

Injection



The magazine from ENGEL for the plastics industry

April | 2021



“Seeing and harnessing the opportunities of digitalisation”

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Actively working to improve

Writing instrument manufacturer Senator relies on tie-bar-less injection moulding machines

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Dr. Stefan Engleder
CEO, ENGEL Holding

Added value for your injection moulding process

We constantly strive to improve the injection moulding process for you, our customers. As you know, sustainability has been and continues to be one of our key priorities. Concentrating on a spectrum that ranges from increasing the energy-efficiency of machines to technologies for improved material effectiveness, and the use of raw materials from alternative sources. For instance, writing instrument manufacturer Senator uses bio-based polylactide and values the ENGEL victory machines' high level of flexibility in its processing operations (page 4). When it comes to bio-plastics and recycled materials, the range of applications is growing. In injection moulding, it makes no difference from which source the pellets come from. With plasticising systems tailored to the material and application at hand, as well as smart assistance systems, standard injection moulding machines continue to ensure a stable process even when there are variations in the raw material.

In part due to the coronavirus pandemic, digital service products have become a major focus area. An increasing number of service calls are being handled virtually. Our ENGEL service team and application engineers are always there to help you, even while travel restrictions are in place. And digital service tools also offer great potential aside from traditional service calls, especially for process optimisation. We want to work with you to unlock this potential using our process optimisation service, performance.boost (page 16). You have a solid understanding of your product, while we know every detail of the injection moulding machine. If we pool our knowledge, we can identify even the subtlest areas of potential for optimisation.

Plus, you can read about another exciting technological development on page 26 of this issue of Injection. Micro injection moulding has continued to be one of our development priorities this year. And this is not only the case for LSR – without giving too much away, it has also been used with thermoplastic materials.

We are delighted to provide added value to your injection moulding process – whether in terms of sustainability, via process optimisation or with new technological applications.

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Layout: Marion Maria Furlinger, ENGEL

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Actively working to improve

400 million parts per year in a wide variety of colours and materials are the basis for the high-quality ballpoint pens by Senator from Groß-Bieberau. When it comes to production, the company from Hessen/Germany is focusing more on sustainability. Senator relies on tie-bar-less ENGEL injection moulding machines, which are not only precise but also versatile and energy-efficient.

In the high, airy and clean production halls there are many injection moulding machines, almost all in ENGEL green. Suddenly an autonomous forklift turns the corner, distributes boxes and picks up a container filled with freshly injection-moulded parts from the injection moulding machine in front of us, before it disappears again around the next corner. "That's Antonio," explains Alfred Kopp, head of the injection moulding department, with a smile. "He supports our production employees in logistics." Automation, including documentation and traceability, plays an important role in the production of several hundred million parts per year. The promotional material manufacturer became

known for its high-quality writing instruments. The company has been back in the family's hands since the end of 2018. The owners focus on developing sustainable products, efficient processes and the use of versatile, energy-efficient ENGEL injection moulding machines.

Bioplastics and recyclable materials

Bioplastics are increasingly in demand from the advertising materials market. Up to 2017, Senator processed

approximately 50 to 60 tons of biobased plastics. Two years later, the amount is almost four times higher. However, the Hessians developed writing instruments made from polylactides (PLA) ten years ago for good reason. "Approximately one kilogram of CO₂ is released to produce one kilogram of PLA. That is only about a quarter of what is generated for the same volume of a conventional plastic," says Michael Monitzer, head of production and member of the management board, quantifying the



Sugarcane is a renewable, fast-growing raw material that is converted by fermentation into lactic acid, the monomer of PLA. It forms the basic material for the Bio Pen product line.

“The long lifespan of these writing instruments is a major plus for the environment.”

Erik Würkner, Head of Production Management, Senator

benefits for the environment. However, since ballpoint pens – even those made of bioplastics – often end up in the residual waste stream due to a lack of a collection system, Senator is taking things a step further and currently testing the processing of recycled PLA that was previously used for other products. “For reasons of sustainability, we are not only focusing on bio-based materials, but also on recycled materials,” said Monitzer. However, these pose a very special challenge for the company.

Writing instruments are high-tech parts

Precision is of the utmost importance when injection moulding the individual parts of a ballpoint pen. Even with the usual plastics, the narrow tolerances

can only be maintained with a great deal of experience. With recycled bio-based material or other newly developed bio-based materials, injection moulding of high-quality ballpoint pen parts requires specific know-how. In order to achieve dimensional accuracy, the residence times in the injection unit, the injection duration, moulds and cooling systems must be precisely engineered. For example, the moulds for each shaft are filled at three injection points as the plastic has to follow long flow paths. “We use a 24-cavity mould with a sprue system that is balanced to allow the parts fill evenly,” says Alfred Kopp, giving a brief insight into the specific requirements for ballpoint pen production.

On the other hand, with bio-based materials the

correct residence time in the screw is one of the secrets for parts that meet all optical and geometric requirements. Injection moulding machines are another of the writing instrument manufacturer's secrets. On both production floors, Senator produces almost exclusively on tie-bar-less ENGEL victory machines with different clamping forces.

“The injection moulding machine plays a major role here,” explains Alfred Kopp. “For example, we inject parts for different orders one after the other from different plastic materials. We only use one mould on the machine for this, as the shape does not change, just the colour and raw material. This means that the screw geometry must be suitable for all materials used, but the process

“Due to the force dividers, the tie-bar-less ENGEL machines achieve outstanding platen parallelism.”

Franz Pressl, product manager for the victory and e-victory series at ENGEL

parameters on the machine need to change. If we also take into consideration that we process all kinds of materials, from recycled material to bioplastics and conventional plastics – and with different colour additives, then it is easy to imagine that not a single batch is like any other”.

Precision is particularly important to ensure that the switching mechanism in a ballpoint pen works correctly. It is also necessary due to the high degree of automation during the downstream steps. “The mechanisms are demanding because they are assembled automatically in the assembly department and need to fit perfectly. We are talking about a range of a few hundredths of a millimetre,” says Michael Monitzer once again making the requirements clear. At peak times, up to 2 million high-quality writing instruments are produced in Groß-Bieberau every day. That is why all the cavities of a mould must deliver exactly the same part with the same dimensions. And even the shaft of the writing instrument must not exceed certain concentricity tolerances, since even the marking process with promotional material is largely automated in the company.

The tie-bar-less ENGEL victory machines achieve this precision thanks to a specific design feature, among other things: the two force dividers. The force dividers are located behind the moving platen and ensure that the clamping force is distributed evenly

“We are talking about a range of a few hundredths of a millimetre.”

Michael Monitzer, Head of Production and Member of the Management Board, Senator

over the entire mould surface, resulting in constant compression of the mould. “Due to the force dividers, the tie-bar-less ENGEL machines achieve outstanding platen parallelism. The very high precision is particularly evident in multi-cavity applications thanks to constant parts weights and geometries within a shot,” explains Franz Pressl, product manager for the victory and e-victory series at ENGEL.

Minimum setup time, efficient parts handling

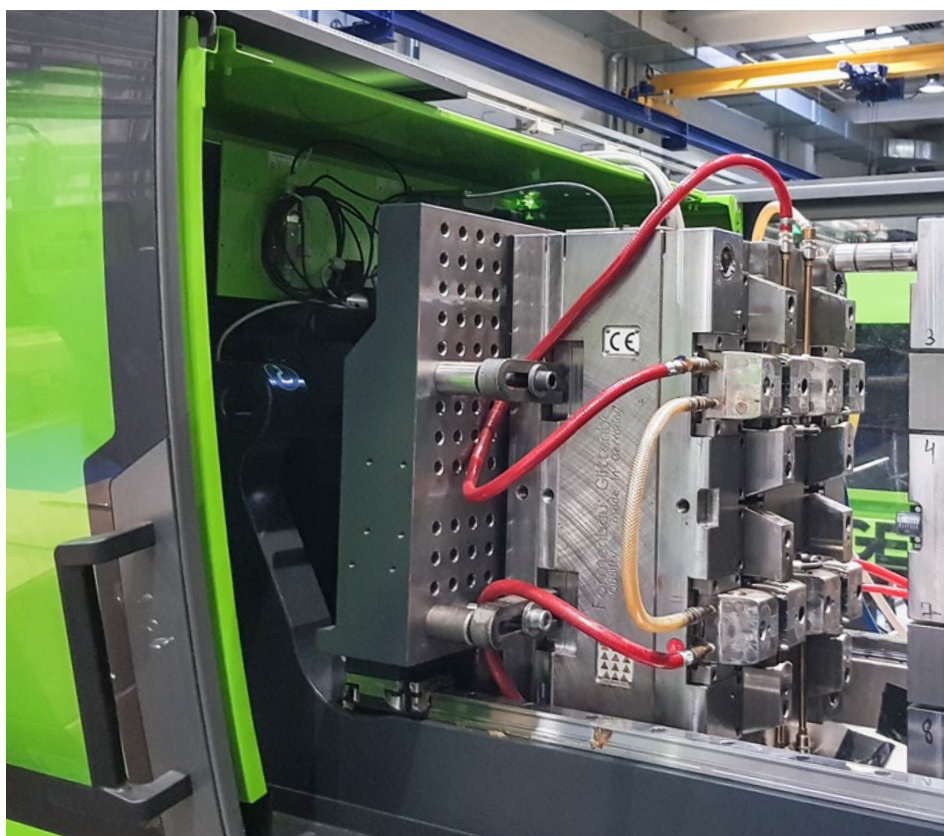
Despite the wide variety of materials and colours, Senator assures its customers that it is able to deliver advertising material of exactly the same quality and colour within a few days. In order to make this work, the company uses authentic TIG. When an order is released, the MES transmits the basic data of the injection moulding process from the host computer to the selected machine, where the order is then produced after fine adjustment by the machine operator.

Due to the variety of products, setup times continually have to be scheduled again and again. For the 43 versatile ENGEL injection moulding machines, this is about four to five scheduled setups per week. Thanks to the barrier-free access to the clamping unit, the actual setup time is only about 20 minutes. According to Erik Würkner, head of product management, the tie-bar-less technology has other advantages, too: “Robot handling becomes easier and the clearances when handling the moulds are greater because there are no tie-bars to interfere with the

crane movements. Additionally, we can also mount larger moulds on smaller machines since moulds can cover the entire surface of the platens. This increases our flexibility in production – and energy efficiency.”

Energy efficiency as part of the sustainability strategy

Sustainability means a great deal to the company: “The durability of our writing instruments clearly benefits the environment, because the useful life is an important, but unfortunately often a little-noticed factor for increased sustainability,” says Erik Würkner. “Because if you look at the entire life cycle of a product, the climate-influencing component attributable to production decreases the longer the product is in use.” In order to further reduce this, the intent is to significantly reduce energy consumption in production in the coming years. And the ENGEL victory machines make an important contribution towards this. Other starting points for greater energy efficiency include minimising energy peaks during start-up; and switching to a smaller machine, which is made possible by tie-bar-less technology, also saves energy. In addition, the use of a smaller machine has further advantages, particularly for thermosensitive bioplastics, such as the shorter residence time of the melt in the smaller injection unit. ■



The mould installation space of tie-bar-less injection moulding machines offers plenty of room for mould set-up and parts handling.

Writing instruments are high-tech parts. The switching mechanism of the ballpoint pens is very detailed and delicate, but it must be durable and can only have tolerances in the hundredth of a millimetre range for automated assembly.



From left to right:
Thorsten Habich, ENGEL
Deutschland; Erik Würkner,
Senator; Alfred Kopp,
Senator; Michael Monitzer,
Senator; Franz Pressl,
ENGEL AUSTRIA.



Sustainability is firmly
anchored in ENGEL's
corporate philosophy.
Find out more:



ENGEL worldwide. **Where you are.**

ENGEL Used Machinery launches

New company for used machines

The foundation of ENGEL Used Machinery s.r.o. sees ENGEL expand its portfolio to include used machines. With ENGEL as their full service provider, customers benefit from comprehensive advice from a single source. Besides injection moulding machines, the new company also buys back used robots from the ENGEL series, refurbishes the products and puts them back on the market for sale. "In some cases, a second-hand production cell is the only option. We want to offer our customers a high-quality solution for this requirement, too, with ENGEL's customary consulting expertise and outstanding service," says Dr. Christoph Steger, CSO of the ENGEL Group, explaining this strategic decision. The repurchased injection moulding machines and robots are reconditioned in-house. ENGEL has created the capacities required for this at its production plants in Austria and the Czech Republic. The newly founded company is headquartered in Prague, Czech Republic. "Eastern Europe is the largest and fastest growing market for pre-owned injection moulding machines," says Leopold Praher, General Manager of ENGEL Used Machinery.

"Eastern Europe is the largest and fastest growing market for used injection moulding machines"



Leopold Praher has taken over the management of the newly founded ENGEL Used Machinery s.r.o.

Making shorter cycle times possible

ENGEL and hotset

The Z-system produced by hotset, based in Lüdenscheid, Germany, is a pioneering development in variothermal mould temperature control. The high-speed process for partially cyclical mould temperature control is being used by more and more plastics processors in the consumer goods and automotive industries as they look to deliver top-quality surfaces without weld lines or dull spots. ENGEL is the first machine manufacturer to offer the Z-system as an option that can be built into its injection

"With the Z-System, our customers benefit from a simple plug-and-play solution without having to invest in an additional control system."



Rolf Saß, Managing Director at ENGEL Deutschland in Hagen

moulding machines. "Thanks to its exceptionally fast heating speeds and cooling rates, highly dynamic mould temperature control is possible without causing longer cycle times. And at the same time, the Z-system is an extremely energy-efficient solution," says Ralf Schwarzkopf, the CEO of hotset. Expectations for visible parts are becoming increasingly demanding – yet at the same time, processing operations need to become even more efficient and cost-effective. This is the balancing act that the Z-system manages to achieve.



At hotset, the Z-system can be tested on an ENGEL injection moulding machine.

Disseminating knowledge – remotely and on site

New training centre in France



The training room offers space for eight participants – but also the best conditions for virtual knowledge transfer.

ENGEL France opened a new training and education centre at the Wissous location. The concept is to provide hands-on injection moulding 4.0 for trials and training on state-of-the-art machinery. Located near Paris, the new ENGEL France training centre can be reached very easily. At the technology centre, a total of 200 m² of floor space is available for training and practical exercises. But thanks to consistent digitalisation, a great deal of customer proximity is achieved "remotely" in our age of Covid-19.

"The pandemic has shown us how important it is to stay in close contact with our customers, also with virtual training courses."



Romain Reyre, Managing Director of ENGEL France

ENGEL supports training and professional development

PlastIQ in Belgium

ENGEL is supporting the training and further education of specialists in the plastics industry in Belgium. Educational institution PlastIQ has taken delivery of two injection moulding machines with comprehensive inject 4.0 packages. Both future and experienced injection moulding experts are trained. An ENGEL victory 330/80 tie-bar-less machine was commissioned at PlastIQ's Circular Material Center in Kortrijk. Another e-victory 310/80 tie-bar-less injection moulding machine is located



PlastIQ and ENGEL Benelux have created additional training capacity at the Kortrijk and Genk sites.

at the T2 Master Campus in Genk. Both PlastIQ and ENGEL Benelux offer training courses at the two locations. In addition to training and professional development, the two ENGEL injection moulding machines are used for R&D projects with partner companies and other institutes. PlastIQ's mission is to connect training and industry, to strengthen skills and qualifications in the plastics technology sector, and to inspire young people to consider a career in the plastics industry.

Sustainable polymers – opportunities for the circular economy

Virtual PlastixLab conference in Italy

Hosted by TMP at the University of Padua's Te.Si research and training centre and supported by ENGEL Italia, the PlastixLab conference was a tremendous success, attracting some 800 attendees. "The virtual platform was an efficient way for customers from faraway regions to take part," says Matteo Terragni, Managing Director of ENGEL Italia. In addition, the theme of the conference – "sustainable polymers: challenges and solutions for injection moulding" – generated great interest. The talks covered the use of recycled materials and bio-polymers, bridging the gap between university research and established practice. For instance, Matteo Terragni shared a number of innovative injection moulding solutions for achieving a circular economy, underscoring ENGEL's commitment to improving sustainability. The event ended with a roundtable titled "The New Normal of Plastic", which was organised together with partners including the Italian Association of Plastic Technicians.

Success with little pressure

foammelt conference held virtually for first time

ENGEL provided detailed information on all aspects of structural foam moulding during a recent conference appearance. The traditional foammelt conference was held virtually for the first time. Held as a free event, this was a great opportunity for anyone looking to get started with structural foam moulding. But those closely familiar with foammelt also stood to benefit. "Structural foam moulding has established itself as one of the most important lightweight engineering technologies," emphasises Wolfgang Kienzl, ENGEL's Product Manager Technology, "which is why many different foammelt technologies are now in use. In any case, process engineering know-how is important for achieving good results. ENGEL supports its customers in selecting and implementing the most suitable process for the respective application."

ENGEL is BEST supplier

Brose gives special recognition to ENGEL



Accolade as BEST Supplier: Periklis Nassios, Executive Vice President Purchasing at Brose, (left) hands over the certificate of appointment to the exclusive group of BEST Suppliers to Stefan Engleder.

Brose has added ENGEL to its exclusive group of strategic suppliers. In doing so, the automotive supplier has shown its appreciation of the performance which ENGEL products offer. This also underlines the exemplary cooperation in the development of lightweight engineering solutions. "We are delighted about the trust and recognition that Brose has shown us with this award," as Dr. Stefan Engleder, CEO of the ENGEL Group, emphasises. "For us, Brose is not only a customer, but also an important development partner that is always open to innovative products." ENGEL has been supplying injection moulding machines and automation to Brose's production plants around the world since 2003. ENGEL's commitment to the new Brose plant in South Africa was particularly emphasised by Periklis Nassios, Executive Vice President Purchasing at Brose, during the award presentation. The same was true of the two companies' shared vision when it comes to automotive production of the future.

ENGEL is one of the world's **most sustainable companies**

ENGEL is one of 50 global Climate Leaders. In cooperation with TBD Media Group, the Bloomberg media corporation analysed and evaluated the commitment of industrial companies from a range of sectors and defined the 50 most sustainable and climate-aware companies worldwide. ENGEL is the only plastics machinery manufacturer to be included.

Find out more
about sustaina-
bility at ENGEL:



Sustainability is firmly anchored in ENGEL's corporate philosophy. The injection moulding machine manufacturer and system solution provider is continuously optimising its processes with the aim of using resources even more wisely and further strengthening recycling. ENGEL also supports its customers with innovative machine concepts and process technologies in the

establishing a circular economy, which ENGEL is leveraging with extensive development investments.

Responsible use of plastics worldwide

"Closing the material loop is one of the plastics industry's priorities". We accept this challenge and are developing solutions that enable processed

allows for a particularly high level of recycled content in sandwich injection moulding, and iQ weight control – a smart assistance system that ensures a constant production process even when there are heavy fluctuations in raw material quality. "From packaging and automobiles to medical products, plastics have become an integral part of our modern life," Engleder says. "They help us save energy and make significant contributions to hygiene and safety. As part of the plastics industry, we have a responsibility to ensure that people in all regions of the world use plastic products responsibly."

By including ENGEL in the group of 50 Climate Leaders, Bloomberg is honouring this commitment and raising awareness of the industrial commitment to climate and environmental protection. "Transparency is the prerequisite for being able to make a difference quickly," says Engleder. "It is important here to involve the entire value chain right from the outset, right up to the consumer." ■



*"Closing the material
loop is one of the plastics
industry's priorities."*

Dr. Stefan Engleder, CEO of ENGEL Group

development of sustainable plastic products and in reducing the carbon footprint in the production of these products. Advancing digitalisation opens up great opportunities for

plastic waste to be used far more widely," says Dr. Stefan Engleder, CEO of the ENGEL Group, in the video that Bloomberg produced for the Climate Leaders presentation. Examples of these solutions include the skinmelt process, which

50 SUSTAINABILITY & CLIMATE LEADERS

A RACE WE CAN WIN



Exclusive insights: **ENGEL launches its own blog**

Customer wishes and requirements drive ENGEL to become even better every day. In launching its own blog, the machine manufacturer invites its customers, partners and prospects to follow it on this exciting path. Injection went straight to Ute Panzer, Vice President Marketing and Communications.



“There is an increase in demand for concise information available at any time. A blog is a great way to address this need for new information.”

Ute Panzer, Vice President Marketing and Communications

Ms Panzer, ENGEL has launched its own blog on the company website and expanded its offerings in the field of virtual communications. What prompted this move?

Securing your expertise advantage and expanding your contact network are key success factors and will become even more important the faster the developments progress. Communication needs to take this dynamic into account. The demand for compact information that is available

online at all times, and that precisely meets the respective information needs, is increasing. A blog covers the need for this type of information gathering in a very good way.

What benefits do you see in this format?

This online format offers three major benefits. On the one hand, it is the

dynamics. We can inform our customers and interested parties very quickly about our latest developments. Then there is the wide range of different perspectives. We assume different viewpoints, to reflect the fact that our customers face different challenges. And thirdly, there is the direct contact with our experts. Our passion for injection moulding, for innovative technologies and services is very much evident in the blog posts. The spirit of our family business. All blog content is personalised and the authors are familiar faces. Experts whose contacts with our customers go back many years, and who are very much familiar with their individual requirements. Feedback and questions from the readers are definitely welcome. The blog actively promotes a direct exchange.

What can readers look forward to in terms of content?

The blog posts offer insights into the ENGEL universe. What are we currently working on? Which new products have been launched? What experiences do our customers have with ENGEL solutions? What is happening in the ENGEL Group around the world? And all of this is tailored to the different needs of the readers. From developers, through production staff and maintenance personnel, to buyers and CEOs – everyone can find the information relevant to them. The blog is a dynamic format. New topics are constantly added. Our experts jointly offer a wealth of knowledge and experience. And they share both in the blog.

Do you have an example for us?

Covid-19 has enormously accelerated the digitalisation of business processes. In one of the first posts, Stephen Zylinski, product manager in the Service Division, reports on a process optimisation project that was carried out in a completely virtual way due to travel and contact restrictions – and with such great success that the approach has set a precedent for future projects. ■

Head straight to
ENGEL's blog:





“Seeing and harnessing the opportunities of digitalisation”

Johannes Kilian is the new head of ENGEL's Process Technologies Department. He is taking over some of the duties previously performed by Georg Steinbichler, the long-standing head of technology R&D, who has now retired and is focussing on his teaching and research activities at Johannes Kepler University in Linz and the LIT Factory. The two came together for the Injection Techtalk at ENGEL's headquarters in Schwertberg, Austria.

Digitalisation is what you will be focussing on in your new role, Johannes. What are your personal objectives and what do you want to see happen?

JOHANNES KILIAN: In the market, I want to see the opportunities of digitalisation and do even more to harness them. Together, in partnership with our customers, we want to create added value. We are confident that by pursuing digitalisation, we can improve the usefulness of our solutions and the way our machines perform, as this potential has often been untapped to date. With the new opportunities for data analysis and improved understanding of models, I also firmly believe that we can further improve on the injection moulding process, which has been optimised over the years. Going

forward, we will be able to do an even better job of meeting expectations with regard to quality. The technologies available to us today, the digital infrastructure and our methodological competence in a variety of areas (such as simulation and our understanding of processes and models) will bring us new insights and allow us to identify areas of potential. It will be a case of unleashing this potential by pursuing digitalisation and working together with our customers to bring the solutions to the shop floor.

Now onto an area that you worked on for a long time, Georg. As the outgoing head of R&D, what do you want to see happening in the market?

GEORG STEINBICHLER: I want to see collaborative relationships developing rapidly throughout the value

chain. Opening doors, being open to shared data platforms – the plastics industry should adopt this as a collective goal. That is a pivotal factor if innovative developments are to become a commercial success.

After 40 years at ENGEL what do you remember fondly?

STEINBICHLER: I can look back fondly on the latitude we were given in our development work, which we took full advantage of. And nothing has changed at ENGEL in that respect. When you think about today's development specialists, too, it is fantastic what you can do at ENGEL. Naturally, innovations have to be commercially successful at some point. But first comes the freedom to think in another direction and try out something

different – paired with that direct contact with the customer. As a development specialist, I often went to see our customers and listened closely to what was bothering them. It was from that direct feedback that we established our development priorities, which is how it still works to this day. That ability to listen to the customer is exactly what has made ENGEL as strong as it is.

What was particularly exciting for you from a technology standpoint?

STEINBICHLER: Process technology is an area that continues to play a major role, although that too is viewed as an increasingly strong space in the context of digitalisation. Digitalisation is not an end in itself – it has to be coupled with a professional discipline, then it will open up new horizons. That is an extremely exciting process, so I am delighted I still have the opportunity to support this development at the LIT Factory. The LIT Factory is an interconnected teaching, learning and research factory for smart polymer processing and digitalisation, in which collaboration throughout the value chain is working exceptionally well. More than 20 companies pool their know-how and experience to forge ahead together in new directions. One goal is to build a circular economy, which is another field where digitalisation is an important precursor.

How did virtual injection moulding come to fruition?

STEINBICHLER: We showed in 1983 how you can use simulation to show a mould's melt fill level. And that was without convenient 3D visualisations with graphics and bright colours. For hardware, we only had an input console without a screen, which looked like an old teleprinter. We used that to describe part geometries in simple segments and sent them to a mainframe in Amsterdam. After some time passed, we would get the results, which were printed out on what felt like an endless roll of paper. We could then check it

to see the values for pressure and temperature in the various segments. How proud we were! Until we noticed that the only thing the customers saw was the mountain of paper.

No doubt you have experienced that more than once – when the time for an idea is not yet right.

STEINBICHLER: Oh, certainly. Here is another example. 25 years ago, we offered software for the first time that already contained more than 90 percent of all the parameters for pre-setting an injection moulding machine. Not with the same precision as today – at that time, it was not yet possible to establish the volume of the mould cavity, for example, from 3D CAD data at the push of a button. That was a laborious task and had to be done based on drawings using a pocket calculator. But all the customers we spoke to were impressed. Finally, the information ended up where it was needed. Still, the product disappeared back into the drawer. And today? Today, this is a highly current topic – but built on a different foundation when it comes to information.

Since those days, great strides have been made with process simulation. How big is the gap between simulation and machine right now?

STEINBICHLER: There is still a great deal left to do. Countless research studies have been carried out to compare experiments and simulations in the injection moulding process, and they have shown differences. But most of the time, no specific proposals have been made for optimisation. Despite some shortcomings, process simulation and CFD simulations are important tools. And we should not be disappointed if the component developer or mould designer carries out a filling simulation without taking machine response into account – or if they do not model a hot runner's flow channel cross-sections or the pressure dependence of a molten plastic's viscosity. These types of results are naturally not suitable when it comes to pre-setting an injection moulding machine or making a comparison with the actual process.

Johannes, when it comes to making further development progress, what is the challenge on the horizon?

KILIAN: The challenge is to deliver the possibility of continuous data flows along the entire value creation chain by specifying and standardising interfaces. This is a must if products are to be developed correctly the entire way through the value creation process. We offer a product, sim link, that we use to close the interface between the simulation and the machine – a small but important step. Our customers can transfer the data from the simulation to the machine, allowing them to generate the correct setting parameters for the machine

in the simulation. We also use real-world data to further improve the simulation. Specifically, the simulation technician uses their optimisation or their virtual design of experiment to generate a process setting for the machine, then they can verify this by gathering and utilising the measurement data.

STEINBICHLER: These days, simulations are used at an earlier stage of development, and the results obtained from them do not always end up in the hands of the professionals who specialise in mould acceptance and process optimisation. A great deal is going to change in this regard. The goal must be to use simulation results for the machine setup and as a basis for process optimisation, which in turn will make things more transparent.

What is your vision for where you would like digitalisation to go, Johannes?

KILIAN: It will soon be ten years since we developed iQ weight control based on an understanding of basic physics. Since the first presentation at the K show in 2013, we have progressively developed the digital tools we use, because there is still great potential for optimisation even in the conventional injection moulding process. We want to unleash this potential. But the setting assistants, including iQ weight control, iQ clamp control and many others, are just one of many building blocks to be used. Processors right along the value creation chain need support. From the first step of component development through configuration of the mould to the machine, mould or product's end of life.

Can you sketch out for me how further progress could be made?

KILIAN: First, we want to keep looking at the basic injection moulding process so that we can understand it even better and use models to explain



"We work on solutions aimed at a range of different applications."

Johannes Kilian, Head of Process Technologies Department



Learn more about the LIT Factory:



it. The resulting products are to be used in a vast range of applications – for example, to help customers with adjusting clamping force and injection pressure. We are talking about process assistance, going as far as ensuring that the machine offers an ideal setup value or adjusts and controls itself in the future – if the operator wants that. Another focus area is digitalisation solutions that provide transparency in the process and offer visual representations of problems and potential areas for optimisation. The machine collects an endless number of parameters and, in turn, important pieces of information. But the goal should be to show operators the essential details in a way that is appropriate for the application and situation at hand. We want to extract the relevant data points from the collected mass, which we hope to use to boost the machine's process capability. And finally, we have the Service Division in mind, where we are using digital solutions to enhance systems' availability. The challenge is avoid focussing on just one area. It is the combined collection of all the individual solutions that will really give our customers the edge.

What role does Artificial Intelligence (AI) and machine learning play?

KILIAN: Artificial intelligence and machine learning are robust methods for solving specific problems. The advantage of AI is that these methods apply well to different data, and we can use a large pool of data. But it is only by combining this with the insights derived from modelling that we can generate added value. We use these methods for some products – in the best-case scenario, the customer does not notice it, but will still be happy that the product works perfectly for them.

What will the machine be able to do in the future?

KILIAN: With the iQ process observer, we have a product that for the first time shows which parameters are out of control in the injection moulding process and at the same time condenses

the data into usable, critical information. And that is the trick – harvesting thousands of data points from the full mass of data in milliseconds so that we can share the most important pieces of information and make it possible to determine which steps should be taken. A variety of modern data analysis methods are used in this context, too. For instance, we use machine learning in our development work. In iQ process observer, the process is continuously monitored, and if anything goes wrong it can be flagged. The detection of abnormality provides direct added value for the operator, as they can identify where things are going out of control. In addition, we give them information on how to solve the problem, i.e. establishing corrective measures for off-course parameters. This is not a vision of a distant future – people will be able to order it in a few months' time.

STEINBICHLER: It is something we could only dream of in the past. The screw starts moving and, while the melt is flowing into the mould cavity, we can see into the process. Then we can figure out where a correction still needs to be made during the current cycle within a few milliseconds. It's fantastic that you can do something like this with today's computing power and computational models.

You were also responsible for process development, Georg. Can you take us on a brief trip through the last three decades?

STEINBICHLER: These memories are often linked to the big topics at the K show. Like fusible core moulding in 1989. At the time, it was considered a good solution to produce intake manifolds with their complex cavity structures by overmoulding cores made of low-melting metal die-casting alloys. Then this method was abandoned for commercial and quality reasons and replaced by more cost-effective cavity technologies. At that time, we used water-soluble plastics instead of the fusible metal cores. The challenges of managing the injection moulding process for overmoulding with short glass fibre-reinforced polyamide in such a way that no major deformation or failure of the insert core occurs were just as great. Every professional in charge of trade show appearances understands the thrill of exhibiting new technologies at trade shows. Before the show, we would work day and night – that was a great experience. And it created a strong bond between our team.

Where did you go from there?

STEINBICHLER: At some point, the idea emerged of replacing the painting process in car manufacturing with in-mould decoration, even for large body parts. When this was applied to a tailgate, we really got to know the process: what it means to form films three-dimensionally when the melt flows in, the film is stretched out further and wrinkles up. At that time, there was also a desire to reproduce paint flow disturbances, known as the orange peel effect, by means of surface structures in the injection mould. At that point, I saw red. Why should we have made the process worse? In-mould decoration was clearly superior to paintwork. But ultimately, the process did not become established for large car body parts for cost reasons. However, it is used in many other applications for decoration and to integrate additional functionalities.

People are often amazed at the complexity on display at trade shows. How can these technologies be transferred to the world of production?

KILIAN: Digitalisation also helps here. That is actually one of its goals: to make the complexity of systems manageable. The skinmelt process is one current example. When producing boxes with a recycled core and a virgin skin, a virtual slider makes it very easy to adjust the mix ratio of core to skin. Digitisation opens up the opportunity to safely control complex processes while unlocking the full potential of the systems.

This interview was conducted by Dr. Clemens Doriát, editor of Kunststoffe, a plastics industry magazine published by Hanser Verlag. ■

Link to
Hanser Verlag:





Regular maintenance of injection moulding machines and robots protects against unpleasant surprises.



Top-quality service is just a click away. Find out more about ENGEL care:

ENGEL's **production support service**

The challenges in injection moulding production are subject to constant change throughout a machine's lifespan. ENGEL assists its customers over the entire life cycle of machines and systems solutions, and we are continuously improving our service programme for this particular purpose. The latest innovative developments are ENGEL performance.boost and the expansion of the ENGEL care service packages.

Optimise processes efficiently with performance.boost

From cycle time to energy consumption to process stability, the factors that can improve efficiency and quality are many and varied. Two things are important to exploit the full potential: in-depth knowledge of the injection moulding machine and extensive experience in application technology. ENGEL's application engineers have both. With performance.boost, ENGEL offers this strong competence as a service for process analysis and optimisation.

ENGEL performance.boost starts with an analysis of the current production process. After this, the customer decides which optimisation steps they would like to implement with the support of ENGEL application technology. Users benefit from ENGEL's high level of expertise in systems solutions. And if desired, the automation solution, the peripheral units, and the integrated upstream and downstream processes can be evaluated and taken into account in the optimisation recommendations.

"Process analysis and optimisation has never been so efficient," stresses Harald Wegerer, Vice President of ENGEL's Customer Service Division. "In many cases, it is even possible to reduce travel time and cut costs thanks to e-connect.24." e-connect.24, the ENGEL solution for online support and remote maintenance, makes it possible to transfer screens from the machine control unit to an external computer via a secure remote connection in real time, allowing virtual collaboration.



"We give our customers the assurance that their production is operating at the best possible efficiency levels and delivering consistently high quality at all times."

Harald Wegerer, Vice President Customer Service

care packages for improved availability, safety and cost efficiency

ENGEL supports its customers in the maintenance of injection moulding machines and linear robots with six maintenance packages. Processors can benefit from the ENGEL service engineers' comprehensive expertise to maximise machine availability and reduce maintenance costs. "Our service technicians have in-depth knowledge of ENGEL technologies and can draw on global lessons learned from

70 years of experience when needed. That's precisely why they have such a keen sense for the small things that so often matter," Wegerer says. From simple inspections including a safety check to predictive and proactive maintenance, the ENGEL care

packages differ in scope. But one aspect they all have in common is that the machine and robot checks are tailored to the system's individual configuration. The care proactive maintenance package is the only service package on the market that includes e-connect.monitor for predictive and proactive maintenance of the plasticising screw. ■

Range of machines for packaging expanded: **ENGEL's fastest large dual-platen machine**

The new duo speed injection moulding machine combines productivity and efficiency with very short cycle times in the high clamping force range. Available with clamping forces from 5,000 to 11,000 kN, the new large machine type is aimed at manufacturers of containers and storage and transport containers.

"The development focus was on short cycle times."

Christoph Lhota, Head of Packaging Business Unit

The new injection moulding machine is based on the ENGEL duo platform, which has been proven throughout the globe for more than 25 years, and has been specifically adapted to the requirements of packaging applications on both the clamping and injection unit sides. "Above all for containers and logistics products, the duo speed extends the portfolio into the higher clamping force range," says Christoph Lhota, Vice President of ENGEL's Packaging business unit. "The development focus was on short cycle times." With dry cycle times of 2.35 to 3.4 seconds, the duo speed is the fastest dual-platen injection moulding machine on the market. ENGEL's compact dual-platen technology further contributes to excellent cost effectiveness. Across

all clamping force sizes, the duo speed is shorter than comparable injection moulding machines used in this field of application, which saves expensive shop floor space. In addition, the platen geometry was optimised to serve the specific needs of the packaging industry.

Particularly clean and energy-efficient

Thanks to exposed tie-bars, injection moulding machines from the ENGEL duo series have a very clean mould area and achieve high energy efficiency. The duo speed relies on ENGEL's energy-saving ecodrive servo-hydraulics with operating point optimisation and is equipped with an electric motor-driven screw drive. Optimised accumulators

are used for particularly fast injection. They support on-demand charging of the accumulators to further improve energy efficiency.

The duo speed already features a barrier screw and sliding ring non-return valve optimised for PP and HDPE as standard equipment.

Leveraging the full potential

This extension of ENGEL's portfolio, puts ENGEL in a position to optimally leverage all efficiency and quality potentials, from thin-walled packaging and caps and closures to thick-walled large containers, with a perfectly matched solution in each case. In addition to the duo speed, the e-cap and e-speed injection moulding machine series were specifically developed for applications in the packaging industry. ■



The new duo speed, tailored to packaging and logistics applications, is based on more than 25 years of experience with large dual-platen machines.

More details on the new duo speed:



Making optical fibres **with maximum purity**

LEDs are becoming more and more versatile in their use in vehicles, increasingly being added as distinctive design elements. The level of variation in their shape is growing accordingly, creating new challenges for optical fibre manufacturers. ENGEL has developed a new plasticising process for injection moulding production of optical fibres to ensure high luminous efficiency, even in cases featuring complex shapes and long structures, such as outline lighting. This increases the homogeneity and purity of the melt, making new options available to lighting designers.

A good optical fibre transports the light from a particular light source, even over long distances, without noticeably losing intensity or changing its colour. This first requires a very smooth surface across the entire transport path to ensure total reflection of the light. As a result, the light can only emerge at certain points, which are designed with prism-like structures for this purpose. Consequently, the expectations for the injection moulding process are that it ensures highly precise moulding of the surface as well as a high level of homogeneity and purity with regard to the molten plastic. In general, injection moulding offers great advantages when it comes to the production of optical fibres, combining flexible design with cost-efficiency.

ENGEL took on this challenge together with its development partners. The result: an injection moulding process optimised for the processing of PMMA, which allows for ultra-clean optical fibres and, in turn, LED solutions with even longer and more complex structures. PMMA is one of the materials preferred by the automotive industry for the production of optical fibres, especially in the context of innovative lighting concepts for vehicle interiors. In order to take

the needs of car manufacturers into account right from the start, the Volvo Car Corporation provided fibre-optic demo structures for the development work. All the tests were carried out using a family mould from INEVO. Three optical fibres of different lengths and shapes were produced in one shot. The longest of the three optical fibres was injected at two points. Altuglas V825T LPL from Altuglas International (Arkema Group) was processed. With the ultimate aim of maximising the light output, the specific development goals were:

- Surface roughness of less than 25 nanometres. At higher roughness levels, short-wavelength (blue) light in particular is not completely reflected but refracted, meaning the light that emerges has a yellowish (warmer) colour.
- No contamination. Any contamination will cause the light to disperse.
- No cavities or micro-cavities, as these will also cause light dispersion.

Starve-feeding reduces shear stress

From a technological standpoint, the principle of starve-feeding is an incredibly important one. And ENGEL has developed its own software for this, which makes it possible to selectively feed fewer pellets to the screw during plasticising than the machine would receive from the hopper in the conventional injection moulding process. Specifically, the barrel is only partially filled with pellets in the screw's feed section. The material only compresses and completely fills the barrel once it has moved towards the screw tip. Less material in the barrel means lower torque levels and, as a result, lower shear stress on

the melt, which reduces material degradation. Simultaneously, the barrel above the feed section is purged with nitrogen to prevent oxidative material degradation.

The injection moulding tests conducted as part of the development projects were carried out on an e-motion 310/120 TL injection moulding machine with a screw and non-return valve specially configured and coated for PMMA processing. The all-electric machine series combines efficiency with maximum dynamics and precision, which is particularly important for moulding the very fine structures on the top of the demonstration components used to couple out the light. Two particularly noteworthy examples of peripheral units that can enhance quality are the Luxor EM-A 60 pellet dryer and the Minicolor dosing unit with disc dosing, both from Motan-Colortronic. To factor in the varying flow path lengths of the three different fibre optic geometries, ENGEL's development partner, HRSflow (INGlass Group), tested out a variety of gating systems with electrically operated needle valves. This involved working with the HRS Flex-Flow system, which makes it possible to individually actuate the valve pins depending on the screw position.

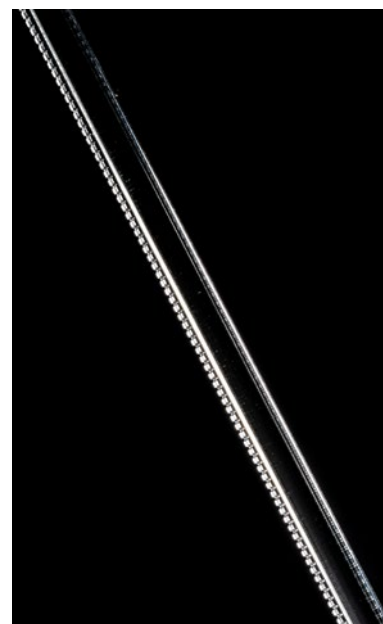
The transformation of motor vehicles is also having a significant impact on their interiors. Light is growing in importance as a design element.

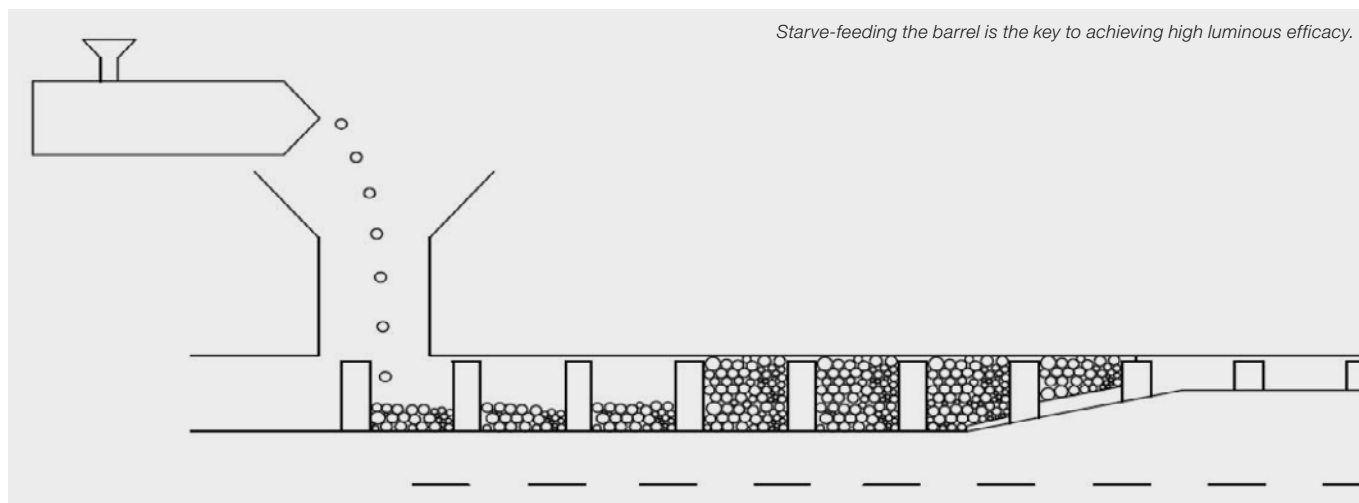


Three optical fibres of different lengths and shapes were produced in a family mould.



The aim of this development process was to achieve a high level of optical quality for long optical fibres with complex shapes. The highly intricate structures on the top of the demonstration parts are used to outcouple the light.





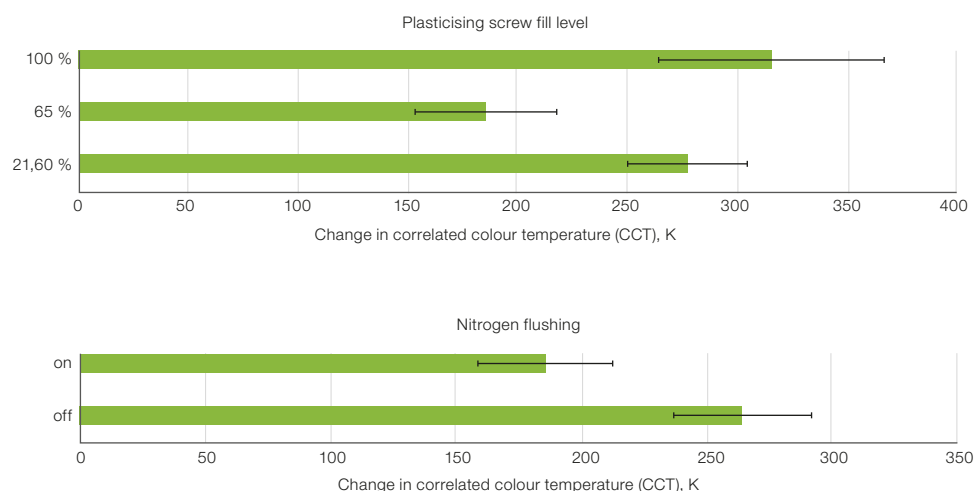
Correlated colour temperature confirms high optical fibre quality

To ensure part quality, an in-line quality inspection mechanism was integrated into the system concept. The shortest rod-shaped optical fibre, measuring 15 cm in length, was tested for each shot. This was placed on an inspection station with an LED light source immediately after being removed from the robot. The change in correlated colour temperature (CCT) was measured using a Radiant Vision Systems IC-PMI8

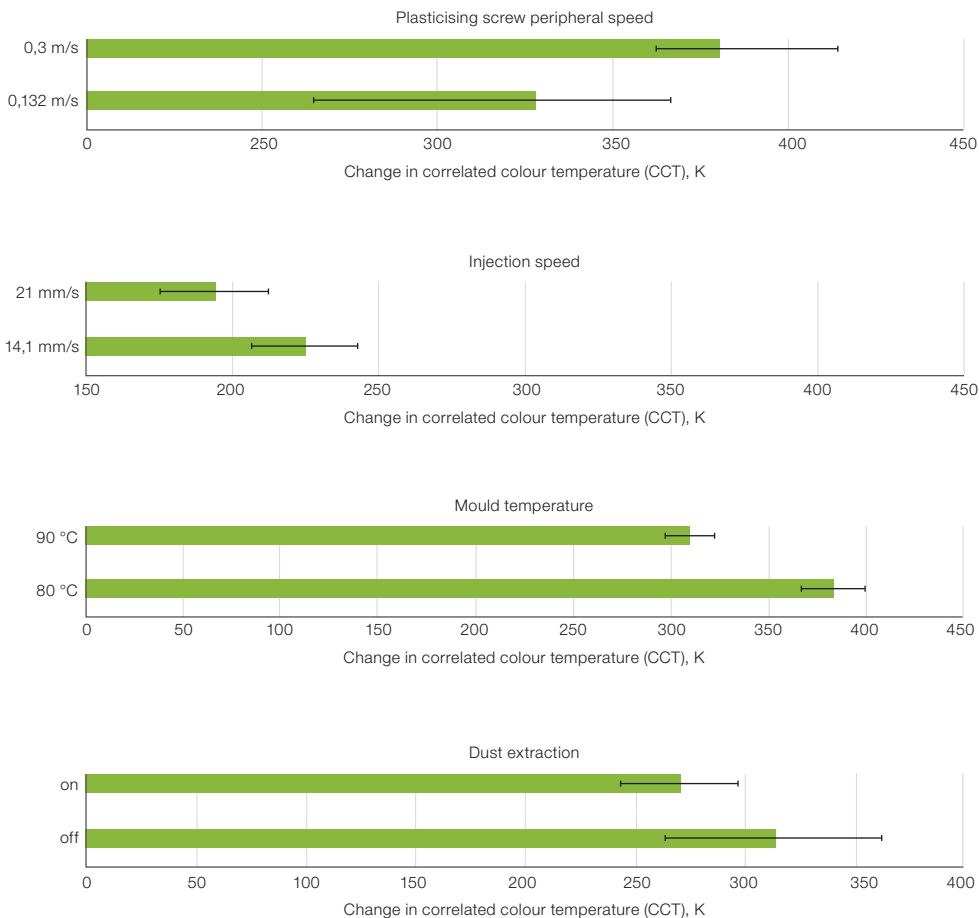
from Konica Minolta Sensing Europe. CCT is a measure of how the human eye perceives the colour of light. The light colour depends on the object temperature – with a black body used as a reference – as well as on the characteristics of the light source in the case of LEDs. Temperatures under 3,000 K are considered warm colours, while those below 3,000 K are deemed cold. The less the CCT value deviates from the reference value (light colour of the LED source), the better the quality of the optical fibre.

The injection tests convincingly confirm the positive effect of the starve-feeding on the quality of the injection-moulded optical fibre (**Graphic 1**). The metering device was used to vary the amount of material added in the test series, with less material always being added than the machine would have drawn in from the hopper in the conventional injection moulding process. The best results

were achieved when the barrel was filled to 65% capacity. If the material supply is reduced beyond this level, the optical quality goes back down. This is because the recovery time increases as the material supply decreases, which again intensifies the shear stress on the melt. The nitrogen purge has an additional positive impact (**Graphic 1**). In the tests, the feed zone was flooded with 0.2 litres of nitrogen per minute to displace the oxygen and prevent oxidation of the molten plastic.



Graphic 1: The injection tests confirm the positive effect of the starve-feeding on the quality of the optical fibre. The best results are achieved when the barrel is filled to 65% capacity. In addition, the nitrogen purging of the feed zone improves the melt's purity. The smaller the change in the correlated colour temperature (CCT), the higher the quality of the optical fibre.



Graphic 2: Additional parameters were varied and correlated with the fibre's optical quality to optimise the moulding process. The peripheral speed of the plasticising screw, the injection speed of the melt, the mould temperature and dust extraction from the pellets have the greatest effect on the injection-moulded final product.

Injection moulding of optical fibres live:



Identifying optimum process parameters

The effect of other process parameters on the fibre's optical quality was also investigated for process optimisation purposes (**Graphic 2**).

The top diagram shows the impact of the plasticising screw's peripheral speed. Although a peripheral speed of 0.3 m/s is permissible for the PMMA used according to the material specification, the tests show that an even slower plasticising process significantly improves the optical quality.

When injecting the polymer melt into the mould, on the other hand, a higher speed initially leads to better light guide quality. However, if the injection speed is increased further, the quality drops off, as the rising speed also increases the pressure and, in turn, the shear stress.

The tests confirm that the mould temperature also has an influence. A higher mould temperature improves the moulding of the surface, which increases the CCT consistency.

With regard to the peripheral unit, the positive effect of dust extraction is the most noteworthy aspect. The smaller the proportion of dust in the pellets and in the melt, the lower the level of dispersion inside the optical fibre.

Summary

ENGEL's newly developed plasticising process is creating new opportunities for lighting technology. Starve-feeding combined with optimised process management results in a high level of optical quality for long optical fibres with complex shapes. This can be assessed and permanently secured with the help of an inline measuring system. All-electric injection moulding machines are the main systems used to produce optical fibres, which is why ENGEL opted for an e-motion machine for this development project. However, the new plasticising technology is most often combined with injection moulding machines that span a vast array of different designs and drive technologies. If requested by customers, ENGEL can integrate the relevant peripheral systems into the system concept. The technology is not limited to peripheral systems from one specific brand. ■

An eye for the essentials: software-based **tape laying with camera technology**

Reinforced unidirectional tapes are the next generation of thermoplastic composites. A basic requirement for successful mass production is for the tapes to be laid with a high degree of precision, ensuring that the desired performance level is reached and that the process is highly cost-effective. ENGEL is managing this balancing act by combining high-precision control software with camera technology.



The tape blanks are separated on the stacking magazine and positioned on lay-up tables so that the robots can approach at high speed. A depositing time of 3.4 seconds per tape blank was achieved with the system tested.



More detail about
tape laying using
ENGEL technology:

*High-precision,
automated tape
laying is a key
technology for
cost-effective
lightweight
construction.*



Accuracy when laying down the tape blanks is crucial for the quality of the final product. After the laying process, the tapes' positioning relative to each other can no longer be changed. As a result, the tape laying phase is the only opportunity to make any corrections. The Charpy impact test shows that both a gap and an overlap lead to reduced impact strength (**Figure 1**), with gaps yielding a sharper decrease in impact strength than overlaps. With this in mind, ensuring a very high

degree of accuracy must be the aim in order to get as close as possible to the ideal scenario of the tapes being laid exactly edge to edge. ± 1.0 mm is a typical standard for allowable gaps or overlaps, even dropping to ± 0.5 mm for some applications. For processes using constant-width tapes, the laying accuracy depends on adhering precisely to the nominal tape width. Variations in tape width automatically produce changes in the accuracy of the laying process. The challenge is to overcome this cause-and-effect relationship through software-based solutions. And this is possible when using the pick-and-place process.

Camera technology allows for readjustment

A classically controlled pick-and-place process would rely on high-precision tape cuts and precise guides in the magazines, as well as additional

alignment and centring modules. At this point, optical measurement technology with a high-resolution camera opens up new possibilities. With its help, the pick-and-place system implemented in the ENGEL Technology Center for Lightweight Composites is capable of actively and precisely placing tape blanks next to each other. The blanks are picked up with an end-of-arm tool (EOAT), where neither the accuracy of the blank cut nor the position on the EOAT is critical in this step. It is

focus of attention. Through the use of camera technology, information is gained that facilitates active software-based readjustment to optimise laying accuracy. The software works non-stop to achieve an optimum result (i.e. the highest possible degree of laying accuracy).

only when moved to a camera measuring station that the position of the tape blank is determined in relation to reference features on the EOAT. This information is used to finalise the robot's target position when placing the tape blank on the lay-up table. An area is specified along the edge of a tape blank, in which the transition from the tape to the background is identified at a number of positions – specifically, 25 positions in the example shown (**Figure 2**). These points are connected with a best-fit straight line that is extended beyond the scan window. The same is done along a second edge, which produces a corner point from the extended paths of the two straight lines (**Figure 3**). This corner position can be determined much more accurately by scanning the blanks' edges than through direct optical measurement, since punching or cutting often does not generate precise and clean corners.

The information about the position and angle of the tape on the EOAT is factored into the positioning when placing it on the lay-up table. The points along the edge of the tape can be determined to within three pixels. On the laboratory system, it was possible to achieve an accuracy level of less than ± 0.5 mm in multiple measurement series (i.e. the gap or overlap between the tapes was less than 0.5 mm). However, the laying accuracy that can be achieved also depends on how straight the cut or punched edges are. The colour of the tapes and contrast with the background also have an effect on how the edges are determined.

Efforts to optimise the tape-laying process are entirely directed at one metric: accuracy. However, the concept used to deliver this high level of laying precision is also an important

High efficiency in real time

To ensure that tape is easily identifiable on the EOAT during the optical measurement, the entire lay-up surface is illuminated with an electroluminescent film. The edges and the corner points of the tape blank are detected in relation to the EOAT. The information obtained from this is transmitted to the robot control unit in order to correct the position and angle of the tape. In this way, the tape can be deposited precisely and in exact alignment with a specific laid edge. The algorithms for calculating the exact depositing position are applied to the digital image material while the tape is already on its way to the lay-up table. As a result, this process places very high demands on the real-time performance of the system's control unit.

Hybrid set-up and expanded stack dimensions

The opportunity to create hybrid stacks is an important advantage of the pick-and-place concept. As well as high-quality carbon fibre-reinforced tapes, the stacking magazines can also be loaded with thermoplastic sheets with several woven glass-fibre layers, pre-consolidated tape blanks with constant wall thickness, and other thermoplastic preforms. For this reason, cheaper materials that are only locally reinforced can be used as a base layer. This means that products can be produced as cost-effectively as possible while reducing the time and effort required to lay a load-balanced stack.

Stacks with external dimensions of up to 460 x 360 mm can be produced on the laboratory system, and ENGEL is already working on the next tape laying unit size. This will support external stack dimensions of

1,100 x 600 mm, allowing stacks for many structurally relevant components, such as seat structures, to be produced in an efficient manner.

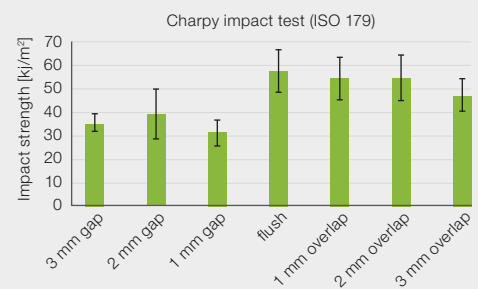


Figure 1: Charpy impact test with tape blanks, featuring deliberately introduced defects – both gap and overlap reduce the impact strength more sharply than a perfectly made blank that sits flush edge to edge.

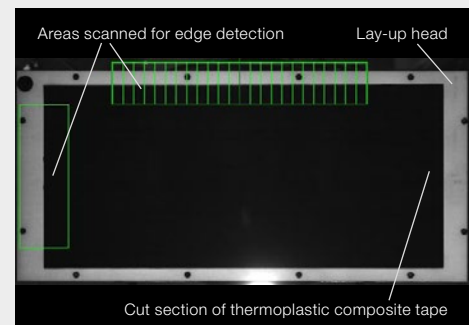


Figure 2: Areas scanned to determine edge paths – measurements are taken at 25 positions to combine the points with a best-fit straight line.

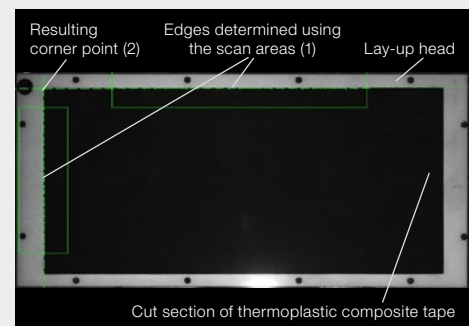


Figure 3: The corner is established based on the edge paths that have been identified. This process is significantly more accurate than direct optical measurement, as the tapes do not always have clean corner points. ■



The perfect lid: Udo Pape and Stefan Witt from ENGEL Deutschland with Phillip and Adrian Schnell from Ilsen (from left to right).

All-electric solution for the strictest thin-wall requirements

And a full container is always a good container. Good for Gerhard Ilsen GmbH & Co. KG in Hövelhof, a specialist for plastic packaging. “5.5 litre container with tamper-evident closure” – this is the simple name of the product, for example. But the seemingly plain packaging product sees the manufacturer face quite a few challenges. After all, the trend is towards even thinner wall thicknesses, both for the containers and their lids. A stable injection moulding process is important. This is one of the main reasons why ENGEL technology is entering the scene at Ilsen. The container lids are produced on an all-electric e-motion 280 injection moulding machine.

Potato salad or coleslaw, for example, are delivered in classic 5.5 litre containers. Food products that are placed on supermarket checkout conveyor belts millions of times a year. The requirements for producing a lid with a tamper-evident closure that fits the container are quite diverse, and they are a constant challenge for the manufacturer. A challenge because production has to be very stable with very short cycle times. And all of this with thin wall thicknesses and long flow paths.

Electric injection, also with high clamping forces

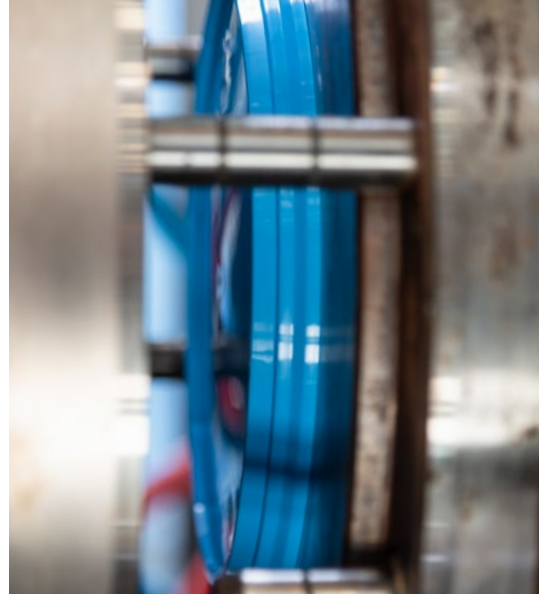
In order to combine high precision with very high output and energy efficiency, Ilsen decided to invest in an all-electric injection moulding machine. The lids for the 5.5 litre containers have been produced

on an ENGEL e-motion with a clamping force of 2800 kN for a year now. The decisive factor is electric injection, which is not naturally possible in the high clamping force range. “ENGEL offers an advantage here,” says Philipp Schnell, authorised signatory and technical manager at Ilsen. ENGEL offers all-electric high-performance machines up to 6,500 kN clamping force. This guarantees a high degree of process stability, and the precision of the machine opening movements also

contributes to this. It ensures that the lids drop uniformly out of the mould onto the conveyor belt without jamming. “If the mould mounting platen stops just one millimetre too early, the entire downstream process stops,” as Philipp Schnell clarifies. “The e-motion mould mounting platens allow us to achieve precision movement in the hundredths of a millimetre range”, says Udo Pape, ENGEL sales manager at the Hanover site. All main movements are servo-electrically driven throughout the entire series, which enables parallel motion in the sequence and ensures extremely high dynamics. “Short cycle times,



Ilse entered the world of all-electric injection moulding with the e-motion 280.



The high precision of the platen movements is necessary for optimum removal of thin-walled parts.



High performance
made by ENGEL:



Containers and their matching lids place high demands on the injection moulding process. At Ilse they are produced on an all-electric e-motion injection moulding machine.

fast injection and cooling are a massive issue in lid production," says Schnell. Speed is synonymous with profitability in the packaging industry. And if a machine is down for too long, and prone to malfunction, this also fails to meet the series producer's requirements profile. Downtime causes additional costs which must be avoided as a matter of course.

Downtimes and energy consumption drastically reduced

Machine downtime is a problem that is impossible to cost for, and further impetus to sound out the injection moulding machine supplier market. "It very quickly became clear that ENGEL offered a complete package that precisely meets our technical requirements", as Philipp Schnell emphasises. And he is right, as the new e-motion 280 demonstrated shortly after commissioning. "Downtime virtually never happens with the new machine", Schnell states. Added

to this are the short setup times. "Once the mould setting data and machine parameters for a part have been stored on the CC300 machine control unit, they can be repeated time and time again", explains Stefan Witt, Sales Engineer at ENGEL Deutschland's Hanover subsidiary. "This guarantees a high degree of flexibility for our customer". "We just start up the machine and it runs", confirms Adrian Schnell, Managing Director of Ilse. "Of course this contributes to boosting productivity in our business."

The e-motion 280 is the first all-electric injection moulding machine on Ilse's production floor. The capital expenditure was accordingly linked to high expectations in terms of energy efficiency. "The issues of energy and sustainability are always in our focus, because we are also audited," says Adrian Schnell. Other electrical devices and the lighting have already been optimised at Ilse. The machinery is now following suit with the e-motion 280. "In the first year since commissioning, we have already been able to save 30 percent on energy," as Schnell reports. Compared to a hybrid machine on which the container lids were previously produced.

Here's to the next technological enhancement

The positive experience with the e-motion 280 and collaboration with ENGEL has led Ilse to set its sights on all-electric injection moulding machines now also for producing the containers. Again, the trend is towards thinner wall thicknesses for the containers. When stacked on a pallet, even the bottommost container needs to hold and reliably protect the product. This stability can only be achieved with a stable injection moulding process. "We are looking to translate the benefits we have in lid production to container production," says Adrian Schnell.

Together with the Application Engineering team and experts from the ENGEL Packaging business unit, injection tests have already been carried out on an all-electric machine. This was on a future development of the e-motion machine series, which will soon reach the market. ■

LSR technology for the future

The massage function in the car seat ensures relaxation on long car journeys. This comfort feature is made possible by air chambers in the backrest and seat pad, which are filled and vented via SMA valves in quick succession. The tiny inlet valves with integrated shaped silicone seals are produced by SEI WOO Hi-Tech Polymer in Holzhausen, Austria, on ENGEL injection moulding machines. Tricky development projects have propelled the silicone processor into the top league of micro injection moulding.



The air inlet valve is produced in a single injection moulding step from polyamide and liquid silicone rubber. The functional element is only 4 mm wide and 3 mm high.



ENGEL's experience and innovative strength in the field of liquid silicone rubber were the decisive factors that convinced SEI WOO Austria to choose ENGEL right from the outset.

The complex multi-component parts are just 4 millimetres wide and 3 millimetres high. The silicone seal, which accounts for a shot weight of 0.02 grams, is located at the top end of the thermoplastic valve housing. This contains a fine memory metal wire, which is crucial for how the process works. SMA stands for shape memory alloy. When powered, the wire heats up and then contracts, actuating the SMA valve. If the current flow is interrupted, the wire cools down in a fraction of a second and the valve closes. In this way, the air chambers' degree of filling, and as a result the massage pressure, is controlled. The two polymer materials are combined in a single step on an ENGEL e-victory 140 combi injection moulding machine. The polyamide (PA) housings are first injection moulded in a 16+16-cavity rotary plate mould. At the second indexing position, liquid silicone rubber (LSR) is immediately gated, while 16 further housing base bodies are produced at the same time. PA and LSR form a chemical compound. However, as the contact area is very small, the finished parts are additionally tempered at 200 °C after injection moulding for safety reasons in order to permanently bond the thermoplastic and silicone. The parts then pass through camera-based 100-percent quality control and are immediately routed to logistics for shipment to the customer, "who is the world market leader in the field of vehicle seat massage," as Peter Lehmann, managing director of SEI WOO Hi-Tech Polymer GmbH, reports. SEI WOO has delivered over 200 million of these components to date.

Reject rate reduced to zero

"Multi-component injection moulding reduces the risk of error, which would be massive during the assembly of the individual micro parts," says Lehmann emphasising that: "Zero defect philosophy is a cornerstone of our success." SEI WOO often collaborates closely with the customer as early as the product development and optimisation phase. The inlet valves for the seat massage function are the prime example of this. "The product was initially



Micro injection moulding
with LSR at the ENGEL
live e-xperience

made by another processor, but the reject rate was high," says Lehmann. "We redesigned the product, adapted the design and were able to reduce process-related rejects to zero." With its high level of development competence, strong customer orientation and a great deal of flexibility, SEI WOO has earned the trust of the major players in the LSR market.

The fact that SEI WOO was founded in Austria back in 2000 shows the early foresight of the Singapore-based SEI WOO Group, for the huge potential of liquid silicone.

Repeatable quality at a competitive unit cost

Due to its outstanding resistance and biocompatibility, as well as its efficient processing capability, LSR has notched up an increasing market share for many years. By specialising in microtechnology and multi-component applications, SEI WOO is leveraging the opportunities of another niche market. The smallest parts that SEI WOO has manufactured to date include sealing rings for smartphone charging cables with a product weight of a few thousandths of a gram. "We are working in an area where gravity has no effect with this product," says Lehmann. "Handling micro parts is a challenge."

It is above all new applications that are driving the trend towards ever smaller component dimensions, for example, in the fields of automotive electronics, mobile communications, loudspeaker technology and medicine. As the component dimensions shrink, the demands on the injection

moulding process continue to grow. "I can only extract what the injection moulding machine and the mould offer for our customers," as Lehmann clarifies. Stable production processes, and maximum repeatability and precision are the requirements that are optimally met by an ENGEL e-victory injection moulding machine in the case of the air inlet valves. This machine type, with its electric injection unit in combination with a servo-hydraulic, tie-bar-less clamping unit, combines very high precision with outstanding cost-effectiveness.

SEI WOO's ultra-modern production floors in Holzhausen house a total of 17 injection moulding machines, including six multi-component machines. They were all supplied by ENGEL in Schwertberg, which is just 50 kilometres down the road. And every machine is fully automated in its operation. "Without automation, we don't stand a chance in Europe," says Lehmann.



SEI WOO Hi-Tech Polymer produces a wide range of parts for the automotive, aviation, electronics and life sciences industries, and others.

Key factors: experience and ability to innovate

ENGEL's many years of experience with LSR and the high level of innovation in this field were the decisive factors in Peter Lehmann choosing ENGEL right from the outset. "I already gained experience with ENGEL with my former employer and am fully aware that ENGEL is one of the technology leaders. This gives us the competitive edge we need."

SEI WOO is one of the first users of the new LSR micro-injection unit that ENGEL has developed in partnership with ACH Solution. The mould-making company, which specialises in silicone and multi-component processes, is also based in Upper Austria and is SEI WOO's most important mould-making partner. The physical proximity of the three partner companies is no coincidence. Upper Austria is an important cluster region for the global silicone industry.



Business partners for more than 20 years: Peter Lehmann from SEI WOO (left) and Leopold Praher from ENGEL. ■



Due to their dimensions and material, the damping cylinder housings place high demands on the injection moulding process.

Temperature control, not just water flow control

The light grey tubes, which are inconspicuous at first sight, are really critical. They enclose a sensitive mechanical system which, in kitchen furnishings, ensures that drawers close quietly and gently, no matter how forcefully the drawer is pushed. Blum, headquartered in Höchst, Austria specialises in high-quality hinge, drawer and hatch systems for the furniture. In order to combine maximum precision with efficiency in injection moulding production, innovative technologies are introduced at a particularly early stage at the fittings manufacturer's production plants worldwide. For example iQ flow control, the smart temperature control solution by ENGEL, which is on its way to becoming the factory standard.

"We always want to be state-of-the-art," states Philipp Schlattinger, responsible for plastics technologies in Blum's manufacturing department. "This is the prerequisite for staying competitive on the furniture market battleground." Sophisticated damping cylinder housings and many other technical precision parts for furniture fitting systems are moulded on tie-bar-less ENGEL machines at the Fussbach plant in Vorarlberg, Austria. Blum was one of the first users of tie-bar-less technology 30 years ago and is also closely monitoring innovations from the Upper Austrian machine manufacturing partner when it comes to digitalisation of production processes. Two years ago, the company invested in its first production line with iQ flow control, including e-temp temperature control units, which were running in pilot production at the time. Due to the very high throughput in continuous operation, the damping cylinders made of POM offer the best possible test terrain. "We were virtually on a greenfield site," reports Martin Sailer, injection mould

design engineer at Blum. "Since the production cell is used exclusively for the cylinder mould, we were able to leverage temperature control with the best possible effect." For the high-cavity mould, the tie-bar-less e-victory 220 injection moulding machine is equipped with four e-flomo type electronic temperature control water manifolds and four temperature control devices from the ENGEL e-temp series. "A large number of temperature control circuits come together in total for the cavities and mould platens, which makes things

pretty complex," says Sailer. Initially, the project managers were sceptical as to whether the four temperature control devices recommended by ENGEL would actually be enough. Today, it is precisely these savings that have helped iQ flow control to make inroads into other products and become the company standard in a growing number of areas.

Maximum dimensional accuracy without rejects

"We know that we have very good moulds, but what was happening in the temperature-control channels was not transparent in the past," says Schlattinger, revealing the company's original motivation for getting involved with ENGEL temperature control



Temperature control on a small footprint. The number of cavities was increased, but the number of temperature control devices was reduced.

technology. "When problems occur, finding the cause is extremely difficult if you are looking at a black box."

More than ten years ago, ENGEL set out on its mission to shed light on the darkness of mould temperature control. "20 percent of all rejects in the injection moulding industry are caused by temperature control errors," says Klaus Tänzler, ENGEL's Product Manager Temperature Control, explaining the reason for this strategic decision. Today, ENGEL supplies integrated solutions for smart management of temperature control processes from a single source. The basis in each case is the e-flomo electronic temperature control water manifold system. Based on the measured values determined by e-flomo, iQ flow control dynamically and independently adjusts the temperature control process to keep process conditions constant. The software from ENGEL's inject 4.0 programme actively controls both the flow rates or the temperature differences in all individual circuits. Where e-temp temperature control devices are used, iQ flow control can also adjust the pump speed in the temperature control devices to reflect actual requirements. This interaction combines temperature stability with very high productivity and energy efficiency.

"In the classical temperature control process, the flow rate is static," as Tänzler explains. "If something changes in one temperature control channel, it triggers changes in the other channels, resulting in uneven water and temperature distribution. Our dynamic system, on the other hand, controls each manifold circuit individually. This means that the thermal conditions in the mould remain constant even if there are fluctuations in the system."

Strength is a critical factor in the production of damping cylinder housings. Due to their dimensions – very

long and thin-walled – the cylinders are on the list of particularly challenging injection moulded parts in the Blum portfolio. Additionally, there are material-specific challenges, because shrinkage is very high with POM. "Thanks to constant temperature control, we can now control shrinkage in a very good way," says Christian Ackerl, production engineer with Blum. The tolerances are in the hundredth of a millimetre range in some areas of the component, because dimensional accuracy is critical for the functionality and durability of Blum products. The Blum guarantee is valid for the kitchen's entire service life, which is calculated to be 20 years.

Switchover to temperature difference control

As a function of the component dimensions, the cooling channels in the long mould cores have very small diameters, which can become clogged by fine particles in the cooling water. "Only e-flomo provides us with the data to recognise whether there is consistent flow," says Sailer. This means that temperature

is why the process managers initially assumed that the scale-up would require an increase in the number of temperature control units. The opposite was the case. The number of cavities was increased, but the number of temperature control devices was reduced. This not only had a positive effect on the new investment, but the on-going operating costs also dropped.



"If we calculate this for all the injection moulding machines here at the location, iQ flow control can help us achieve electricity savings in the six-digit Euro range every year."

Philipp Schlatteringer, Blum

control issues can be detected before rejects are produced. "Anything else is a waste of energy, raw materials and time," as Patrik Johler from ENGEL Sales emphasises.

Even flow control convinced the project managers at Blum within a very short time. And the impact is even greater after switching over to temperature difference control. Instead of flow rates, the system keeps the return temperature of each individual circuit constant. The system only draws as much water as required for this purpose, which further reduces cooling water and energy consumption.

More cavities, fewer temperature control devices

Before investing in the new production cell, the damping cylinder housings were produced for a long time in a mould with fewer cavities. Eight temperature control devices were used for this purpose, which

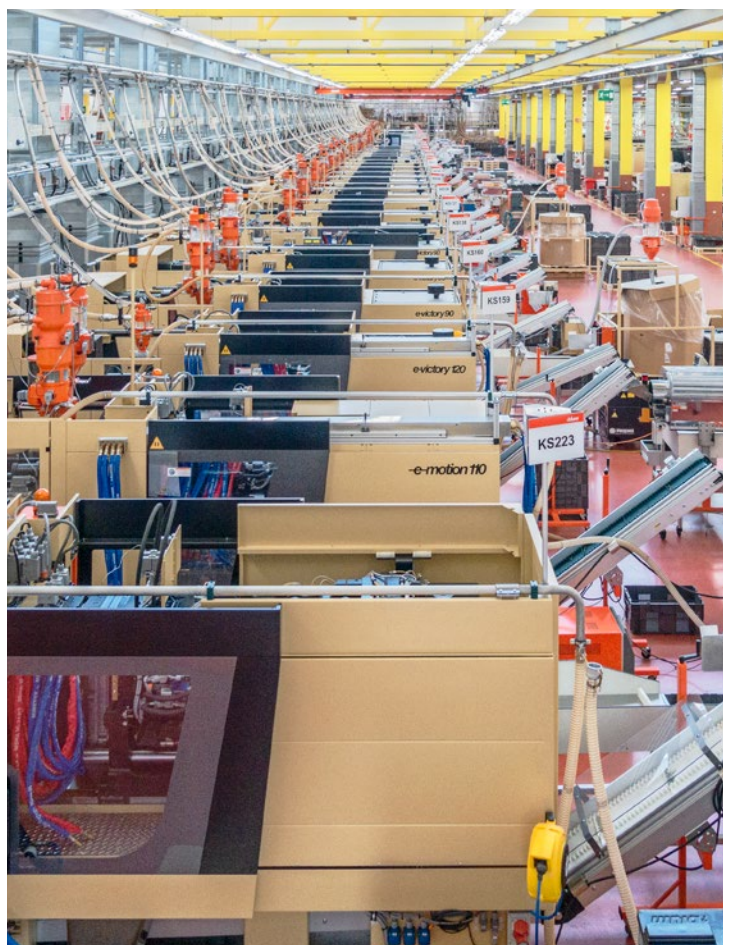
ENGEL temperature control devices are integrated via OPC UA with the CC300 control unit on the ENGEL injection moulding machine. This enables requirements-driven pump speed control. While conventional temperature control devices operate at full power throughout, iQ flow control correlates the pump output with the valve positions in the cooling circuits and adjusts the pump output over the entire duration of the process. Not water flow, but smart temperature control is key – not only to saving energy, but also to reducing maintenance costs. Wear and tear decreases rapidly if the pump is not continuously running at full load. "If we cost this for all the injection moulding machines here at the location, iQ flow control can help us achieve electricity savings in the six-digit Euro range every year," says Schlatteringer. ■

Joining forces to track down efficiency potentials: Blum's Martin Sailer, ENGEL's Patrik Johler and Klaus Tänzler, Blum's Christian Ackerl and Philipp Schlattinger (from left to right).



The e-victory 220 injection moulding machine is exclusively used for the production of damping cylinder housings.

Find out even more about iQ flow control:



Tie-bar-less e-victory and victory machines make up the lion's share at the Blum plant.



Showing our colours – closing material cycles

At ENGEL, we embrace responsibility, helping our customers achieve sustainable injection moulding production. At the heart of this are our inject 4.0 solutions for the smart factory, which also open up new opportunities for the Circular Economy. For instance, the iQ weight control software balances out process fluctuations when processing recycled material. Consistent high part quality increases the range of possible uses for the recycled material.

Technologically, we are also promoting increased use of recycled material. With the new ENGEL skinmelt process, we are enabling a high proportion of recycled material even in complex component geometries.

The bottom line: green is more than the colour of our machines. Check out our inject 4.0 smart solutions and contact us today.



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