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Conformal cooling in the injection mold

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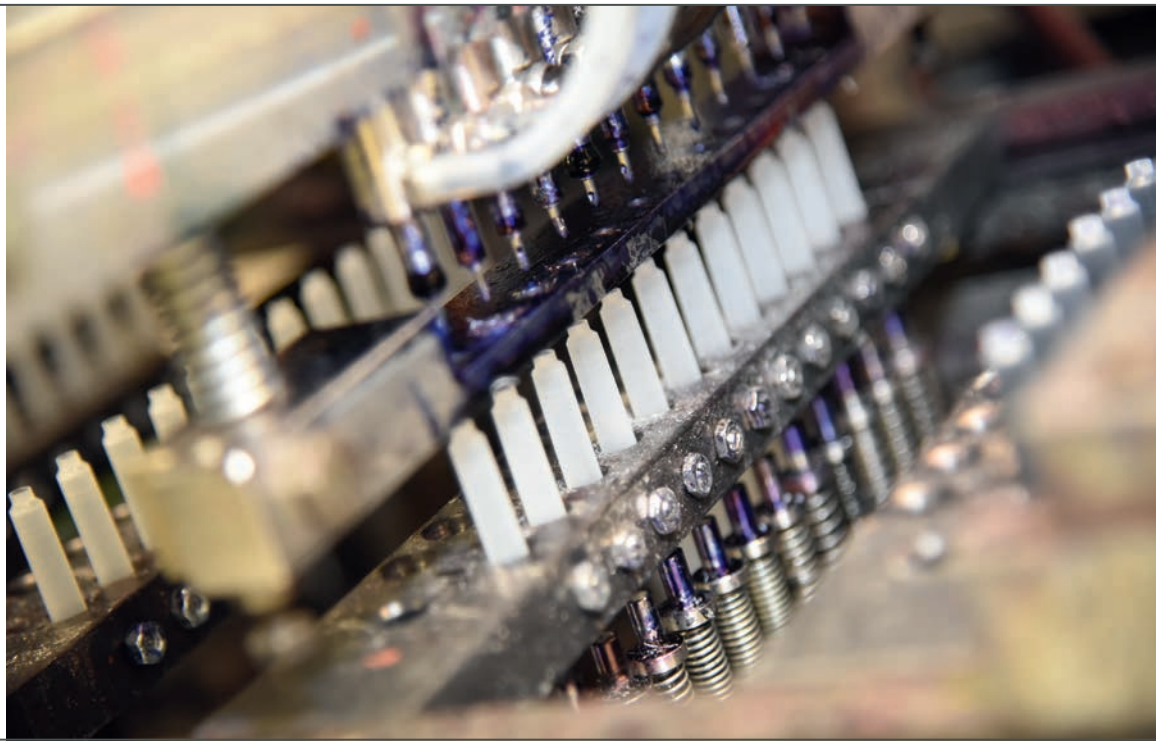


Tightly sealed: After leaving the injection-moulding machine, the ink cartridges are filled. (© iQtemp/Pelikan)

CONFORMAL COOLING IN THE INJECTION MOULD

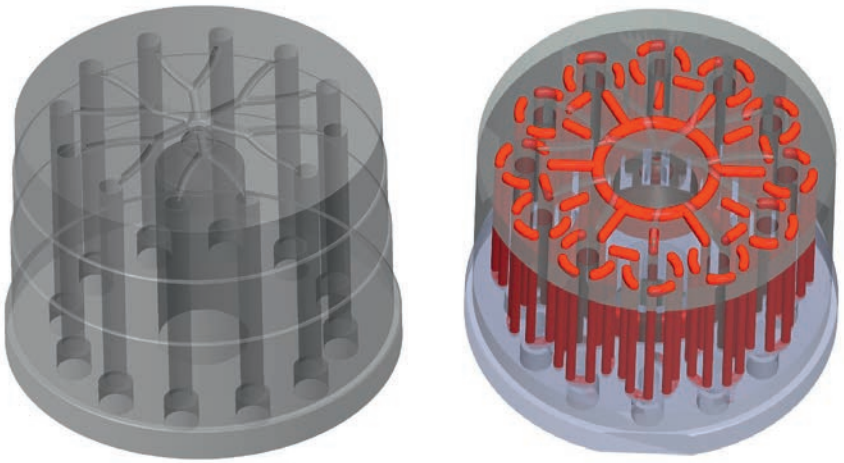
Don't blot your copy-book

Every year, millions of ink cartridges are used for Pelikan fountain pens. Complex technology goes into producing them. To reduce the unit cost, iQtemp has reengineered the mould inserts and, in particular, redesigned the cooling channel.

AUTHOR Volker Gogoll

Who wasn't fascinated by playing with the little pellets from ink cartridges at school? The numerous complex technologies that go into producing a pen of around 20 cubic centimetres are usually hidden from the user. Precision, functionality and quality are absolute essentials when it comes to producing a Pelikan fountain pen. The production of ink cartridges is a prime example of the complex technologies which creates new challenges every day for the Pelikan team in Peine-Vöhrum. The single-use product is manufactured by millions every year. An efficient and sustainable manufacturing technique is required here, in order to be able to optimise unit costs.

Manufacturing processes are regularly put through their paces at Pelikan. Is manufacturing up-to-date with current technology and can manufacturing processes be optimised? So, in the manufacture of large-capacity cartridges, optimisation approaches were sought in the injection moulding process for the ink body. "The objective was to reduce manufacturing costs", explains Helmut Broischer, Head of Engineering at Pe-



View of the mould cavity: the cavities on the left, the conformal cooling on the right. Cooling time could therefore be reduced from twelve seconds to five seconds. (© iQtemp)

likan. One large-capacity cartridge replaces exactly two small cartridges in the fountain pen.

Injection moulding, fill with ink, then the finale: the glass ball

There are many technologies in their manufacture. In addition to the injection moulding, there is an ultrasonic welding process integrated into the machine design for the ink filling. A glass ball is used to seal the cartridge. This must be manufactured with consistent roundness, within a narrow tolerance range. Once it has been placed in the shaft of the cartridge, a defined setting force must be generated between the ball and the shaft, so that the ink does not accidentally leak if the glass ball does not seal correctly. But it must also not sit too tightly, so that it allows the ink to flow freely when the cartridge is inserted into the fountain pen. Manufacturing problems, caused by changes in process parameters, inevitably lead to quality problems.

The old tool for large-capacity cartridges had a total of 96 cavities. Since 1986, 420 million cartridges have been produced on it. That translates into approximately 4.5 million closures. "That reflects both the quality of our tools and the challenge", comments Broischer about these production quantities. The design approach was defined in advance, so that the cycle time could be significantly reduced. They brought in iQtemp, the specialist for conformal cooling, as a partner for co-engineering alongside them. Contact with iQtemp came about from a recommendation.

Fine-tuning in the design department: Imre Törö (left) and Günther M. Rehm during the engineering phase. (© iQtemp)

Pelikan toolmaking: The traditional company trains its own toolmakers – with the guarantee of ongoing employment after their apprenticeship. (© Listemann/Pelikan)

Specification for new development: 4.5 million shots

"We conducted an analysis of the current state using the existing tool", explains Günther M. Rehm, Head of Sales & Marketing at iQtemp. "In order to meeting the specification, namely, to design a new tool with significantly improved temperature control subject to the target of a reduced number of cavities, we focused our attention on eliminating the residual heat in the product." The analysis highlighted this as a weak point in the old tool.

iQtemp obtained 3D data for the planned mould inserts from Imre Törö, the design engineer responsible for the project. "Ensuring that we took fluid mechanics and suitability for brazing into consideration, we first designed the very complex cooling channels. These close-to-cavity designed cooling channels were then verified using a CFD simulation", says Rehm, as he describes the process. CFD stands for Computational Fluid Dynamics.

After the customer had given its approval, iQtemp handed over the 3D data for the cooling, including the completely dimensioned and tolerated production drawings for the brazing blanks, to the customer. Using this design specification, Pelikan then manufactured the required semi-finished products in their own toolmaking shop. Once the brazing blanks were completed, they went from Peine and travelled south – their destination was Bendern in Liechtenstein.

For the perfect assembly: annealed and grinded before brazing

At iQtemp, work started with the technical implementation for manufacturing the tool inserts. "The blanks first had to be stress-relief annealed", explains Rehm. The brazing surfaces must be precisely machined and flat. They must therefore be grinded once again, within a defined tolerance range, before the actual vacuum-brazing process. The

parts are then metallurgically joined in the vacuum-brazing process with a customised braze alloy foil. "Brazing this insert was a real technical challenge", recalls the sales representative. This consisted mainly in the technically demanding task of ensuring a permanently tight seal on very narrow brazing surfaces. "In addition, we could not allow molten braze alloy to flow into the drilled holes."

Other important production stages are vacuum hardening and triple tempering of the complete tool insert. "Hardness testing and the helium leak test always form part of the finalisation of our manufacturing process, to check the insert for leaks", reveals Rehm. Pelikan's in-house project managers are delighted with the results. The new concept for efficient temperature control not only changed the conformal cooling, but the concept of gating, too. What was originally exclusively intended as a cold runner was replaced with a combination of cold and hot runners.

Cool-down in 5 seconds instead of 12, output increased by 15%

Creation of a new tool with the number of cavities reduced from 96 to 48. Simultaneously, output has risen from 15,120 pieces per hour to 17,510 per hour. The new concept enabled the gating weight to be reduced from 45 grams to just seven grams. In addition, the cooling time could be reduced from twelve to five seconds, so to less than half. The total shot weight is now 40.8 grams, compared with 81.6 grams in the old tool.

Pelikan has a generously equipped toolmaking shop. It is used for the repair and maintenance of existing tools and for new tool manufacturing. In particular, a high priority is given to the professional training of skilled workers. "Young people who receive an apprenticeship contract with us also obtain a guarantee of ongoing employment at the end of their apprenticeship", explains Harald Schmidt, the plant manager. The requirement for high quality also applies for the tools: "For us, they have to have a long service life." ◆

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