Components such as high-torque direct drives and a novel cooling and filtering system are delivering increased moulding efficiency. Thomas Brettnich of Sumitomo Demag explains how

Pushing up production efficiency

When it comes to volume production, the issue of efficiency plays a central role. Efficient injection moulding machines require an energy efficient design. However, efficiency is not only dependent on the energy consumption of the machines. Efficient operation concerns the productivity of the system as a whole and aspects such as machine availability, speed, precision and reproducibility must also be taken into consideration. Some of the latest technologies that can help increase efficiency are described here.

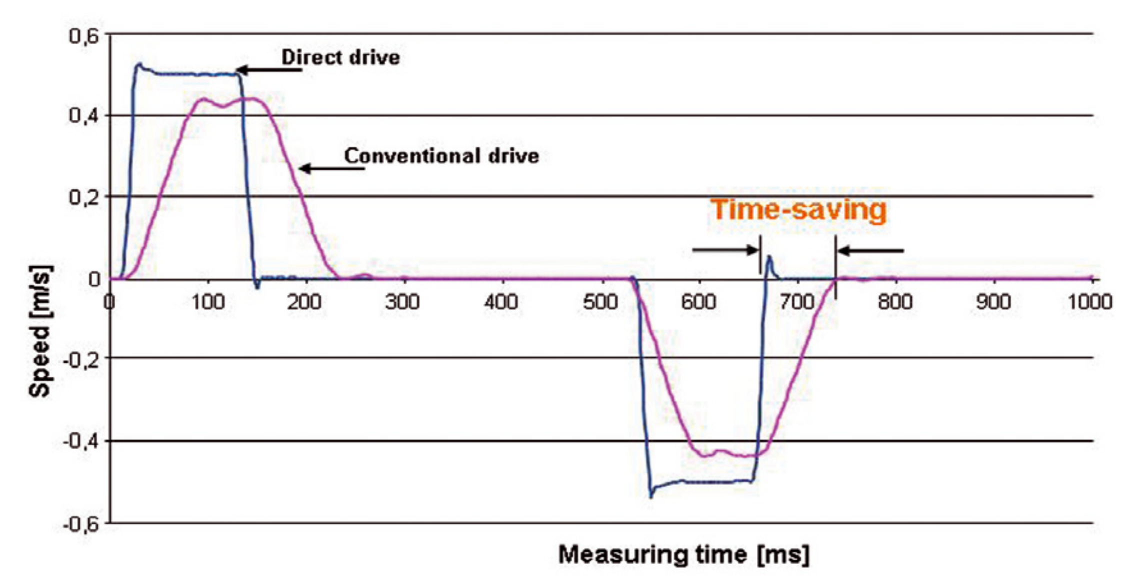
High-torque direct drives

Distributed electric drives, which are used in all-electric or hybrid injection moulding machines, are usually synchronous servo motors. There are distinct differences among these types of motor that affect the energy consumption or productivity of injection moulding machines.

In contrast to conventional synchronous servo motors, high-torque direct drives provide high torque even at lower speeds. They do not use transmission systems that reduce efficiency, and therefore they do not have a negative effect on the energy consumption, drive dynamics, precision and reproducibility of the machines. Their minimal inertia, in combination with direct power transmission, provide high levels of dynamics (short and steep acceleration and breaking ramps) and zero backlash. The absence of transmission means that the drive requires virtually no maintenance and is highly reliable.

The benefits of high-torque direct drives in terms of energy efficiency becomes obvious when the dosing drive is considered. Usually, the dosing drive is the

CYCLE TIME SAVING: A COMPARISON OF THE DYNAMICS OF DIRECT EJECTOR AND BELT DRIVE



component in the injection moulding machine that consumes the most energy. Increasing the efficiency of this axis will have a significant effect on the efficiency of the overall machine. If high-torque direct drives are used here, no reduction or increase of the speed or torque via belt drives or planetary gearing will be required and, as opposed to standard synchronous servo motors, there will be no energy loss caused by these components. Thus, the efficiency of the dosing drive in the injection moulding machine will be as high as 90%.

The benefit derived from the optimised drive is even more obvious when hydraulic dosing drives are considered. Hydraulically driven dosing axes usually comprise a number of components. A motor drives a pump that delivers oil through hose lines. The oil is then fed to the hydraulic motor via a valve for the hydraulic motor to generate the required rotational movement. Every component in a standard drive loses efficiency and when these losses are multiplied together, their overall efficiency when used in injection moulding machines is rarely higher than 50%.

High-torque direct drives also have advantages when employed in other axes such as injection or mould movement or the ejector, which require linear movements. Here again, no reduction or increase in speed or torque is needed because the required performance will be provided directly by the drive. There is no need for belt drives, planetary gearings or other mechanical transmission systems, which will have a negative effect on the inertia of the drive. The dynamics, rigidity and reproducibility of the axes will also be enhanced, which, in turn, will bring about a reduction in the cycle time, and will, therefore, increase the efficiency of the machine.

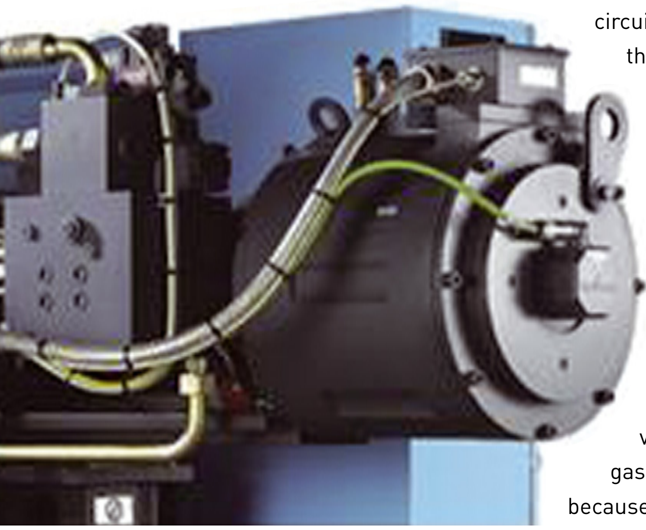
Use of toggle systems

The toggle system is a good example of a technology that contributes to reducing energy consumption and increasing productivity, and it has a positive effect on input and output. The optimal force–speed characteristic will facilitate fast movements. Moreover, dynamic locking and unlocking will reduce the dry cycling times of the injection moulding machine. Mechanical locking applies a constant clamping force, without any further input of energy. Because locking is purely mechanical and because there is no hydraulic cylinder in the force path, a toggle clamping unit will be extremely robust.

Toggle system technology is currently experiencing a revival through its use in all-electric injection moulding machines. But, when used on all-hydraulic clamping units, the toggle system helps boost efficiency and provides high levels of reliability and low maintenance costs.

Cooling and filtration technology

As well as reduced energy consumption, an increase in productivity is the second result of enhanced machine efficiency. When developing new products, the goals are to avoid downtimes and reduce reject rates. A novel cooling and filter concept for the hydraulic oil of injection moulding machines is geared towards those objectives. With this system, available from Sumitomo (SHI) Demag under the name of activeCool&Clean, as well as the pressure circuit of the machine, there is another hydraulic circuit that is operated by a small, energy-efficient rotary vane pump in the low-pressure circuit, which is designed to exclusively supply the oil filter and oil cooler. This additional hydraulic circuit operates independently from the other main pressure



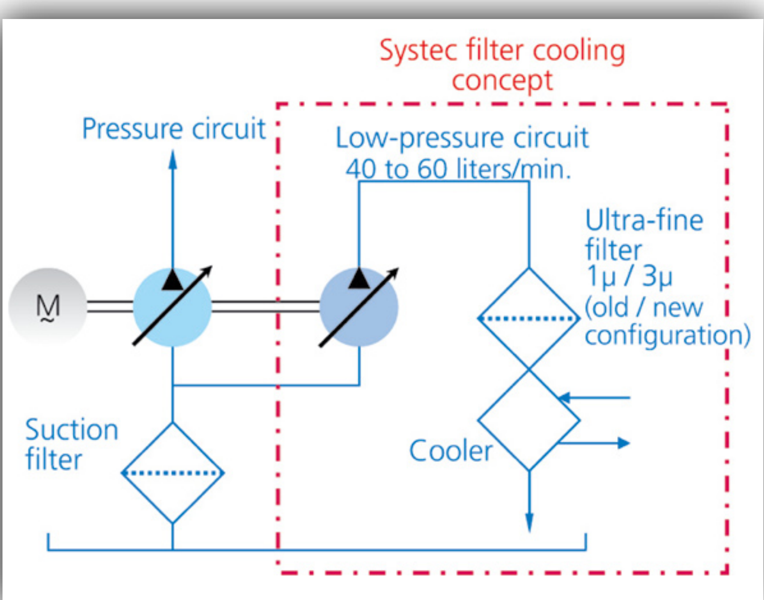
circuits, which facilitates the use of a micro oil filter. A laminar oil flow without pulsation, even during the pause times inherent in the cycle, increases oil service life by 40,000 hours. In addition, the service life of the pumps, valves, cylinders and gaskets will increase because of the clean oil. This will help reduce downtime for maintenance or routine servicing and increase production hours per year. Continuous cooling with optimal heat transfer facilitates higher oil cooler flow temperatures, which means there is no need for complex cooling systems.

Electric direct drive for dosing

Linear guidance to reduce mould wear

To increase system availability in the production of injection moulded parts, it is vital to take care of the mould itself by reducing wear and tear. Appropriate ways to do this include linear guidance systems to ensure perfect platen alignment and reduce machine frame deflection. Correct design of the overall machine will facilitate platen parallelisms that are above the recommendations of Euromap so that wear on the mould is reduced. Moreover, reduced frictional resistance in the guides will lead to fewer losses and thus an increase in energy efficiency.

The active Cool+Clean concept is used on the Systec machine series



Mould protection

A system to protect injection moulds, called ActiveQ, developed by Sumitomo (SHI) Demag, records the force path on mould closing. A control curve can be applied to this saved master curve at a freely adjustable axial distance. If the force path as currently measured intersects the control curve during the closing movement, for example, because a part is caught in the parting line, the machine will stop the closing movement. Compared with conventional mould protection systems, this system is reliable even at maximum mould closing speeds, thus the shortest mould movement times will be achieved. The system not only provides positive protection for the injection moulds, but also reduces cycle time, with the result that efficiency of production increases.

Switchable non-return valves

In the past few years, considerable progress has been made with all-electric injection moulding machines in terms of precision and reproducibility. However, with highly precise parts, a weak point has been the non-return valve; the systems used still do not lend themselves to active selection or activation. With conventional non-return valves, ring or ball-type, the closing behaviour is dependent on various process parameters such as back pressure, decompression, homogeneity of the melt or injection movement. It is only the melt pressure generated by injection that will push the sliding ring or ball of the valve backwards to provide sealing. Up to that point, a part of the plasticized melt will flow back through the non-return valve. The closing behaviour of the non-return valve and thus the amount of material flowing back will vary with process or material fluctuations. This will cause fluctuations in the remaining cushion or shot weight, which, in turn, may result in quality fluctuations of the injection moulded part or even cause a reject.

This is where the switchable non-return valve design is useful. The active closing of the non-return valve at the end of the dosing cycle will provide enhanced process consistency. Closing the non-return valve at the end of dosing by reversing the direction of screw rotation will guarantee constant and actively controlled closing behaviour. Process consistency will be increased, the fluctuations in the remaining cushion and the shot weight will be reduced, and the risk of rejects will be minimised. This new technology can be used on all-electric machines for applications that demand the highest level of precision.

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