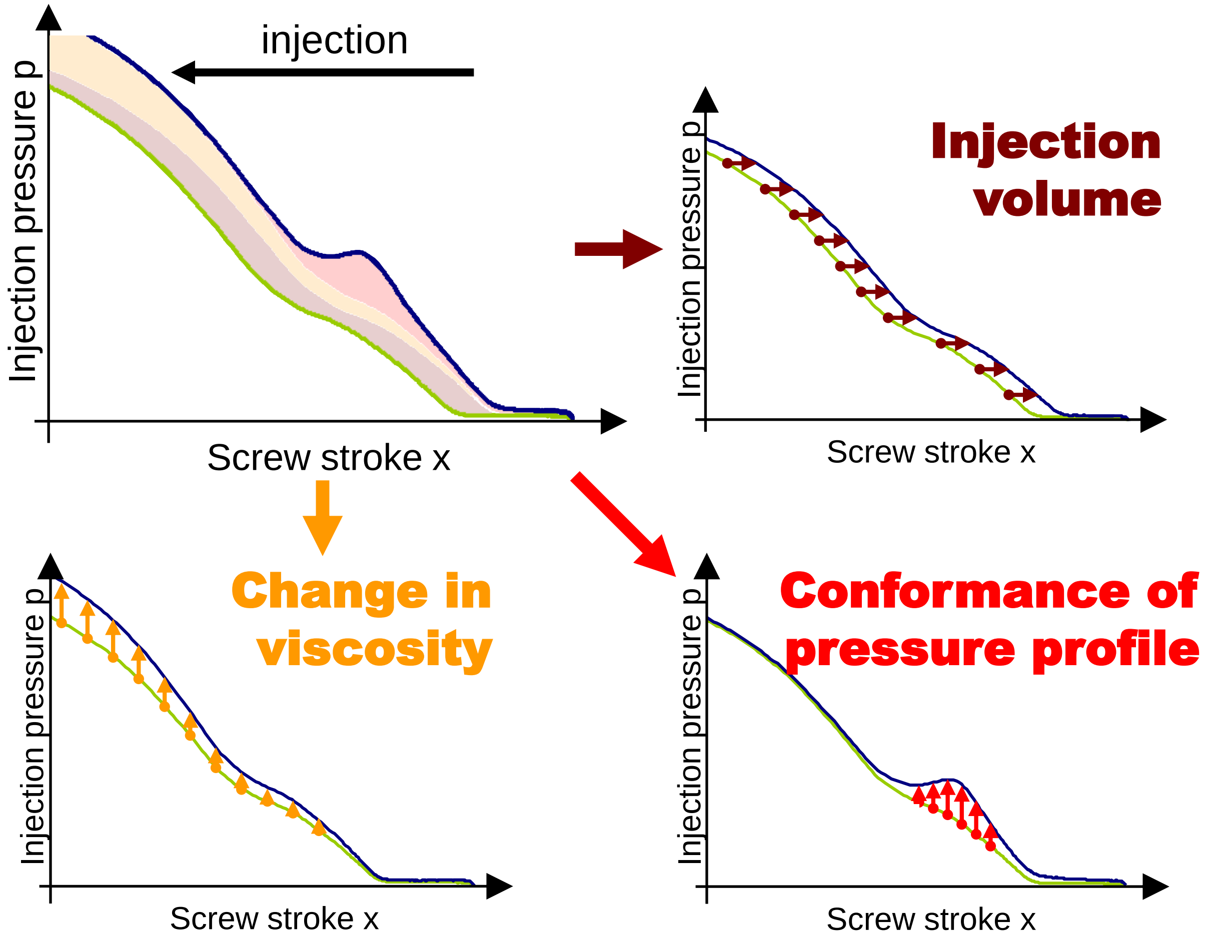


iQ weight control
New process parameters

iQ weight control **compares** the **actual pressure curve** with a previously stored **reference curve**

The deviation from the reference curve is split up into **three contributions**

Each contribution forms one of the **new iQ weight control process parameters**

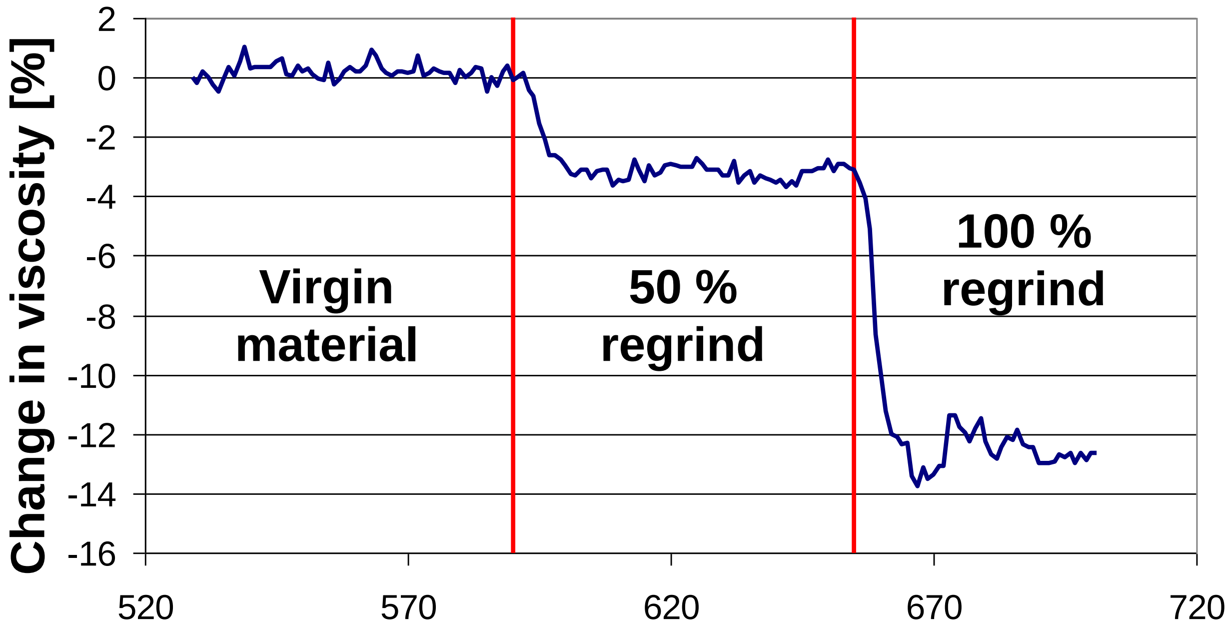


iQ weight control
Change in viscosity

Example | Cover for connector plug
- 2-cavity cold-runner mould
- Polyamide 6.6

Regrind content was changed

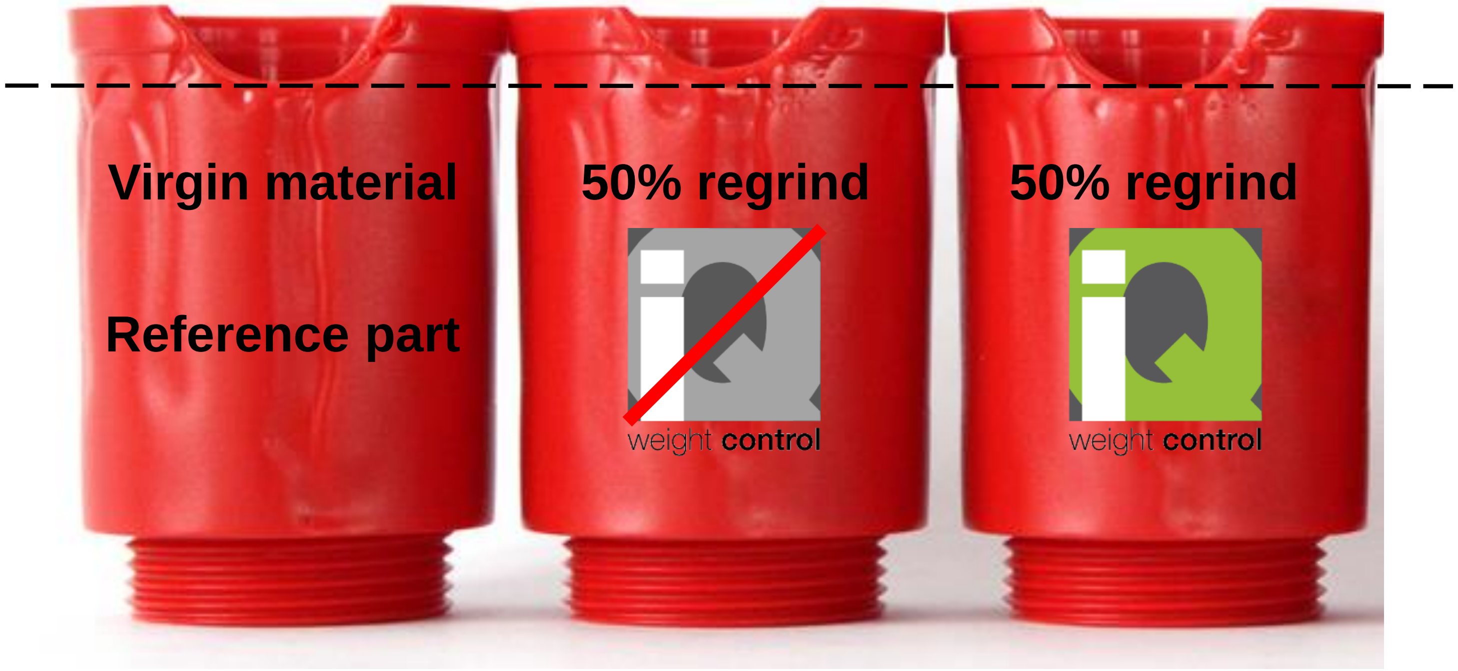
Change in viscosity
- Virgin material = reference: 0%
- 50 % regrind: approx. -3%
- 100% regrind: approx. -12%



iQ weight control
Example partial filling

Cover for connector plug

- Partial filling without holding pressure
- Change from virgin material to 50 % regrind content
- With iQ weight control switch-over adaptation: **Fill state remains the same**



iQ weight control
Example regrind

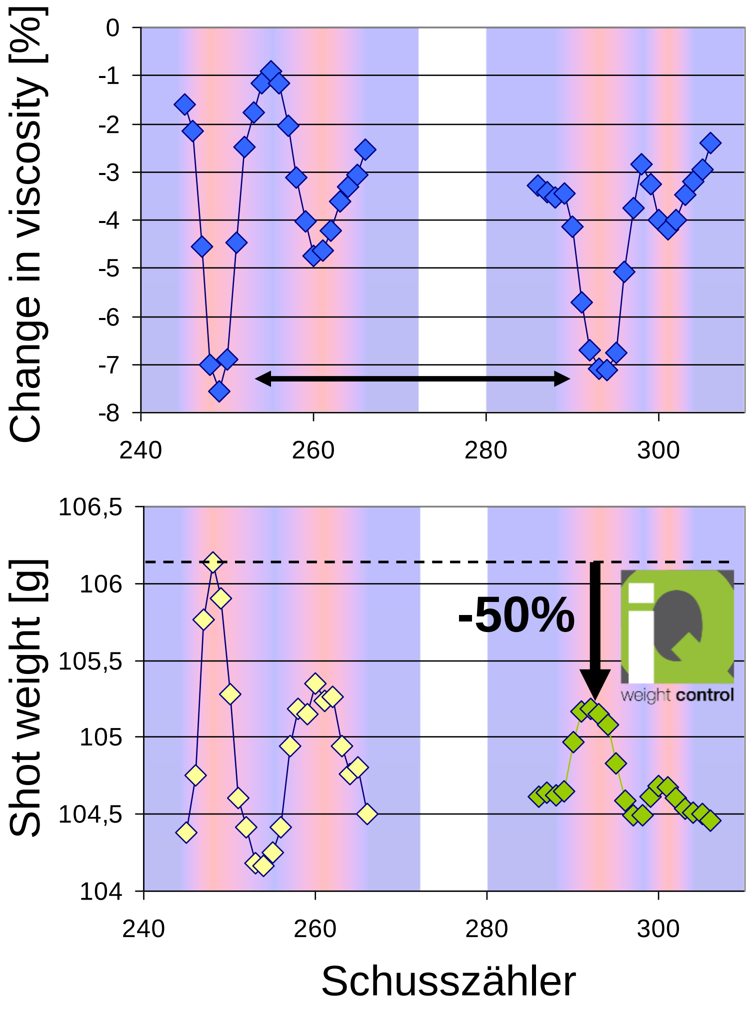
Engine cover

- 2-cavity hot-runner mould
- Polyamide 6.6

- Layered material in feeder
  - Virgin material
  - Regrind

- **Change in viscosity** in first regrind layer is in both cases approx. **-7%**

- **Weight deviation** was **cut in half** by iQ weight control
(only switch-over adaptation, without holding pressure correction**)**



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Thank you!

ENGEL Machinery Korea
Application engineering

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