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Sumitomo (SHI) Demag

Switchable non-return valve "activeLock" for maximum precision and reproducibility

Efficiency is the basis of competitive production. In addition to energy efficiency, machine/production cell availability and minimization of rejects are also important aspects of this.

With our switchable non-return valve "activeLock", we are providing our customers with a powerful tool for improving the precision and reproducibility of their processes and, thus, for minimizing rejects and increasing efficiency. In modern, high-precision applications the closing behaviour of the non-return valve is frequently the cause of variations in the melt cushion, the shot weight and, therefore, the quality of the products. Especially in the case of parts with high requirements, e.g. of dimensional stability, weight consistency and other quality features, the process windows are often so small that even minimum deviations of the shot weight can result in rejects. Modern all-electric machines operate easily within such small process windows. However, more and more often it is the non-return valve which is the weak point.

Limitations of conventional systems

Conventional non-return valves, whether they are ring or ball-type check valves, work according to the same principle:

During plasticizing the non-return element is in its forward position, thus releasing one or more melt channels. The melted plastic is moved forwards by the rotation of the screw and can flow through the melt channels in front of the non-return valve into the area in front of the screw. Usually

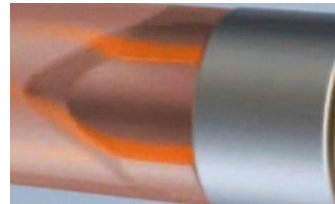
at the end of the dosing process a screw suck back is executed, in order to reduce the pressure of the melt in the area in front of the screw (decompression).

Standard non-return valve

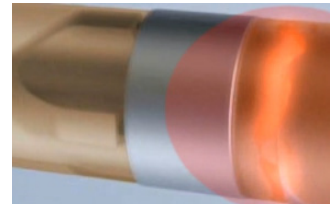
In the case of conventional systems, the decompression also helps to improve the closing behaviour of the non-return valve and is therefore generally necessary to achieve good process consistency.

At the beginning of the injection phase the ring or ball-type check valves are open.

As a result of injection, pressure builds up in the area in front of the screw, which pushes the non-return element (ring or ball(s)) backwards. The non-return valve is closed when the non-return element reaches the rear end stop. Until then melt flows back through the open non-return valve during the injection process.



Plasticizing process



Injection process

As long as the processes described above are uniform, it is easily possible to achieve good reproducibility with conventional systems as well. However, there are numerous factors which can affect the closing behaviour of the non-return valve. These include, for example, fluctuating melt viscosities due to batch or temperature fluctuations of the material. Fluctuations in the mould or hot runner temperature can also lead to a different composition of the counter pressure and thus lead to varying closing behaviour.

All in all, the disadvantage of conventional systems is that the closing of the non-return valve is a **passive process**, which cannot be influenced directly. The closing can only be influenced indirectly, for example by selecting the decompression and injection speed. Variations in the closing behaviour of the non-return valve always have a direct effect on the shot weight and, therefore, the quality of the parts.

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Principle of the new activeLock

During plasticizing, the non-return valve is open due to the rotation of the screw. The melt channels are open and the material flows through the non-return valve into the area in front of the screw.



activeLock

At the end of the dosing process, decompression can optionally take place with the non-return valve closed.

Following dosing, the non-return valve is closed by rotating the screw in the opposite direction. This process can also (additionally) take place (again) shortly before injection. The

melt channels of the non-return valve are completely and reliably closed by the backward rotation.

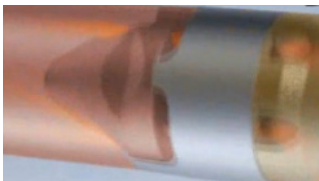
The non-return valve is completely closed during the entire injection process. The closing behaviour is therefore a process, which can be **actively influenced** and which takes place in isolation from other process steps.



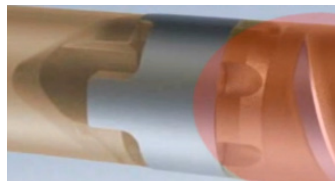
Non-return valve open



Non-return valve closed



Plasticizing process



Injection process

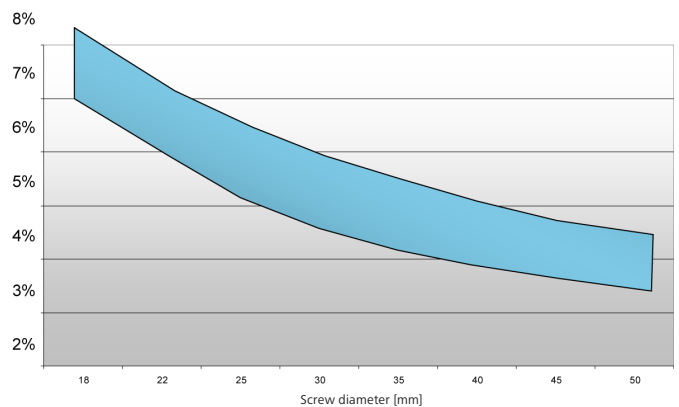
Possible applications for the new activeLock

At the time of its market launch, activeLock is available for screw diameters from 14 mm up to 35 mm. It can be used on all IntElect smart machines. The typical areas of application are applications which make the highest possible demands on precision and process consistency.

These are in many cases applications in the electronics and medical sectors. One of the particular strengths of this technology is the fact that it can also be used for applications involving production utilizing very small strokes as well as applications which do not allow any screw suck back after dosing.

Due to high precision requirements, such applications usually utilize moulds which only have a few cavities. This is also one of the main reasons for limiting the activeLock to screw diameters ranging from 14 to 35 mm.

Another reason is that the negative influence of the switching behaviour of standard non-return valves decreases as the screw diameter increases. The following diagram shows the stroke of the check ring in relation to a usual screw stroke versus the screw diameter. It is very clear that the effect of the check ring stroke decreases in the case of the usual injection strokes of larger screw diameters.



Stroke of the check ring in relation to a usual screw stroke

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Limitations of activeLock

The technology of non-return valves which can be closed by rotation was patented several years ago by Sumitomo. Non-return valves of this design are marketed under the name "SK" and several thousand switchable non-return valves are already in use on all-electric Sumitomo machines.

In order to be able to exploit the properties of the switchable non-return valve in the best possible way, some boundary conditions have to be observed. The cost of an activeLock is significantly higher than the cost of a standard non-return valve. This is due to a number of reasons, one of which is the fact that the mechanical stresses are higher for this non-return valve. For this reason, high alloy steels and partial, powder metallurgical steels are used, which can withstand the occurring stresses and minimize wear. In addition, the special design results in greater machining efforts during the production of activeLock. The complicated processing, therefore, also contributes, in part, to higher production costs. The optimized flow cross-sections minimize the additional stresses for the processed plastics. Nevertheless, some boundary conditions also have to be observed for the plastics.

activeLock can be used in many applications. For details, please get in touch with your Sumitomo (SHI) Demag contacts in Sales and Technology.

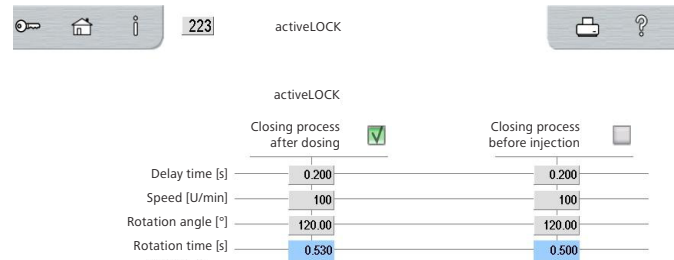
Ease of use of activeLock

The additional operating options arising from using activeLock are minimal. The machine operators simply have to enter three values:

- The angle of rotation
- The speed of rotation
- The timing of the closing process

In order to achieve the best possible results, it is nevertheless necessary to deal with the properties of activeLock in more detail. For example, it has been possible to determine the following simple basic rules for the three variables in numerous technical tests:

- Rotation angles in the region of 120° show the best results for most plastics
- Materials with a glass fibre reinforcement benefit from faster closing movements and larger closing angles (120-150°)



Face of activeLock

- Closing activeLock immediately following the dosing process generally produces the best possible results.
- In the case of very highly viscous materials, as well as material with a glass fibre reinforcement, an additional closing movement prior to injection is recommended.
- Generally, a fast closing movement is advantageous in the case of low viscosity (easily flowing) materials, and a slow closing movement is more advantageous in the case of highly viscous materials.

Interchangeability with conventional non-return valves

activeLock can, in principle, be easily interchanged with conventional non-return valves. The installation dimensions and the connection threads are identical to the non-return valves previously used at Sumitomo-Demag. The exception to this is the 14 mm-diameter non-return valve.

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Test results

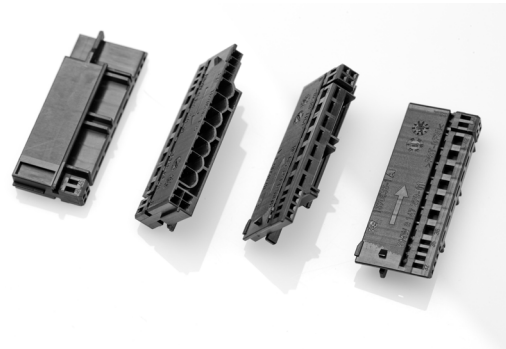
In addition to the thousands of applications of switchable non-return valves in Asia, numerous tests have also been carried out in Europe prior to the market launch. These included, for example, an endurance test with more than 3 million pressure peaks for a non-return valve, various process engineering tests with various types of plastics, field tests at selected customers facilities, trade fair applications and customer tests, etc. The general conclusion is that, when operated correctly, activeLock can offer some significant improvements in terms of process consistency and precision.

A selection of results for typical applications:

1. 8-pin connector housing

on IntElect smart 160/520-500 with 40 mm activeLock (Fakuma 2009)

Material: PBT GF - 20% glass fibres
Shot weight: 42,0 g
Cycle time: 15 s
Sample size: 50 shots each



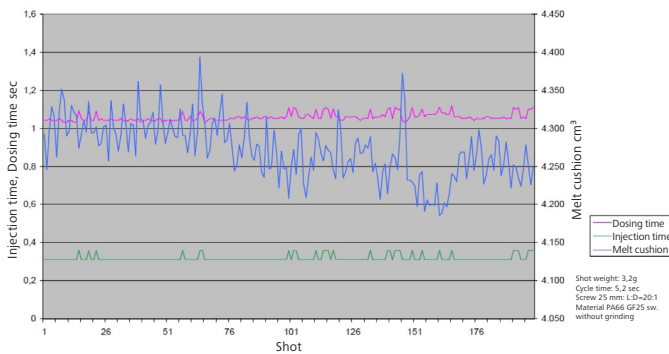
Improvement of weight and melt cushion consistency

Non-return valve	Shot weight			Melt cushion	
	Absolute	Dispersion	Dispersion	Absolute	Dispersion
	[g]	[g]	[%]	[cm]	[cm]
Standard non-return valve	42.094	0.037	0.09	6.485	0.190
activeLock	42.035	0.017	0.04	4.719	0.087
Change with respect to the standard non-return valve in %		-54 %			-54 %

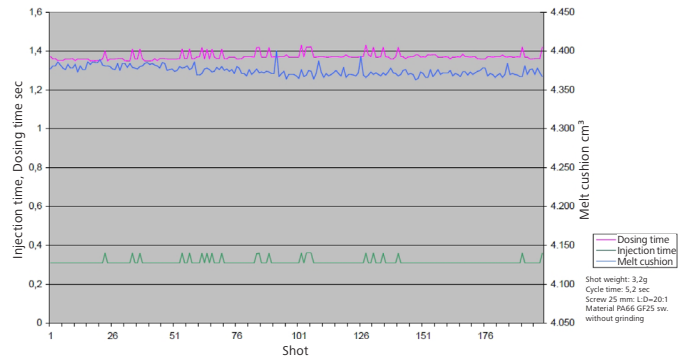
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2. Comparative test for ball bearing cage on IntElect smart with standard non-return valve and activeLock Ø 25 mm

Material: PA 6.6 with 25% glass fibres
Particular feature: very small injection stroke



Standard non-return valve



activeLock

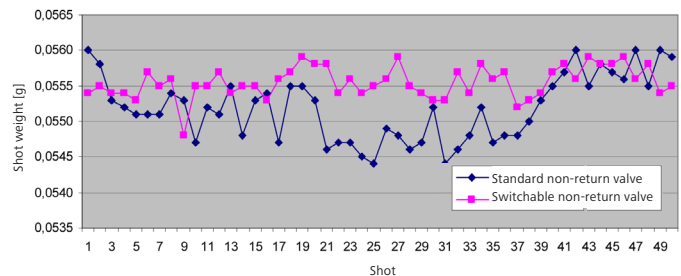
3. Micro-application pinion cage on IntElect smart 50/370-45 with 14mm activeLock

Material: Hostaform (POM)
Particular feature: very small injection stroke



Pinion cage

Non-return valve	Part weight (4 Kavitäten)		
	Absolute [g]	Dispersion [g]	Standard deviation [g]
Standard non-return valve	0.0552	0.0016	0.000461
activeLock	0.0556	0.0011	0.000218
Change with respect to the standard non-return valve in %		-31.3	-52.7



activeLock – The technological innovation in precision injection moulding