Disposable Syringes Manufactured to Dimensional Accuracy Standards

HPS III-MH linear hot-runner nozzle with moldings (figs.: Ewikon)

Hot-Runner Technology. Drilling is a thing of the past. As a result of a new method for treating caries dentists spray the medicament directly onto the tooth. The bodies of the syringes made from the demanding material Topas are manufactured in a 16-cavity injection mold. In doing so a hot-runner solution for direct side gating involving heat conductive tips angled at 60° eliminates core displacement, increases the dimensional accuracy of the parts and speeds up color changes.

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In the form of the dental product "Icon" DMG – Chemisch-Pharmazeutische Fabrik GmbH, together with scientists of the Charité Berlin and the University Clinic Kiel, has developed a novel microinvasive method which completely does away with the need for drilling. The treatment – involving the application of various active agents by means of disposable syringes to the affected tooth – ensues in three steps. Accordingly, a packaging unit consists of three syringes provided with differently designed applicators **(Fig. 1)**. In the first step of the treatment an acid gel is employed to gain access to the porous region of the caries. The second syringe contains an alcoholic solution for drying. The infiltrate, a liquid dental plastic, applied in the final step penetrates deep into the caries and after a period of action is cured by light. In order to prevent premature reaction the liquid in the pack must be protected against exposure to light.

Fig. 1. The syringes in the finished Icon set are equipped with various applicator fittings which are secured by means of a Luer lock thread (photo: DMG)

A Transparent and a Light-impermeable Version

Accordingly, the syringe barrels having a volume of 1.14 cm^3 and a length of 5 8mm →

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are manufactured from Topas in a highly transparent and a light-impermeable black version **(Fig. 2)**. Apart from its resistance to acid this cycloolefin copolymer (manufacturer: Topas Advanced Polymers GmbH, Frankfurt, Germany) is characterized by high transparency, sterilizability, high thermal resistance and biocompatibility. The injection cone is constructed in the form of an adapting cone to which a separately manufactured Luer lock thread is attached. This secures the applicator end fittings. Since Topas cannot be demolded by force a split mechanism is needed in the mold so that the undercut of the adapting cone can be demolded.

The company Hans Rethwisch GmbH, Hamburg, Germany, is responsible for the design and construction of the mold and for the manufacture of the syringes. As a specialist in the manufacture of moldings for medical technology and as a long-standing associate of DMG, Rethwisch is extremely well acquainted with the high demands that this type of application imposes. "Our customer, DMG, has introduced with Icon an innovative handling principle to the market and places great value on a matching overall concept extending through immaculate quality and functionality of the plastic moldings employed", declares Jens Heinze **(Fig. 3)**, Director of Mold Making at Rethwisch. "This requires not only high dimensional precision, but critical color changes also have to be carried out during production. It was clear to us from the outset that the project should be implemented using hot runners and we wanted to collaborate with a competent partner having a suitable reputation in the market."

Fig. 3. From mold design to first samples. Jens Heinze, Director of Mold Making at Rethwisch (right), and Ewikon's Regional Manager Hans-Jürgen Hartmann (left) worked closely together in the course of the project

Side Gating in Linear Arrangement

Heinze's ideal solution was a hot-runner solution for side gating in linear arrangement because the necessary split mechanism can be integrated more easily and at lower cost when the moldings can be arranged in a row. "Linear nozzles machines of appropriate productive power, however, are more of an exception on the market" in the opinion of Jens Heinze. Rethwisch struck gold at the Hotrunner Forum 2009 held by Ewikon Heißkanalsysteme GmbH und Co. KG, Frankenberg, Germany. By means of the HPS III-MH nozzle it is possible to have direct gating with a heat conductive tip without a cold slug. In doing this the mold insert need not be divided.

Ewikon's solution for side gating, for which a patent application has been filed, makes it possible to put the tip inserts in place simply from the parting surface after installation of the nozzle body **(Fig. 4)**. In doing so the tip insert is introduced laterally into the geometry of the mold insert and put into place in the nozzle body by a tilting movement. A clamping disc presses the readily fitted insert against the nozzle whereby the necessary sealing force between the tip insert and nozzle body is generated by an oblique surface in the nozzle body/tip insert and is defined by the tightening torque of the screws. Leak-proofing in the junction between the tip insert and mold insert is ensured by the thermal expansion of the nozzle body and tip insert.

Fig. 2. The syringe barrels made from Topas are manufactured in two versions: highly transparent and light-impermeable black

By this method even angled tips can be fitted without problem into the corresponding undercut geometries of the mold insert. In the case of Rethwisch heat conductive tips angled at 60° are used. In the mold **(Fig. 5)** four linear nozzles are positioned in series. Each of them has four tips so that the 16 articles are arranged in two rows in the cavities with a row spacing of 67 mm and a unit cavity spacing of 48 mm.

Minimum Core Displacement with Angled Tips

"As a result of the angled tips we can position the gating point 3 mm closer to the

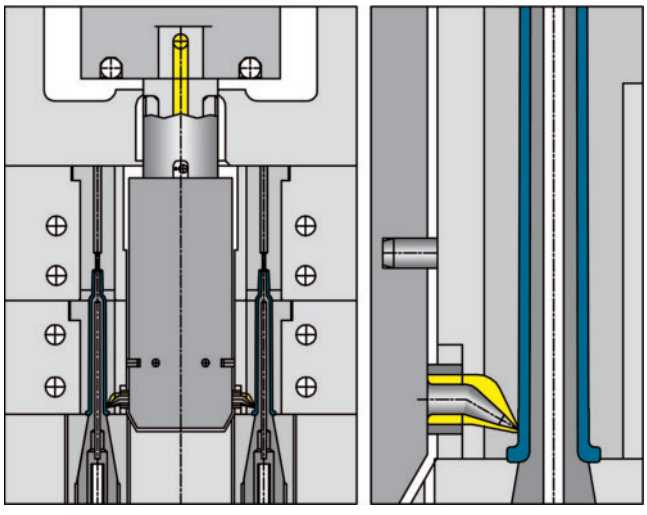

Fig. 4. Section through the structure of the mold. Despite the undercut geometry of the mold insert the tip insert angled at 60° can be installed easily from the parting surface. Since sealing ensues directly on the mold insert only a small volume of melt need be exchanged on change of color

core support and minimize core displacement. In this way we fulfill one of the key requirements in DMG's specification of requirements" explains Jens Heinze, "for in order to obtain friction-free sliding of the injection piston and hence easy and precise metering the injection element must be manufactured with high dimensional uniformity. A decisive feature here is a uniform wall thickness. This is not the case when there is marked core displacement."

The 60° solution proposed by Ewikon results in a more favorable flow front profile. As tests show, the specific tip and channel geometry in the tip insert gives rise to a flow situation which initiates a uniformly rising melt front around the inner core of the cavity. At the same time slight running ahead of the wall located opposite the gating point is generally observable which stabilizes the core during the injection operation **(Fig. 6)**.

In comparison with conventional side connections, in which core displacement for this size of part in the least favorable case is of the order of a tenth of a millimeter, core displacement at a value of just 0.02 mm could be very nearly eliminated using the angled tip variant.

Easy Maintenance and Rapid Color Change

The structure of the mold measuring 296 × 446 × 443 mm is kept very compact **(Fig. 5)** and is characterized by ease of maintenance. Once the actuating plate for the split mechanism has been pulled to the ejector side both the cooled individual mold inserts for each of the 16 cavities and the hot-runner nozzles are accessible for servicing purposes. In this way a change of tips can be carried out with minimum downtimes directly on the open mold on the machine without the need for dismantling the mold. For this purpose the engineer, just as in the assembly operation, only has to remove the clamping disc of the nozzle. In the event of a fault it is possible with little effort to shut down a cavity by inserting a tip insert without a melt bore so that production can be maintained in the short term.

Fig. 6. Gating with a 60° tip allows the melt flow front to rise uniformly around the inner core. The easy running ahead of the wall with respect to the gating point stabilizes the core

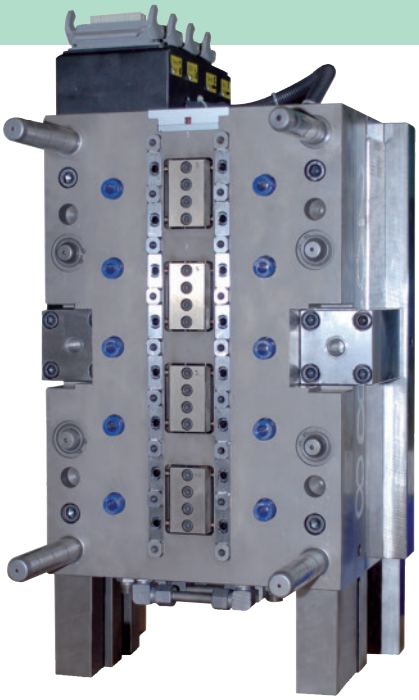

Fig. 5. In the compact injection mold both the linearly arranged hot-runner nozzles and the cooled individual mold inserts are readily accessible from the parting surface for maintenance purposes

When changing color other advantages of the HPS III-MH nozzle design become apparent. The flow channels in the nozzle are constructed for balance and optimization of flow. Dead spots in which melt residues might be left behind are not present. In combination with the fully balanced manifold technology employed as standard by Ewikon, which are likewise equipped with flow-optimized direction elements, there is a flow channel layout designed throughout for rapid color change. Since sealing of the melt in the tip region ensues via a sealing joint directly on the mold insert no melt sump is produced around the nozzle member and the melt volume to be exchanged is generally small **(Fig. 4)**. The result is a color change from black to transparent which is completed within 50 shots.

In the course of the project Rethwisch and Ewikon worked closely together. In doing so intensive personal contacts were just as self-evident as the rapid exchange of all the necessary 3-D CAD design data. Furthermore, Ewikon was able to provide a test mold with a HPS III-MH nozzle. By this means it was already possible in advance to undertake materials matching with Topas, to test settings and to appraise the quality of the gating point. The initial testing of the finished mold proceeded correspondingly without trouble. "In the first shot we immediately had 16 good parts" sums up Jens Heinze. "That's a gratifying conclusion to this rapidly implemented project. The hot-runner solution, specifically with the molding quality achieved, its ease of maintenance and good color change characteristics, has met all expectations in full."

In time for the global market launch of Icon at the end of 2009 production at Rethwisch started on a machine having a locking force of 650 kN. Since then the mold has been producing without malfunction. ■

Company Profile

Kunststofftechnik Hans Rethwisch GmbH with headquarters in Hamburg, Germany, has been manufacturing high-grade plastic injection molded parts for 40 years and in addition to its own development and design department has its own highly capable mold making unit. The key capabilities of the company certified by DIN EN ISO 9001 lie in the development and manufacture of demanding thermoplastic moldings for medical technology and aviation and marine lighting technology. The machine inventory includes 25 fully automated injection molding machines having locking forces of 250 to 6,500 kN. For the further processing of moldings equipment for ultrasonic welding, hot embossing, adhesive bonding and printing are available.
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