



ENGEL

Smart machine

ENGEL Finland

Mikko Ketonen

Jonne Metsänen

Design

Digital design of plastic parts



optimised part design | smart component concepts

- Increase the quality of the simulation
- Reduce mould optimisation loops
- Reliable data transmission to the machine
- Smart interface between development and production

sim link

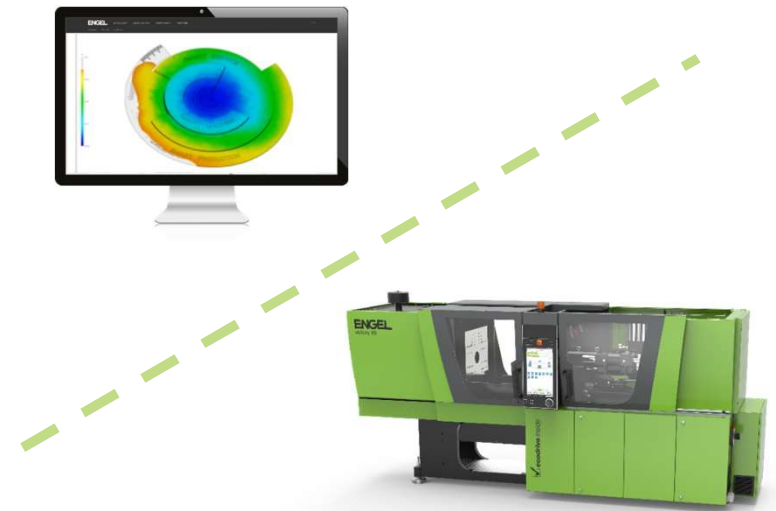
sim link

Direct data exchange between moulding simulation and machine



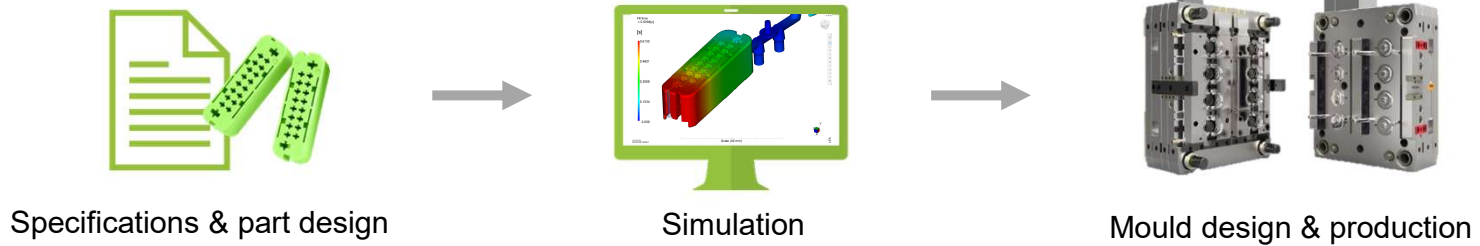
Challenges

- Simulation is often far away from the real world
- Many (expensive) optimisation loops between mould design and production
- Process optimisation without valuable information from the simulation
- No feedback from production to simulation (optimised process settings)

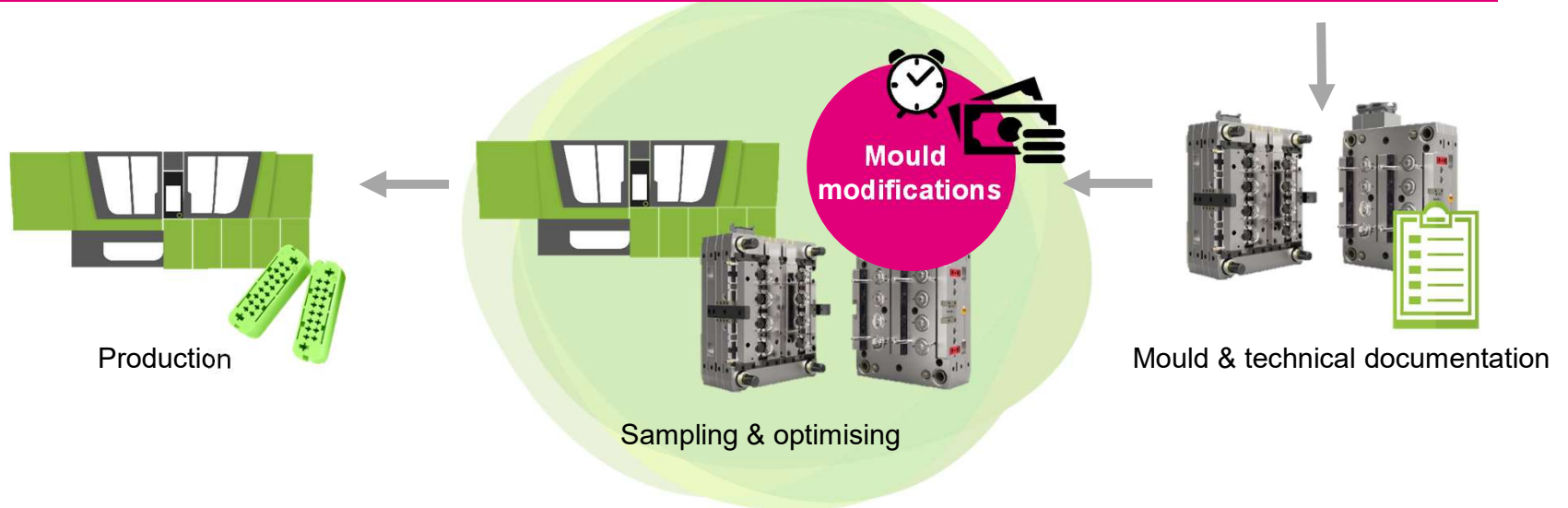


sim link

Direct data exchange between moulding simulation and machine

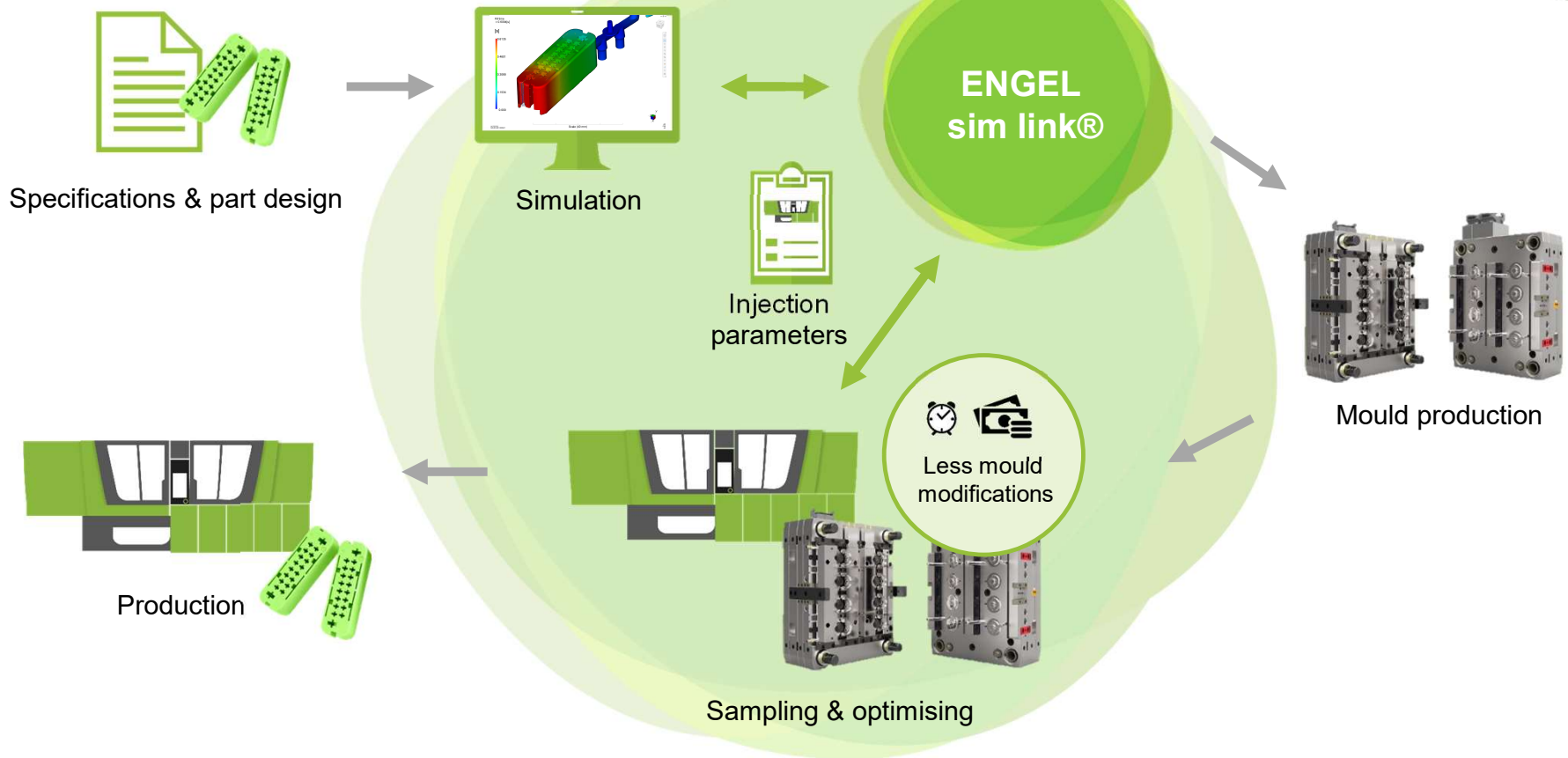


Data barrier



sim link

Direct data exchange between moulding simulation and machine



sim link

Direct data exchange between moulding simulation and machine



The ENGEL solution: **sim link**

1. **MODIFICATION** of process profiles and parameter limits based on the selected machine
2. **EXPORT** of simulation data to the machine
3. **IMPORT** of real production data into simulation project

Results

- Increase simulation quality loop-by-loop
- Reduce time-to-production by reducing optimisation loops
- Knowledge transfer form simulation to production and vice versa → **closed loop/digital twin**
- Facilitates co-operation between departments



sim link

at Customer Intercable



Customer: Intercable
Country: Italy



Industry: Automotive and electrical industry
Products: Connection systems and technical plastic parts

Challenges

“The correlation between injection parameters and residual stress is a good indicator on how Intercable products will perform in life tests. It is impossible to analyse this correlation using experimental methods only.”

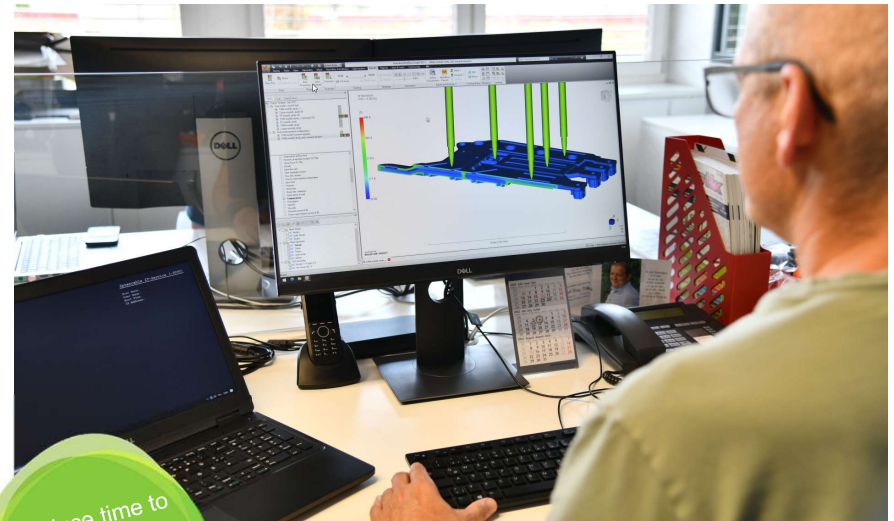
Solution

“It is most important that the experts from the simulation and the production team communicate and work together. Each optimisation loop cost precious time and money. Using sim link helped to reduce these loops significantly. The quality of the simulation could be improved as well. The data communication between simulation and production department has improved as well.”

Result

“sim link helps reducing the time needed for finetuning process parameters. The achieved savings range between 10% and 50% depending on material type and part geometry.”

Gianluca Cappella, Tool Engineering at Intercable



Reduce time to
set up process
by 50%

Sampling

Digital solutions for mould sampling



guaranteed part quality | your headstart on serial production

- Start serial production faster
- Reduce costs, save energy and avoid issues during serial production
- Reduce cycle time
- Easy operation makes the job trouble-free for your team

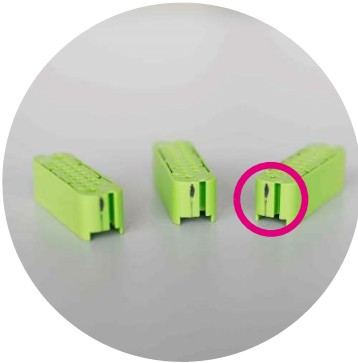
iQ clamp control

iQ clamp control

Calculate & optimise clamping force

Challenge

- Clamping force settings vary from operator to operator
- Clamping force settings too high
- Flash
- Burn marks



iQ clamp control

Calculate & optimise clamping force



The ENGEL solution: iQ clamp control

- determines the optimum clamping force
- calculates the mould breathing

Results

- Determine and optimise important process parameter settings
- Reduce rejects, improve repeatability
- Reduce wear on mould and machine



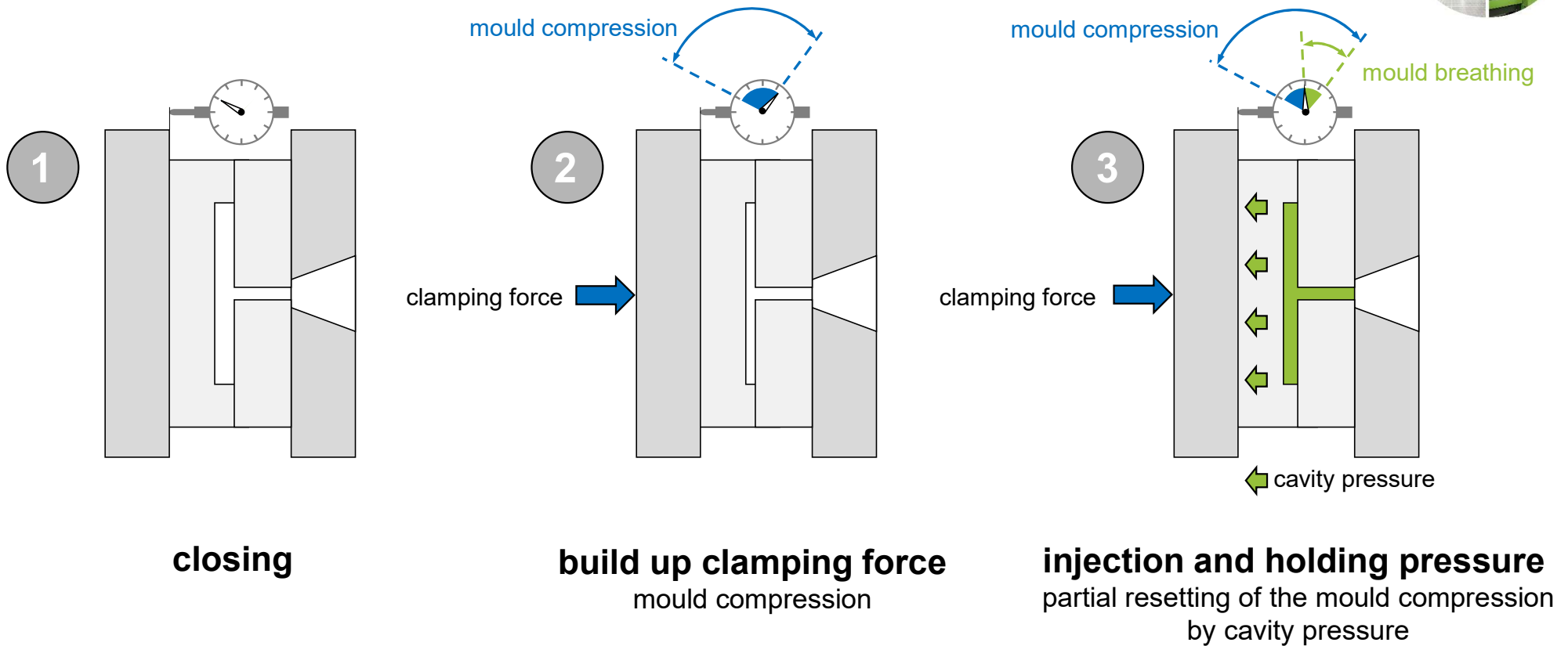
Available for all machine models

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ENGEL

iQ clamp control

Mould breathing – the basis for iQ clamp control



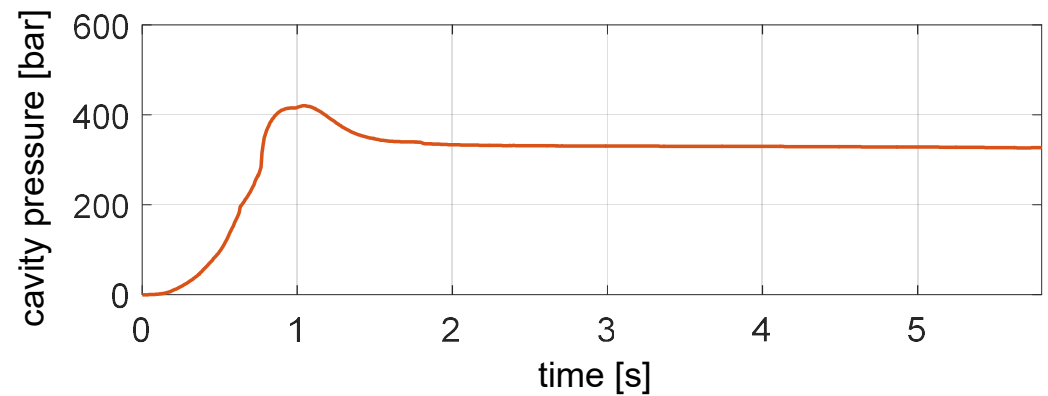
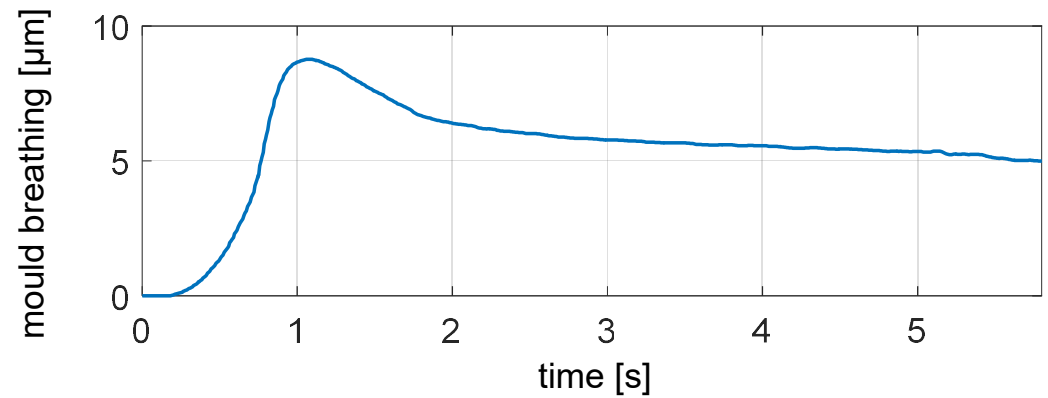
iQ clamp control

Cavity information without cavity sensor



Mould breathing signal

- Behaviour similar to cavity pressure
- For process optimisation and monitoring



iQ clamp control

Example | Energy consumption

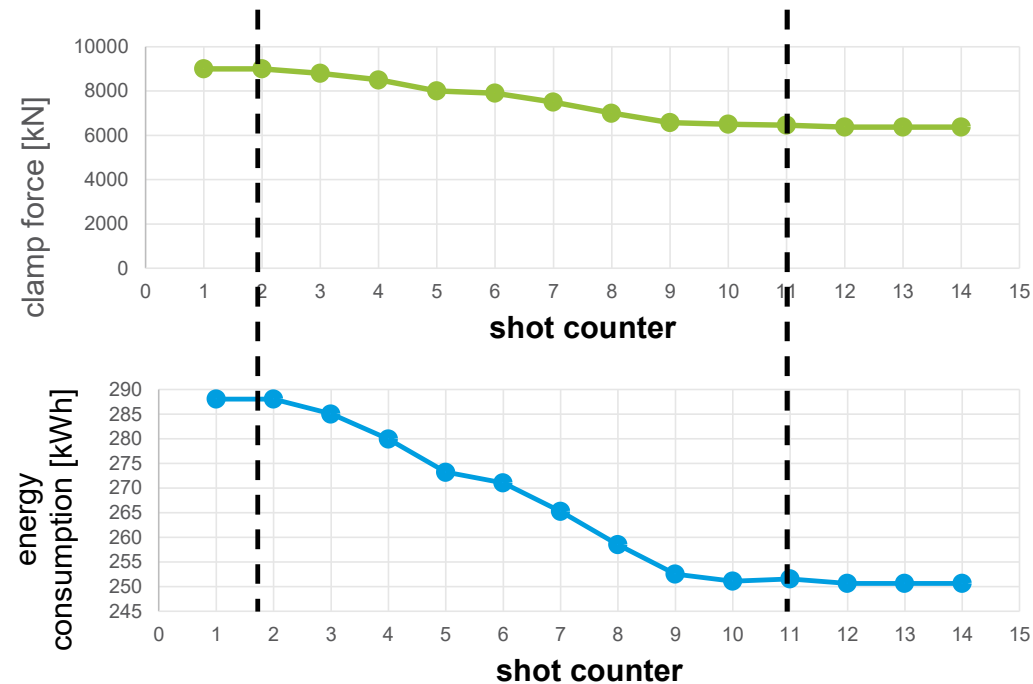


Product: Flower pot
Machine: DUO 12060/900

Material: PE
Shot weight: 1700 g

Result

	Clamping force	Energy consumption
Nominal clamping force	9000 kN	10.9 kWh/h
Optimised clamping force	6400 kN	9.5 kWh/h
Reduction	-29%	-13%*



*savings on energy of clamping unit

iQ clamp control

Example

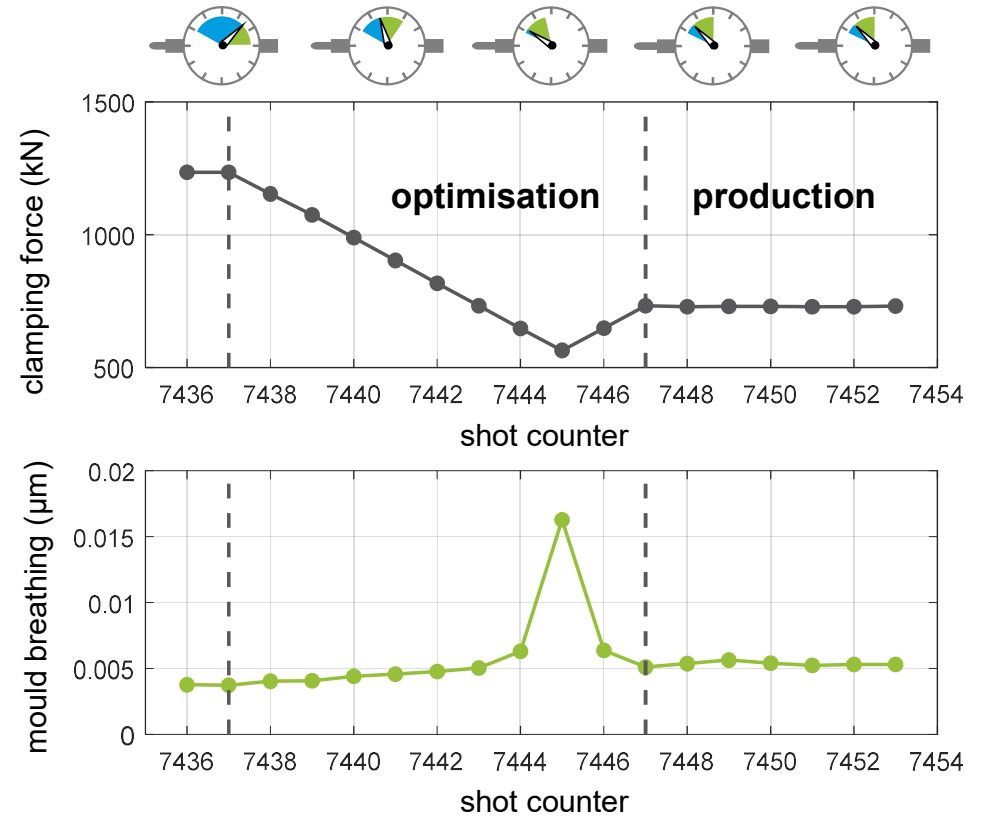


Product: Demo part
Machine: VC 460/120TL

Material: ABS
Shot weight: 42g

Result

	Schließkraft
nominal clamping force	1200 kN
optimised clamping force	730 kN
Reduktion	-39%



iQ clamp control

Example

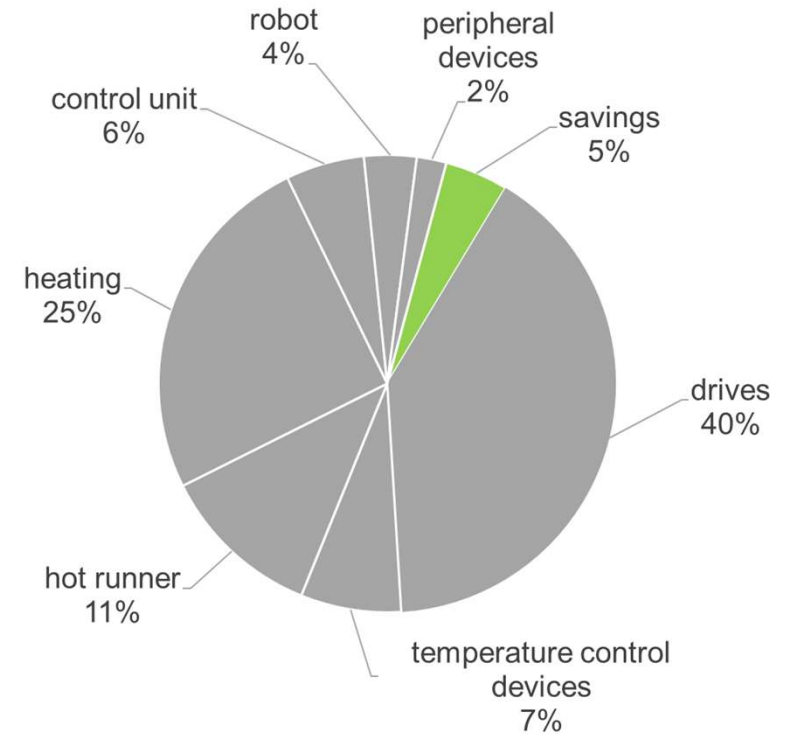


Product: Demo part
Machine: VC 460/120TL

Material: ABS
Shot weight: 42g

Result

Energy savings	Cycle time reduction
5%	0.1s



iQ clamp control

Customer Dallmer



Customer: Dallmer
Contry: Germany



Industry: Technical injection moulding
Product: Innovative drain technology

Challenge

„We rely on very high moulding accuracy. Precision and repeatability are our key requirements for the injection moulding machines.”

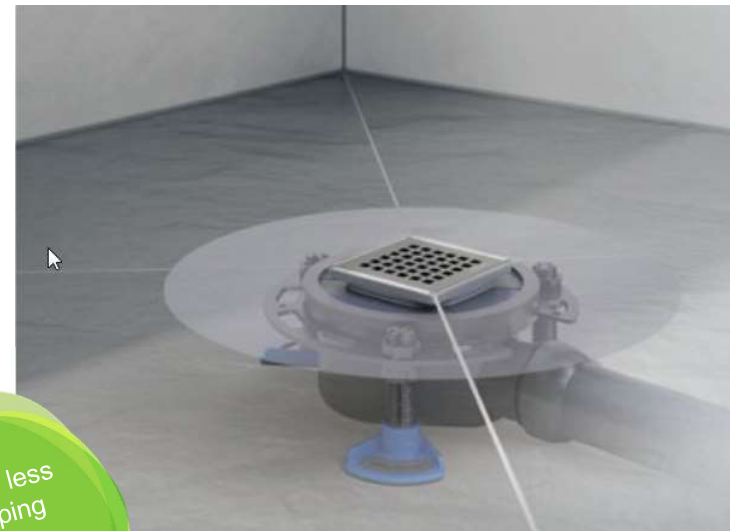
Solution

“All newly delivered injection moulding machines were equipped with intelligent assistance systems from ENGEL’s inject 4.0 programme. iQ clamp control surprised Dallmer the most. The software determines the optimum clamping force for the respective injection moulding process on the basis of mould breathing and in some cases reduces the clamping force from 1200 to 800 kN during the production of DallDrain components.”

Result

“This solution helps us increase part quality and process repeatability. We could eliminate flash. On top of that, we could also improve mould venting and reduce wear.”

Andreas Föltz, Production Manager at Dallmer



400 kN less
clamping
force
needed

iQ hold control

iQ hold control

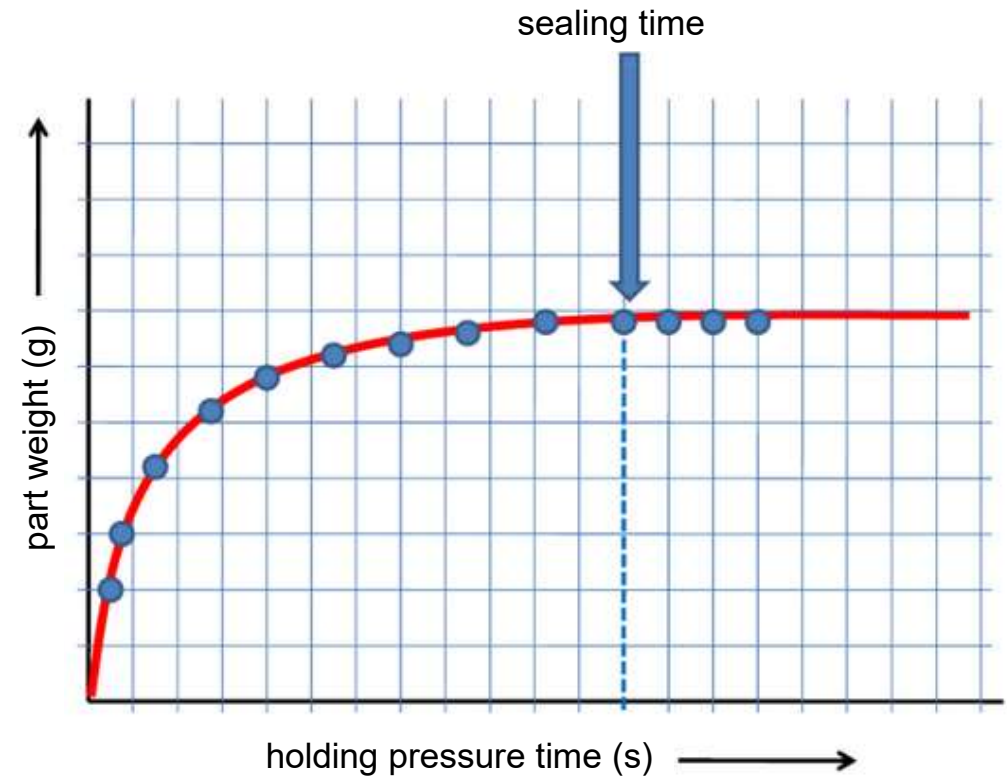
Automatic holding pressure time optimisation



Challenges

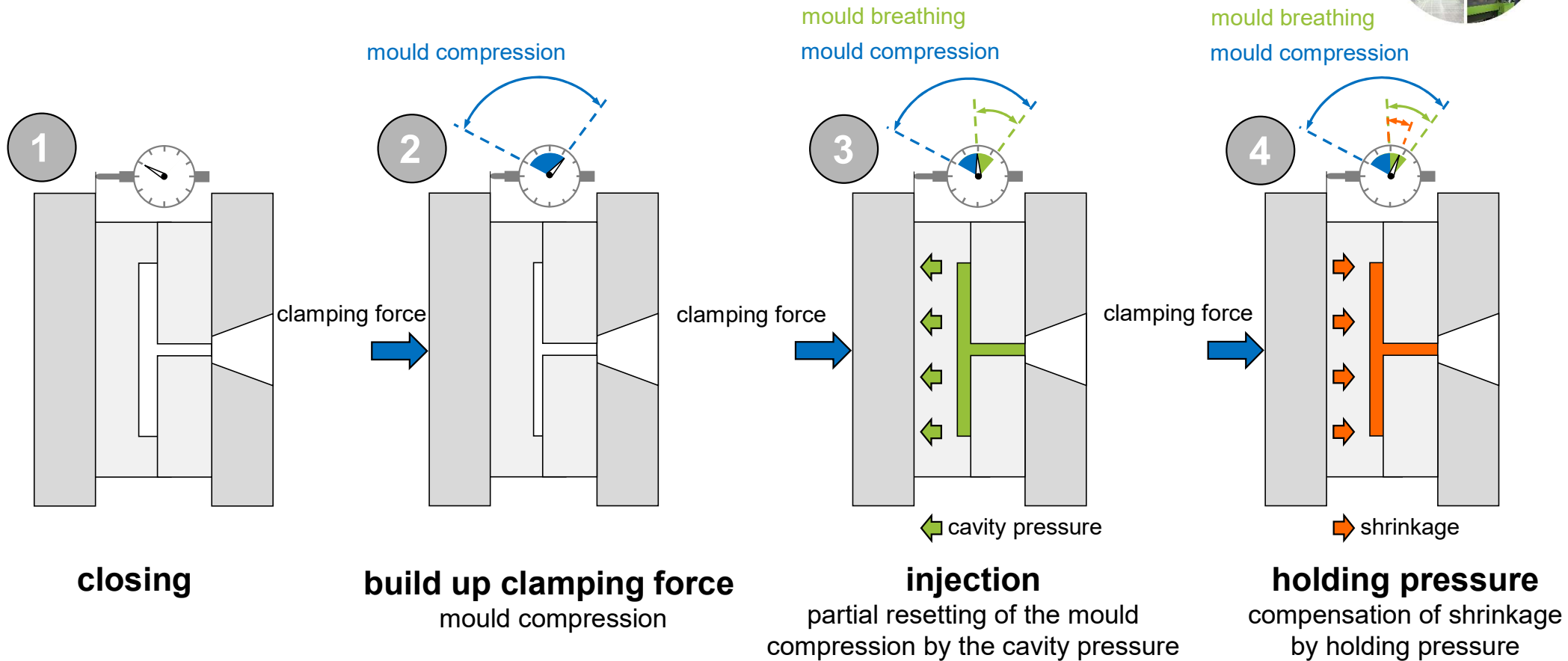
Calculating the holding pressure time by determining the sealing point

- Time consuming
- Equipment required (scales)
- Documentation and interpretation



iQ hold control

Holding pressure and shrinkage



shrinkage

mould breathing

mould compression

iQ hold control

Practical example

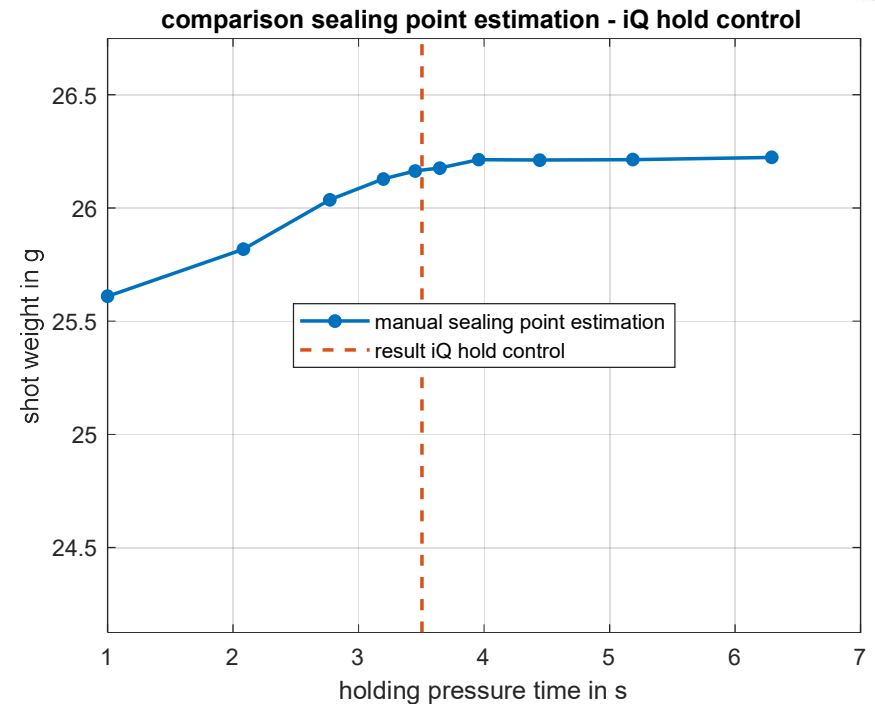


Produkt: Connector
Machine: e-mac 265/80

Material: ABS recycleate
Shot weight: 28 g

Result

holding pressure time before optimisation	optimised holding pressure time
4,50 s	3,50 s



1s cycle time reduction results in approx. 6.2% energy savings

iQ hold control

Expert statement ENGEL



Country: Austria



Industry: Technology centre

Challenge

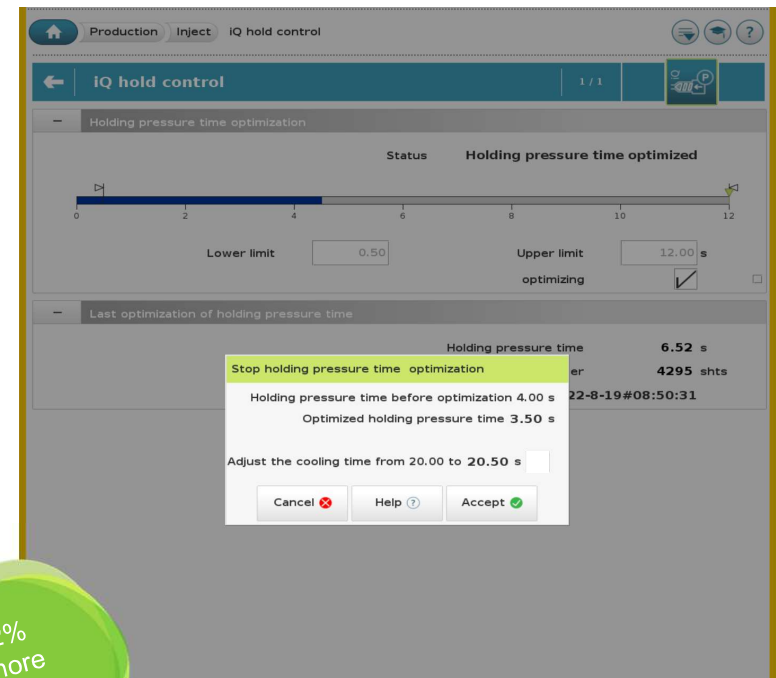
"Under production stress, one often does not have the time to optimise all process settings. The determination of the sealing point takes at least 3 hours."

Solution

"iQ hold control supports me and automatically determines a holding pressure time of 3.5 seconds. Previously, 4.0s had been set."

Result

"This reduced the cycle time by 0.5 s while maintaining the same part quality. Without iQ hold control, I would have needed at least 3 hours to properly determine the holding pressure time. I could use this time for other tasks."



2%
more
output

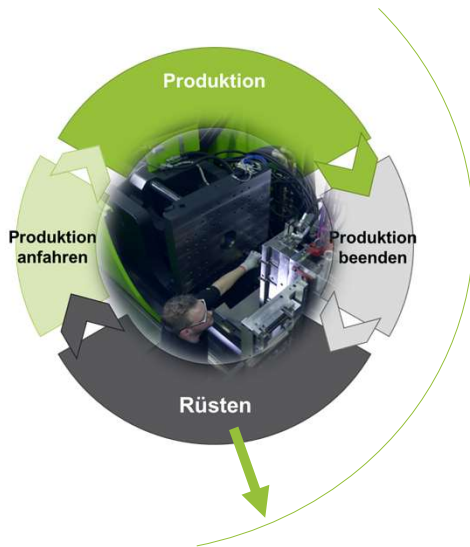
Sebastian Weindlmayr, Application engineer

Set-up assistant

Set-up assistant

Mould change - manual

How do you support your operators during set-up?



- Experience
- Daily tasks
- Defined team
- Checklist



CHECKLIST - Mold Change

1.	Last cycle finished, robot last part	✓
2.	switch to manual mode	✓
3.	carriage unit backward	✓
4.	inject material	✓
5.	switch off mold heating	✓
6.	open safety gate	✓
7.	spray in mold	✓
8.	close safety gate	✓
9.	Close the mold with closing sequence	✓
10.	Uncoupling media on fix and moven platen	✓
11.	Dismount high speed mounting device	✓
12.	Open mold to change position	✓
13.	Bring out the mold	✓
14.		
15.		
16.		

CC300 | Set-up assistant

Showing potential with duo 1300 as an example



Set-up time 60 min → 10 min



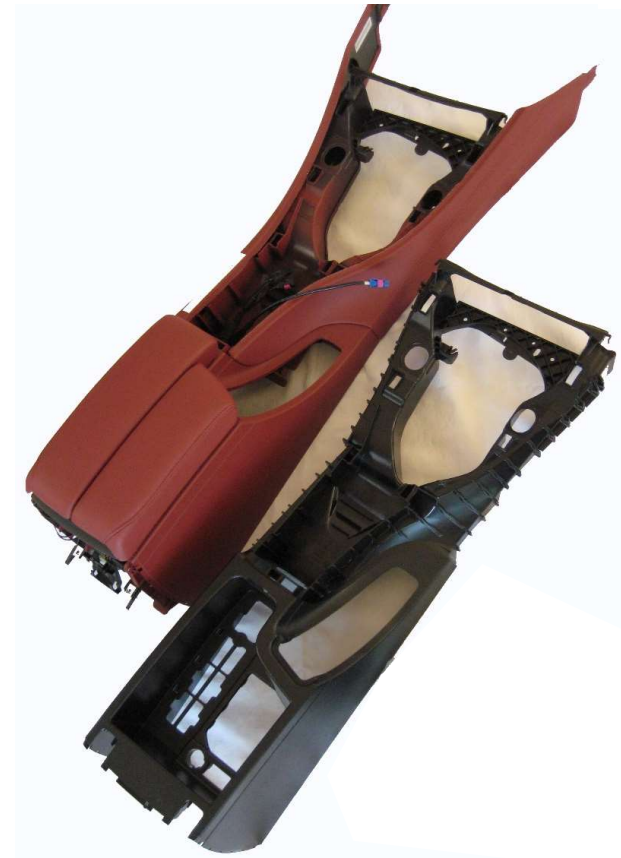
Productivity increase

1x
per shift

+12 %

1x
per day

+4 %



Production

Digital solutions for injection moulding production



consistant part quality | cost & energy savings | use the full potential of your equipment

- Know what is going on in your production
- Digital solutions support sustainable production
- A stable process reduces costs
- Machine data collection makes planning easier
- Intuitive operation makes the job trouble-free for your team
- Keep process settings consistent independent from production location
- Track and log part quality

iQ process observer

iQ process observer

Automated compilation of process data



Challenges

- 80% of process engineers rely on their experience when solving quality problems
- Trial & error approach
- Impact of parameter setting changes is often only apparent later (rejects)
- Spending too much time on identifying errors delays troubleshooting



iQ process observer

Automated compilation of process data

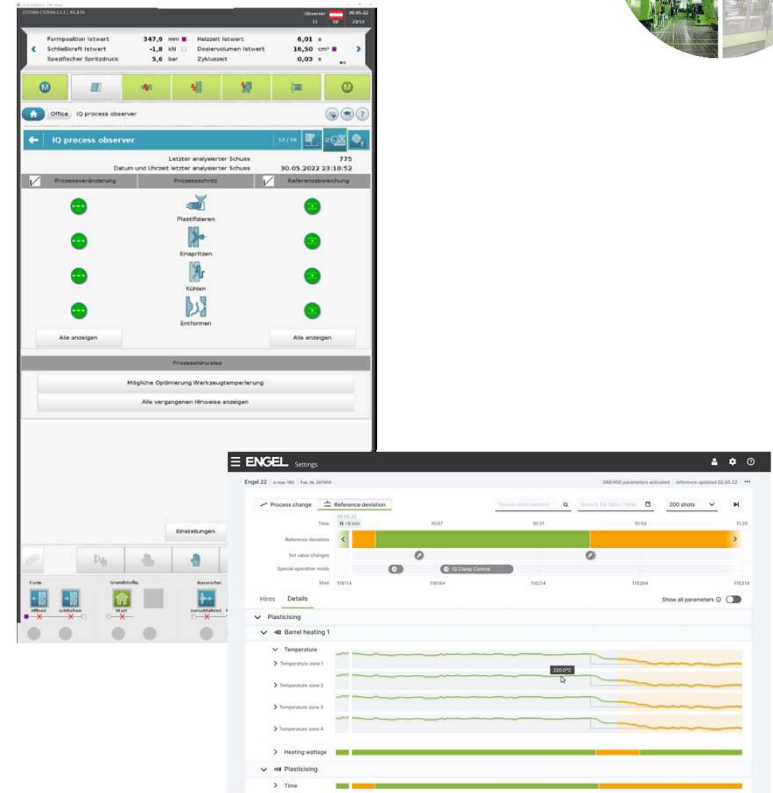


The ENGEL solution: iQ process observer

- Constant real time analysis of hundreds of process parameters
- Process deviation identification and alerts
- Identification of deviations from reference values without manual parametrisation

Results

- Fast troubleshooting
- Avoid downtime
- Reduce scrap



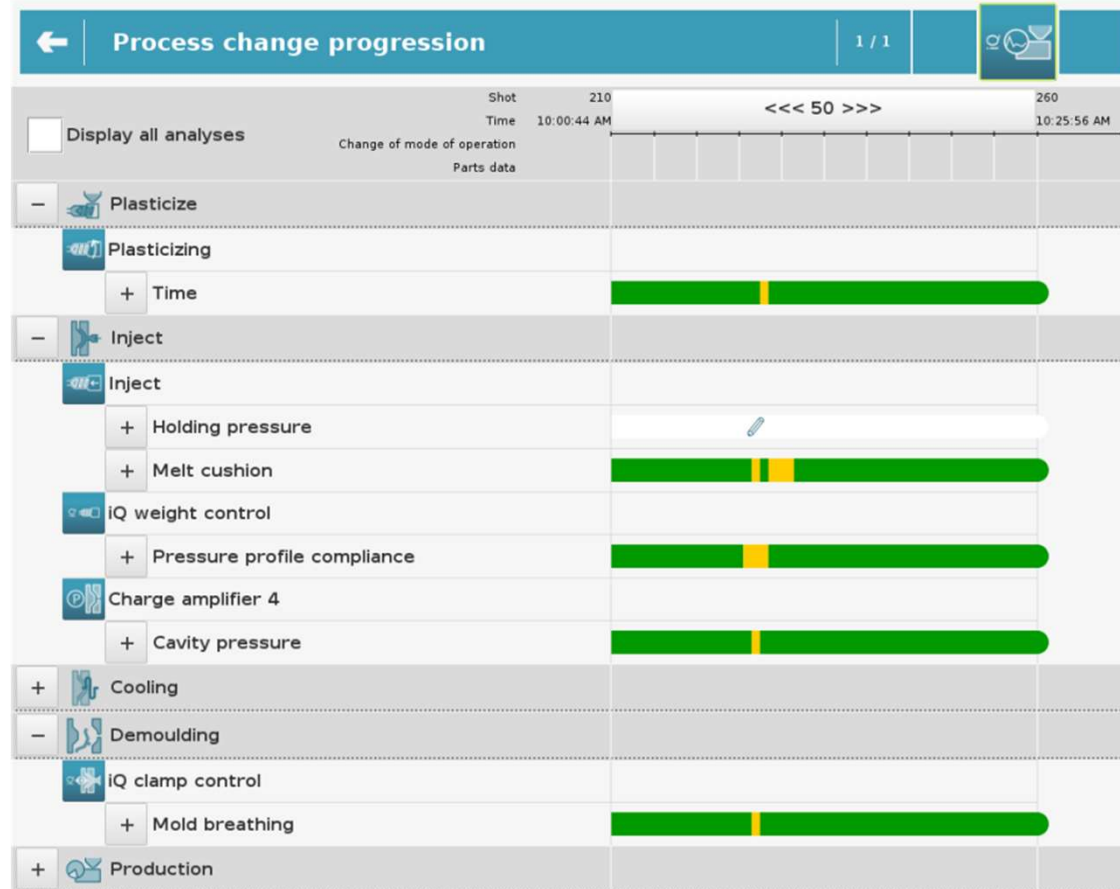
Available for controller software versions CC300 V4.80 and higher (except flexseal and elast models)

iQ process observer

The command centre for mould sampling and process optimisation

Navigate, recognise, react faster

- From the iQ process observer to any process-relevant page with just one click
- Change setting parameters
- Return to the iQ process observer with one click
- Immediately see the effects of a change on the entire process thanks to the "storyline display"
- Recognise when the process is stable again
- Assess the part quality



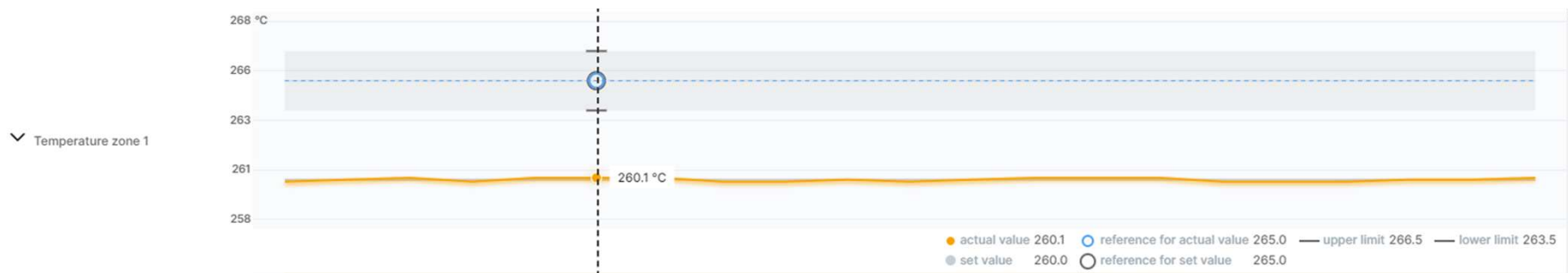
iQ process observer

Suddenly more rejects: What has changed?



Detect long-term changes with the reference comparison

- Data ready to use at any time - zero effort for the user
- Changes compared to a reference state of several hundred nominal and actual values visible at a glance
- Reference comparison directly on the machine: the reference is defined once at the touch of a button and saved in the parts data record
- Reference comparison in the web browser: Convenient analysis at any location



iQ process observer

Uncovers hidden productivity issues

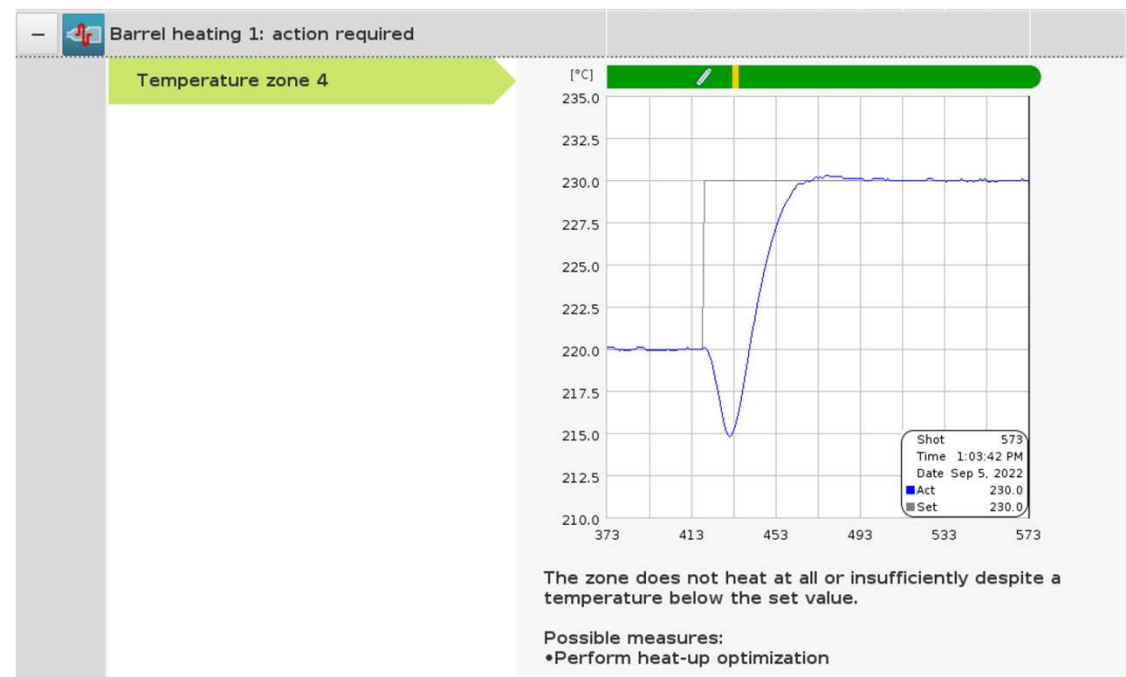
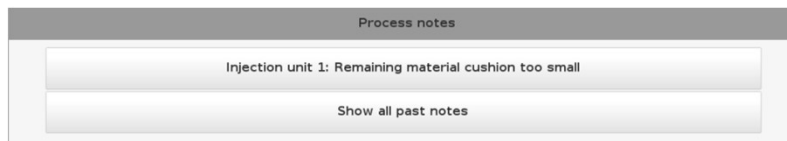


The virtual injection moulding expert comes straight to the point

Process notes detail view

- Intelligent algorithms recognise whether certain predefined states are present with the help of cycle-actual process data.
- During **mould sampling**, the system identifies potential for improvement for future production at an early stage
- In ongoing **production**, the system warns of newly occurring errors
- Recommendations for action help to solve the problem

Process notes overview



iQ process observer

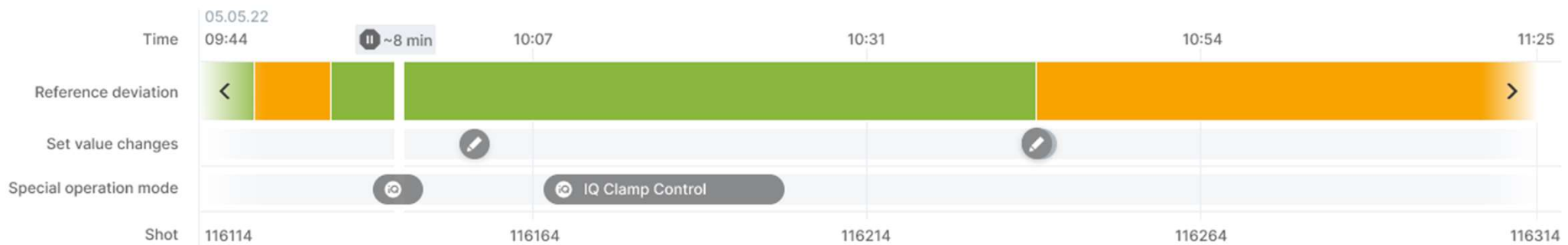
Track setpoint changes and recognise effects



How do you get an overview of the individual production lots?

- What was changed and when?
- What influences did the changes have?
- Were there also negative side effects, e.g. on cycle time or energy consumption?

Display of the most important events (set value changes, operating states, use of iQ assistants) along a timeline:



iQ process observer

Customer Schöfer



Customer: Schöfer
Country: Austria



Industry: Automotive
Products: Technical molded parts with high quality requirements

Challenge

“A good production process depends on the skill and experience of the plastics technician. Since there is always room for interpretation when finding solutions, you never really know whether the new settings will be profitable or not. Setpoint changes usually have an effect very late in the process and unexpected rejects arise.”

Niclas Lugmayr, Process technician

Solution

- Automated checking of process parameters by iQ process observer

Results

- Prepared data and expert advice as a basis for process optimization
- Identify process changes in an early state
- Avoid machine downtime and rejects
- Simple and clear display on the machine control
- Benefit from automatic updates on an ongoing basis



iQ weight control

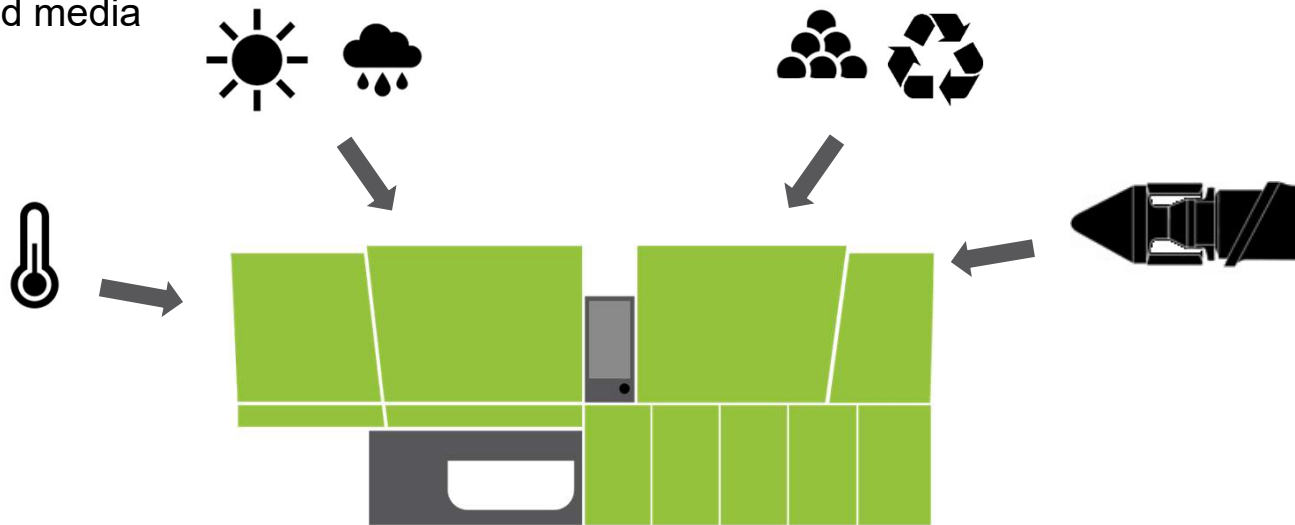
iQ weight control

Smart compensation of process fluctuations



Challenges

- Material batch quality and moisture fluctuations
- Changes in ambient temperature and air humidity
- Fluctuations in temperature control and media supply
- Short shots
- Flash (overfilled cavities)



iQ weight control

Smart compensation of process fluctuations

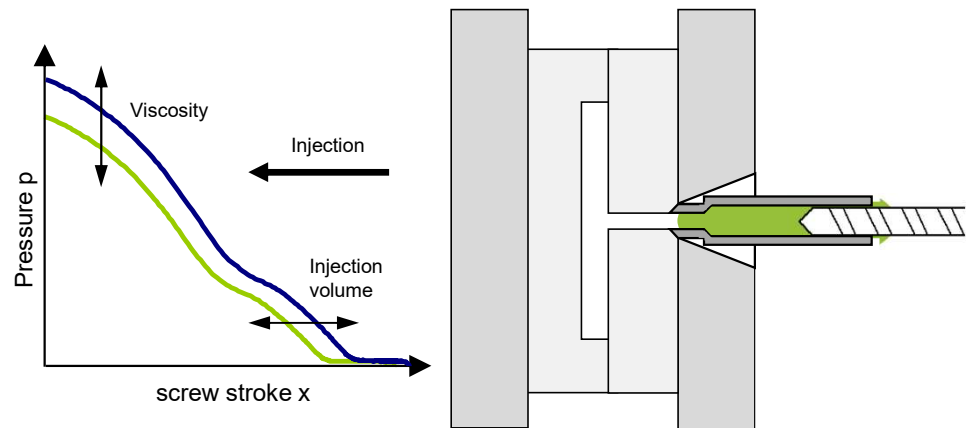


The ENGEL solution: iQ weight control

- Smart software detects changes of material quality and viscosity
- Automatic holding pressure and switch over correction in real time

Results

- Consistent shot weight and high repeatability
- Significantly reduce scrap rate
- Broad range of applications for recyclate



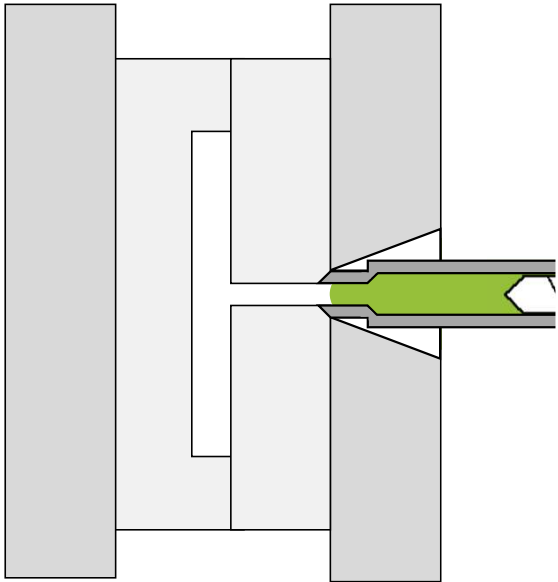
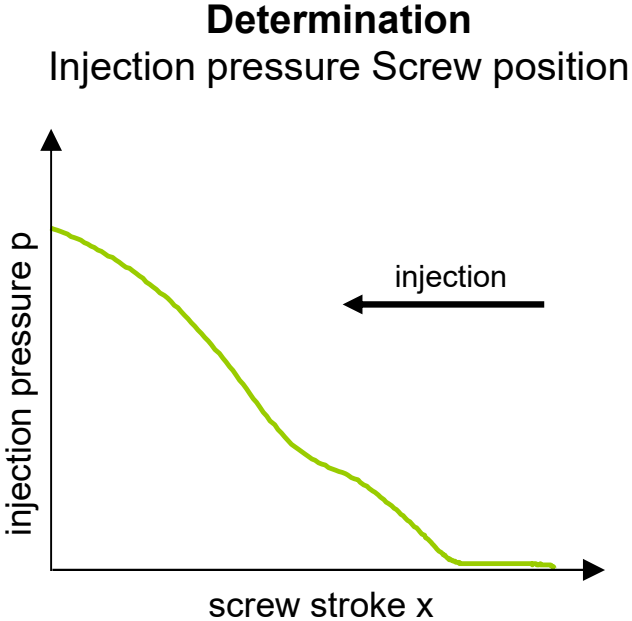
Available for all machine models

iQ weight control

How it works



Pressure over screw stroke is recorded during injection



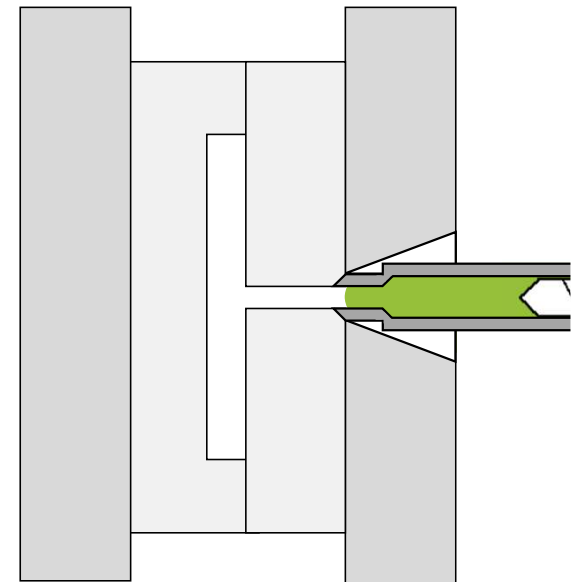
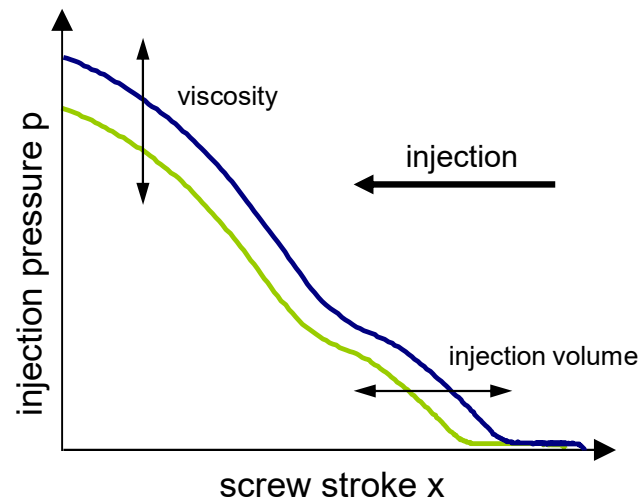
iQ weight control

How it works



Pressure over screw stroke is recorded during injection

iQ weight control compares the **current pressure curve** with a **reference curve**



iQ weight control

Example | For hydraulic injection units

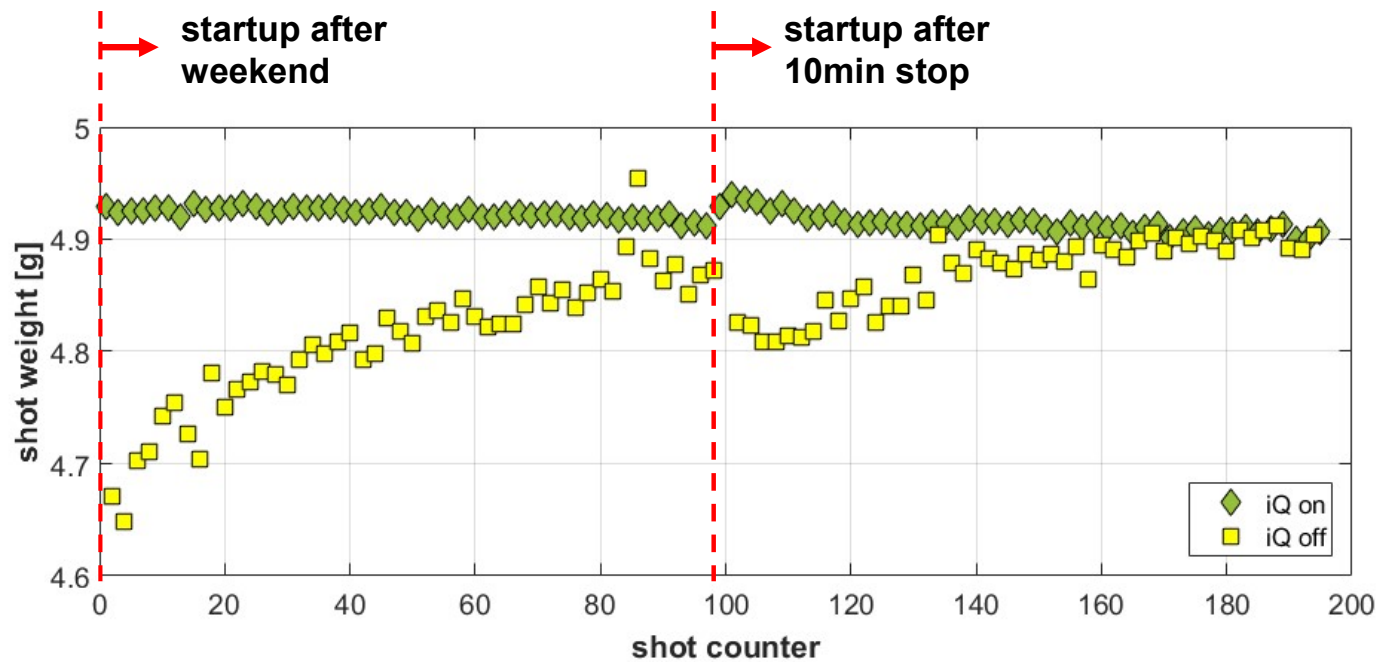


Product: LCD-bezel
Machine: VC 330/120

Material: PP
Partial filling

Result

Compensates for deviations in the ongoing process



iQ weight control | ZKW

Example | 15 min production interruption



Product: Scheinwerferrahmen
Machine: DUO 3550/650

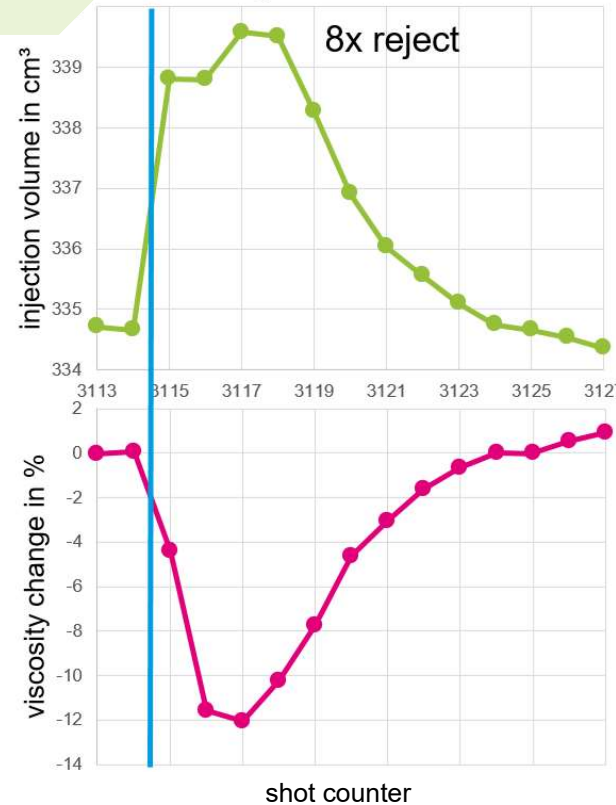
Material: PBT
Shot weight: 360 g (Kavitäten 1+1)

Result

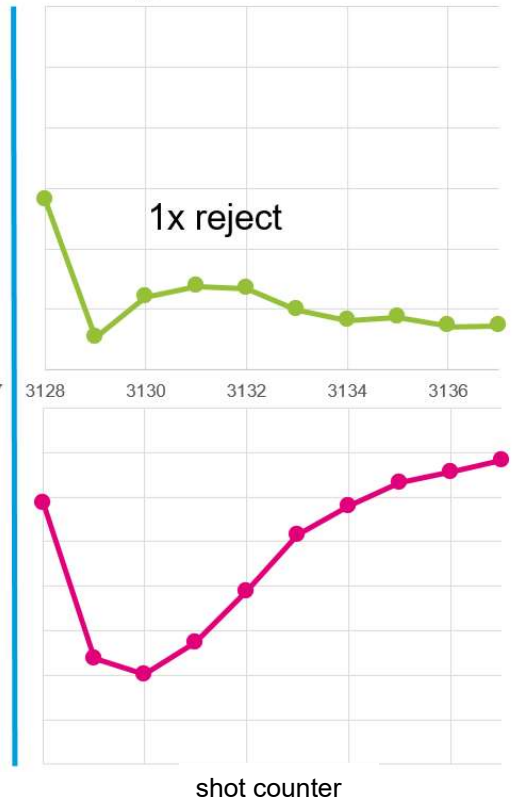
	Distribution
iQ weight control off	2 g
iQ weight control on	0,5 g
Reduction	-75 %



startup **without**
iQ weight control



startup **with**
iQ weight control



iQ weight control

Customer Braun



Customer: Braun / P&G
Contry: Germany



Industry: Technical injection moulding
Product: Swing bridge for razors

Challenge

In a country with relatively high wages, outlasting the competition requires a state-of-the-art production environment. You must prove to your customers that you can quickly adapt to every requirement.

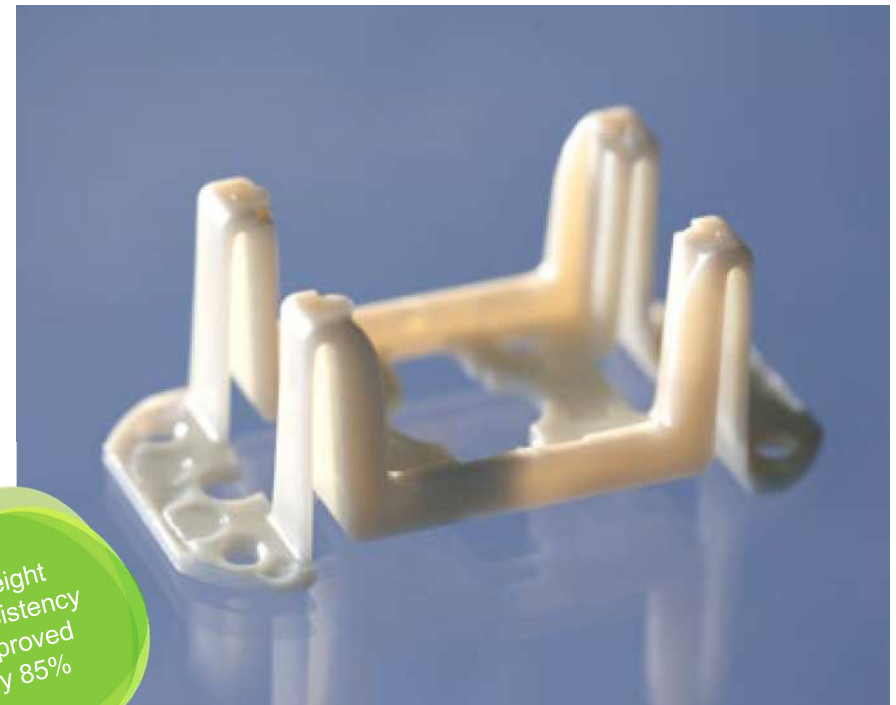
Frank Breuning, Production Planner

Solution

- existing machines retrofitted
- new machines purchased with iQ weight control

Ergebnis

- Reduced weight fluctuation from 0.02g to 0.003g
- Reject rate reduced from 0.1 to 0.047%
- Reduced effort for quality control
- Increased efficiency in the manufacturing process



Weight consistency improved by 85%

iQ flow control

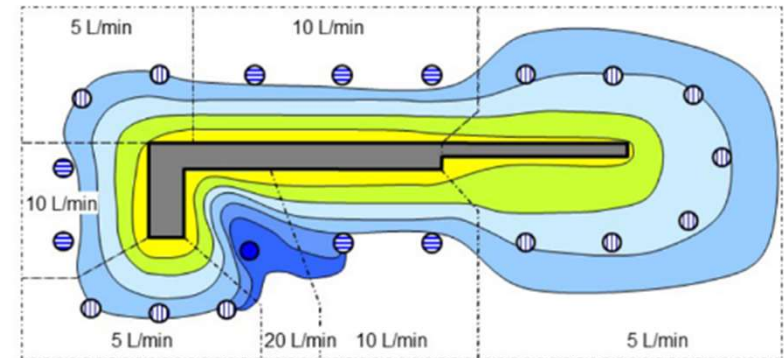
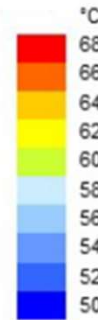
iQ flow control

Mould temperature control in injection moulding



Challenges

- Different flow rates necessary in one cavity
- No knowledge about optimum flow rates - no process stability
- Different settings have to be tested to set optimum flow rates
- High energy consumption and high energy costs
- Long cooling times due to high temperatures on mould surface affect productivity



Source: HB-Therm AG

iQ flow control

Example | Energy savings with intelligent speed control



Product: demo disc Inject 4.0
Machine: e-mac 170/80 TL

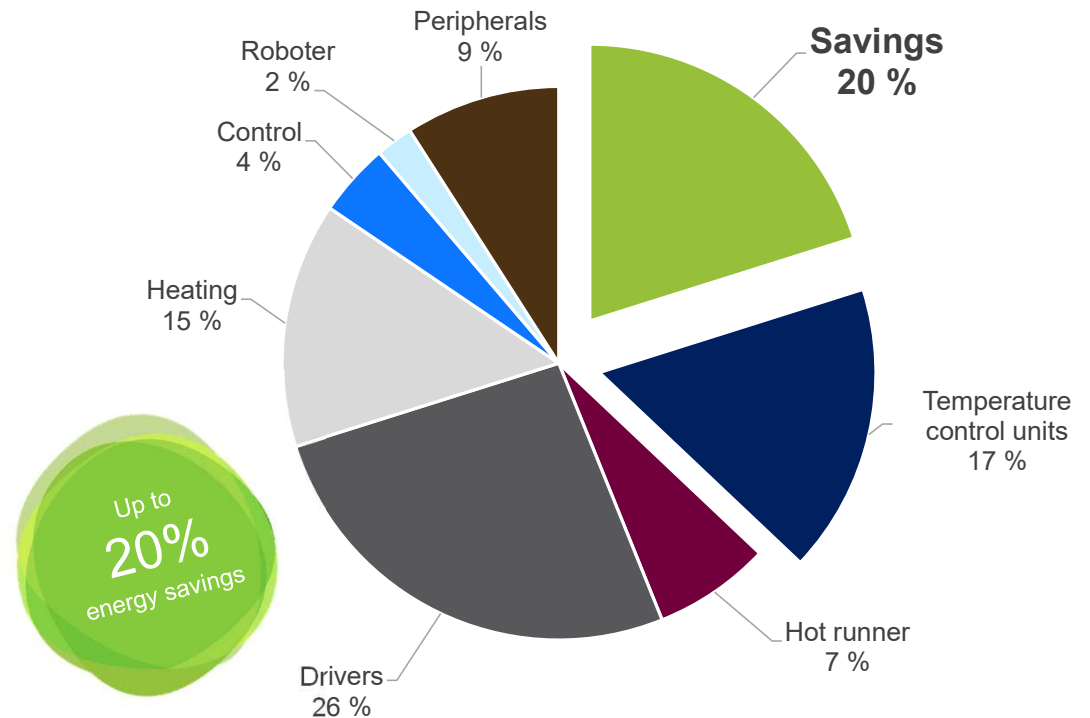
Material: ABS
Shot weight/Cycle time: 7,1 g/10 s

- 2 temperature control units e-temp H8-100

Flow temperature 50 °C



Energy consumption reduced by iQ flow control



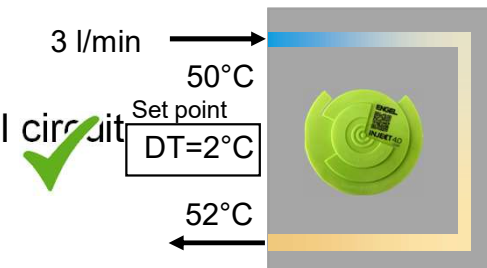
iQ flow control

Temperature difference control



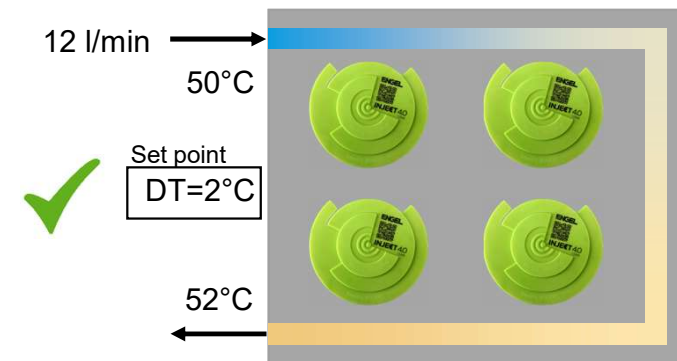
What does the temperature difference (ΔT) describe?

- Difference between feed and return temperature of a temperature control circuit
- Quantity for the uniform temperature distribution



Advantages of the ΔT control

- Guideline values from practice for ΔT available
- Uniform temperature distribution
- Same setpoint adjustment independent of tool size



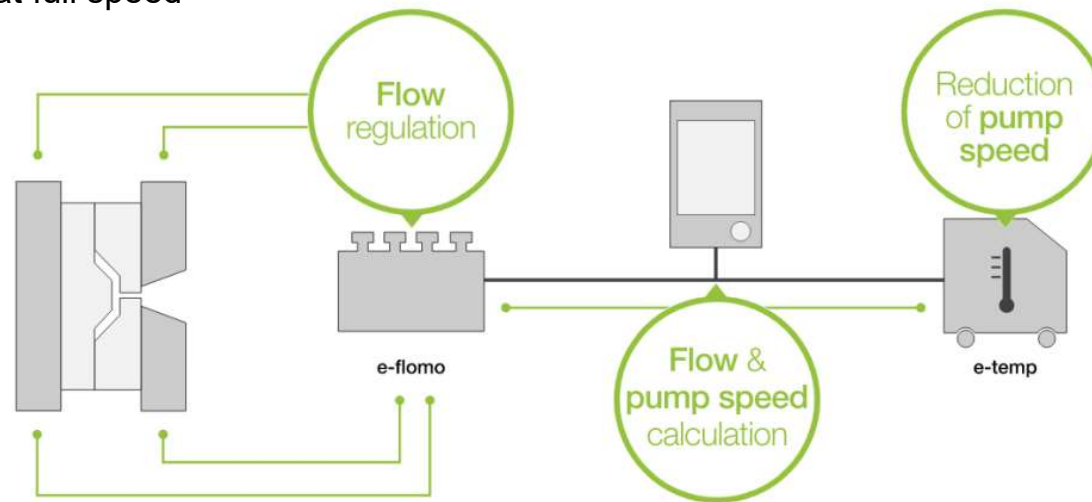
ΔT control in each distribution circuit with iQ flow control

Guide values for ΔT : 1-3 °C Precision parts
3-5 °C Standard injection moulding

Energy savings with smart speed control of the pump

Current situation

- Throttling of the valves
- Pump is always running at full speed



Energy savings with smart speed control of the pump

Optimisation of the hydraulic system

- Opening of the valves
- Reduction of the pump speed → reduced energy consumption!

