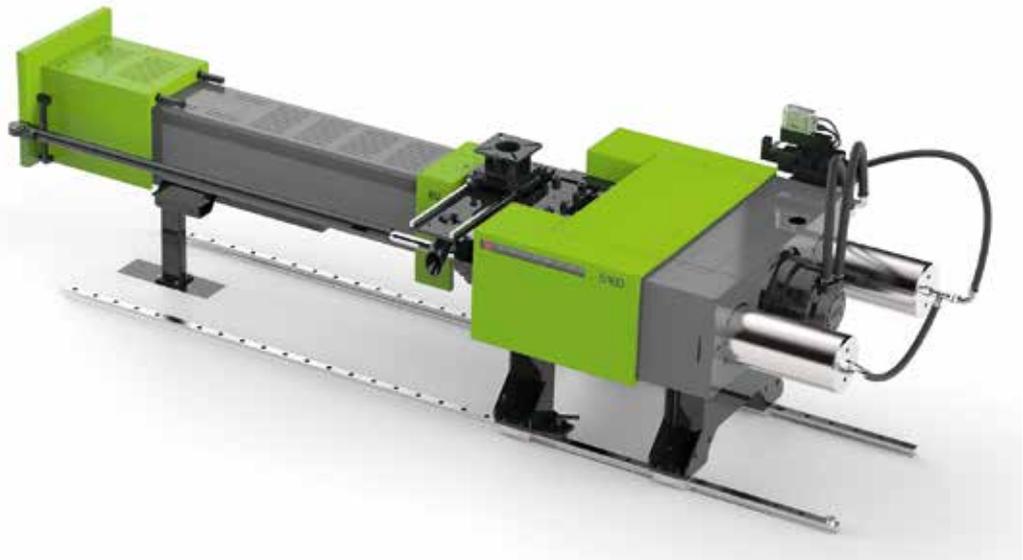


Integrated Optimization of Hydraulic Injection Units

The New Machine Generation Achieves Significant Benefits in Efficiency, Precision and Performance

With their new injection units, the Victory and Duo series of hydraulic injection molding machines from Engel Austria achieve even greater precision, performance and efficiency. Only with a development based on a new system model approach can the integrated mechatronic optimization of all components be assured.

Performance, precision and efficiency, modularity and ergonomics: With the development of the new hydraulic injection units, Engel often reconciles contradictory attributes © Engel



The injection units, together with the clamping unit, form the heart of an injection molding machine. These two core elements are responsible for the high performance of the machine and are crucial for its efficiency. The injection units presented at K2016 by Engel Austria GmbH, Schwertberg, Austria (**Title figure**), are the result of several years of development in cooperation with Johannes Kepler University in Linz, Austria. Instead of optimizing individual components in isolation, the development team decided on an integrated approach using a mechatronic system model. They also concentrated on improving the ergonomics and meeting specific customer desires.

The system model approach enables for the first time an overall mechatronic

optimization. That means that the components of the injection units were not each considered individually but in the context of the entire system from the start. As a result, all the subsystems are matched to one another in such a way that demands that are contradictory at first sight can be reconciled. Five topics equally attracted the attention of the product developers: efficiency, performance, precision, modularity and ergonomics.

The temperature and pressure control in the barrel has a considerable influence on both the precision of the injection process and the process stability, efficiency and performance. To take this influence into account during the development process, detailed thermal finite ele-

ment simulations were performed. This allows the different measures that are conceivable for increasing the control precision to be tested without constructing a prototype.

For this purpose, not only the mechanical components were optimized but the heating zones were also adapted to the screw zones and the temperature sensors repositioned. The heat convection is thereby more precisely modeled in the control system, which increases the process stability and control precision. This high process capability is only made possible by integrated development, which, already in the simulation, takes into consideration the requirements of classical mechanical engineering and process engineering, as well as con- »

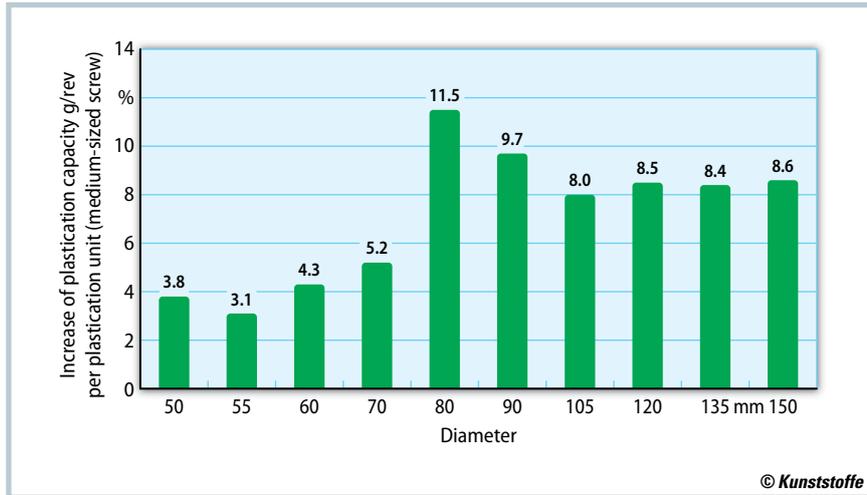


Fig. 1. The new injection units achieve up to 11.5% higher plastication performance (source: Engel)

control technology, and correlates them with one another. Particularly when temperature-critical materials are used, the optimized temperature control has a beneficial effect on the efficiency.

Precise Control over a Wider Process Window

To allow an even wider material spectrum to be reliably processed, the temperature control range was increased in the feed zone. Even with the given screw geometry, this extra flexibility increases the plastication performance. With today's Engel standard screws, performance increases of between 3.1 and 11.5% are possible, depending on the screw diameter (**Fig. 1**). Larger performance boost can be achieved by using new screws of the type UAS (universal automotive screw), MBS (mixing barrier screw) and SPC (special purpose screw) (**Fig. 2**). Engel developed these screws, which were also presented



Fig. 2. The new screws obtain even greater performance boosts. The UAS (Universal Automotive Screw) increases the performance for processing a wide spectrum of materials, from PP, through glass-fiber-reinforced PA to shear-sensitive PC+ABS (© Engel)

at K, in parallel with the new injection units and can now exploit the full performance potential.

Thanks to the optimized temperature control and the new cooling concept in the feed zone, a higher plastication performance is also obtained by using low viscose materials, which have a lower torque requirement. The new performance control system allows a higher screw speed, and thereby a larger process window, with a reduced torque (**Fig. 3**).

A further increase of the energy efficiency is gained by strictly separating the heating and cooling zones, which is achieved by means of a thermal barrier in the smaller units (up to size 2460) and by a cooling ring in the case of the larger units (3660 and higher) (**Fig. 4**).

Servohydraulics Now Standard

With the new development of the injection units, Engel has adopted the ecodrive servohydraulics in the standard scope of its Victory and Duo series, and thereby achieved a high energy efficiency across all applications. Since this decision was made at a very early development phase, all the components of the injection units could be radically optimized for the servohydraulics. For example, the new machines have a considerably smaller oil volume – a factor which contributes considerably to the operating cost optimization and to environmental protection. Finally, Engel has already equipped 90% of its hydraulic injection machines in the small and medium-sized machine segment and 80% in the large machine segment with ecodrive. The customers wanted to adopt the servohydraulics as a standard features.

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Fig. 3. The new performance control system extends the process window. Low viscose materials, too, can now be processed with high plastication performance (source: Engel)

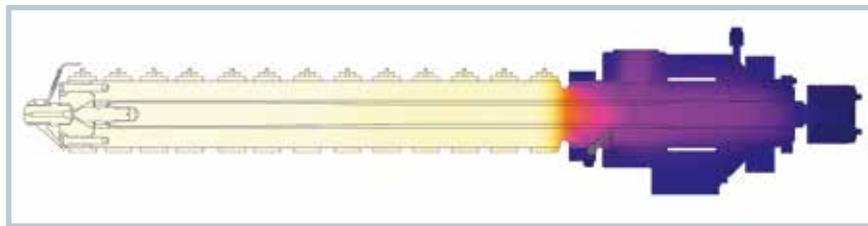
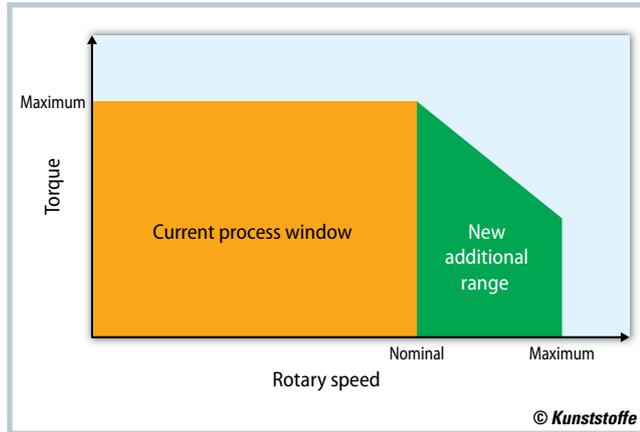


Fig. 4. To minimize energy losses, injection units up to size 2460 have their heating and cooling zones thermally separated from one another in the feed zone of the barrel by means of a separating channel. With larger models, an optimized cooling ring is used (© Engel)

An additional contribution to process stability and precision can be made by iQ weight control. The solution from Engel's "inject 4.0" program is already very well established on the market in the field of electrical machines. Now, Engel also offers this software as an option for hydraulic injection molding machines. It continuously analyzes the melt volume, recognizes deviations and corrects them automatically in the same shot. In this manner, fluctuations in ambient conditions and in the raw material can be compensated for while the process is running, and rejects actively avoided.

Rapid Clamping for Barrels

Based on its many years of experience with applications in a wide variety of industries, Engel has restructured the sizes of its injection units. The injection molding machines can now be even more accurately adapted to the individual demands of the particular applications. Overall, the Victory and Duo machines cover a very wide spectrum of applications. The Victory series covers clamping forces from 280 to 5000 kN, and the applications spectrum is further expanded by the tiebarless design of the clamping unit. The two-platen machines of the

Duo series are available with clamping forces from 3500 to 55,000 kN (Fig. 5).

The variety of models generally goes hand in hand with greater complexity. To counteract this, Engel is rigorously pursuing a modular design with optimized interfaces for the barrel heating and a plug-and-play concept for the plastication unit. The modular design makes barrel exchange faster, and makes it easier to combine different injection units in one machine. To make set-up and operation more convenient, Engel systematically gathered and analyzed customer demands at the start of the project.

One result of this practically oriented development work is that the barrel can also be shut down outside the machine without additional equipment. For this purpose, the plasticizing units through-

out the series are equipped with stable pedestals. Installation and removal of the barrels does not require special tools, and thereby speeds up the process and reduces downtimes. A particular significant boost in efficiency is achieved for the large units, which can be interchanged simply by releasing and tightening a few screws. In this manner, with the new design, Engel has applied the principle of rapid tool clamping to the plasticizing unit.

Some other design features of the hydraulic injection molding machines make life easier for machine operators and maintenance staff. The new arrangement of switch cabinets and pumps for the larger injection molding machines (Duo), for example, thus improves the clarity and accessibility. With some machine models, the footprint is even reduced. The pump space features new two-part covers with integrated handles. Moreover, their weight was significantly reduced to allow them to be very quickly opened, thereby saving time for maintenance of the pumps.

Summary

For over three years, the Engel developers, together with the Johannes Kepler University, have analyzed where there are mechanical optimization potentials, and how users' concrete desires can be taken into account. The new injection units that Engel presented at K2016 are the result of this systematic, integrated development.

In a first step, the Victory machines, from injection unit 860 (screw diameter from 45 mm) and the Duo machines up to size 23060 (screw diameter up to 170 mm) can be ordered in the new design. The first machines were delivered shortly after the K show in November 2016. The positive customer feedback will now speed up market launch. ■



Fig. 5. The new injection units enable the hydraulic injection molding machines Victory and Duo (shown in the picture) to be selectively adapted to the users' individual requirements (© Engel)