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Sumitomo (SHI) Demag

activeFlowBalance – an innovation for improving process reliability and parts quality

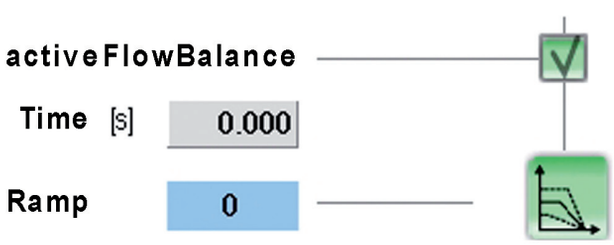
This innovation from Sumitomo (SHI) Demag is an option with a variety of applications which can be used as an effective way to optimize processes and achieve corresponding improvements in quality.

The primary purpose of the activeFlowBalance function is to balance pressure ratios in a cavity or between cavities. Active intervention is undertaken in the sensitive injection process of the cutoff from injection to hold pressure.

The use of activeFlowBalance allows for a robust and simple injection process for applications which up until now had to be run at critical levels and with complex adjustments.
The option builds on Sumitomo's Zero Moulding and represents a unique selling point in our sector. It is a technological innovation with uses which can be practically applied in a variety of processes. A key advantage of activeFlowBalance is the ease with which it can be operated.
activeFlowBalance has a broad range of applications and makes full use of the advantages of highly dynamic electric drive technology.

Process

The description which follows provides insight into the injection process when using the activeFlowBalance function. We are restricting ourselves here to the injection hold pressure process, since it is here where the differences are found. The speed-regulated injection process is terminated by the cutoff being reached. This is precisely where the activeFlowBalance function begins to operate. It is activated by the setpoint displayed, which can be shown on a separate screen.



Einfach und übersichtlich

As a result, the screw is held at a fixed position for a period of time which can be adjusted. Only a duration period (downtime) needs to be set for this. As another option, the braking speed of the screw can be set via a ramp (from injection speed to downtime).
After the activeFlowBalance time has expired, the cutoff to the standard hold pressure setting is effected. The duration of activeFlowBalance can be deducted from the hold pressure period, meaning that no extension of the cycle has to occur.

Result

What is this process meant to achieve? During the injection process, a specific melt pressure profile is built up in the entire plastic melt system in front of the nonreturn valve (space in front of the screw, nozzle, feed runner / hot runner, cavities).
If the movement of the screw is now stopped at the end of the injection process and the position is maintained, the melt pressure at the various stages of the system is given time to decay and adjust. During this balancing of compression, the melt under pressure acts like a pressure reservoir. The elastic properties of the plastic melt are exploited. During this short phase, on the one hand the pressure level in the melt system balances out, while, on the other hand, the movement of the melt front is conveyed into the cavities not yet filled volumetrically while becoming slower.
The cutoff to hold pressure then occurs.

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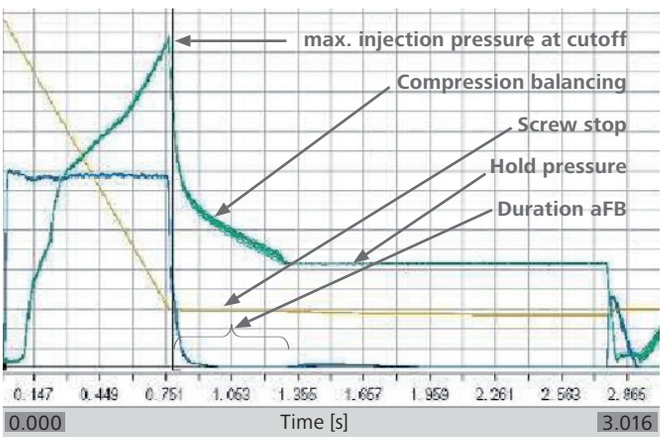
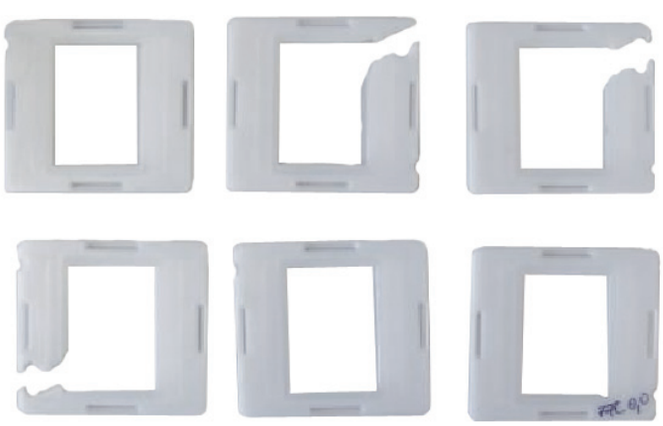
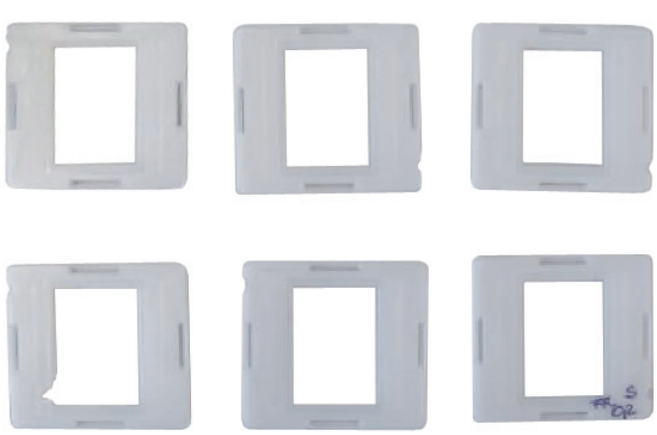


Profile graphs when using the activeFlowBalance-Funktion



Filling at cutoff after 0 s → 3 cavities completely, filled 3 clearly incompletely

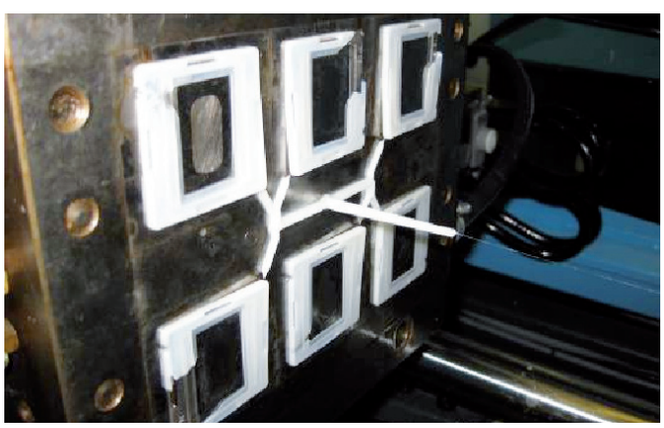


Filling after 0.2 s activeFlowBalance Time → Balanced fill level with balanced melt pressure

Intended use

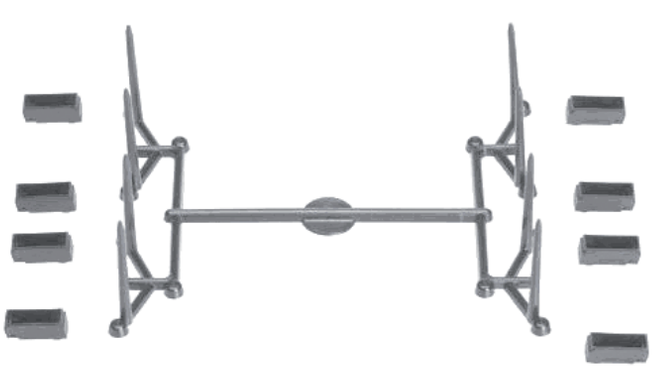
The process has been designed for various applications. The greatest advantages are offered with regard to injection processes, in which the cutoff from injection to hold pressure is effected dramatically. For example:

- Multi-cavity mould with balancing problems
- Moulds with hot runner fluctuations
- Moulds with ventilation problems



Example of an unbalanced multi-cavity mould

- Parts with multiple gatings
- Parts with thin-walled areas at their flow-path end
- Parts which are very small in relation to the sprue weight
- Parts made from tandem processes



Parts with large sprue and small part weights

- Parts with different flow-path lengths or fill ratios

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Limitations of traditional processes

Let's take a multi-cavity mould with inadequate balancing as a representative example.
Up to now, the mould setter only had 2 basic options for dealing with the problem of the uneven or fluctuating balancing of cavities.

1) Injecting until all cavities are filled volumetrically.

The result is an increased injection pressure, as the machine keeps building up pressure ever further until even the last cavity is completely filled. Pressure peaks develop in this process, especially in the cavities which have already been filled, which can lead to burrs forming.
In addition, various pressure levels, and therewith various morphologies (morphology = internal properties), can be generated in the various cavities, (e.g. residual stress, warpage, contraction of the parts).
A further, negative effect is the erratic increase of the melt front speed as soon as the first cavity is filled. In the case of 2 cavity systems, for example, this is doubled and very frequently leads to ventilation problems, which result in combustions and/or not incompletely moulded parts.

2) Cutoff to hold pressure when the volumetric filling of the first cavity has been achieved.

The advantage rests in the fact that the pressure peaks mentioned above and their negative effects can be avoided. The resulting disadvantage is, however, the risk of short shots, as the injection pressure is reduced and lowered to the hold pressure level before all cavities have been filled. This can result in a "pause" of the melt front and thus to short shots, which lead to the sporadic occurrence of defective parts in the event of fluctuating surrounding conditions (for example, through fluctuations of the mould hot runner). Various morphologies are in turn generated with resulting deviations in the structure of the parts.

The active principle of activeFlowBalance

Let's stay with the example given above and apply the activeFlowBalance function. In this case, the process would occur as follows:

Establishment of the screw position, at which point the first cavity is filled volumetrically. Up to that point, a quite normal injection process takes place (cutoff is the starting point of the activeFlowBalance function). It is now that the activeFlowBalance function is activated. For this purpose, the screw is slowed down to a standstill (adjustable ramp) and held in position. The duration of the screw standstill can be adjusted and is cancelled after it has expired by the standard hold pressure process.

What happens in the process? When the activeFlowBalance function starts, the screws stops and no further increase in injection pressure occurs. A natural balancing of the melt pressure ratios between the individual cavities or in the entire melt system is initiated. Areas with high pressure (nozzle, distributor) release tension in favour of areas with too low pressure (partially filled cavities) and build up further pressure exactly at those points.

The residual filling of the remaining cavities (in partially filled cavities, a lower counter-pressure prevails than in cavities which have already been filled) is therefore effected by the reduction of the pressure stored in the elastic melt. This means partially filled cavities are more strongly balanced out with less counter-pressure during the activeFlowBalance period than cavities which have already been filled.
Since the screw does not move during this time, no additional injection pressure is introduced into the system and any erratic increase of the melt front speed of the cavities to be filled last is avoided.

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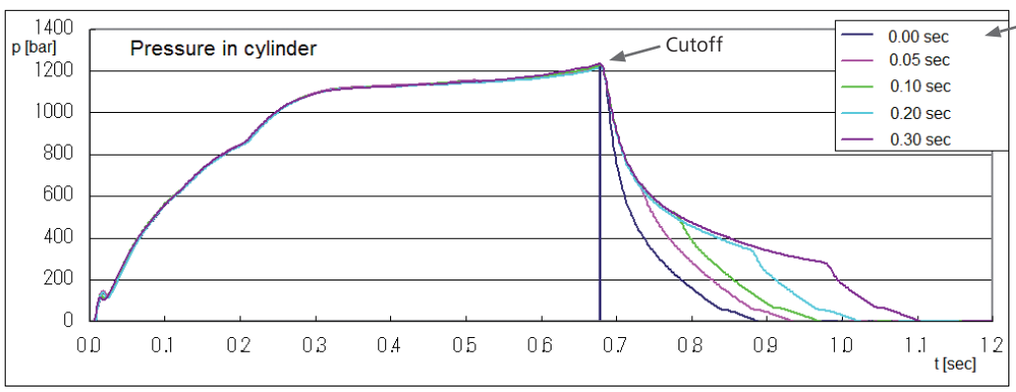
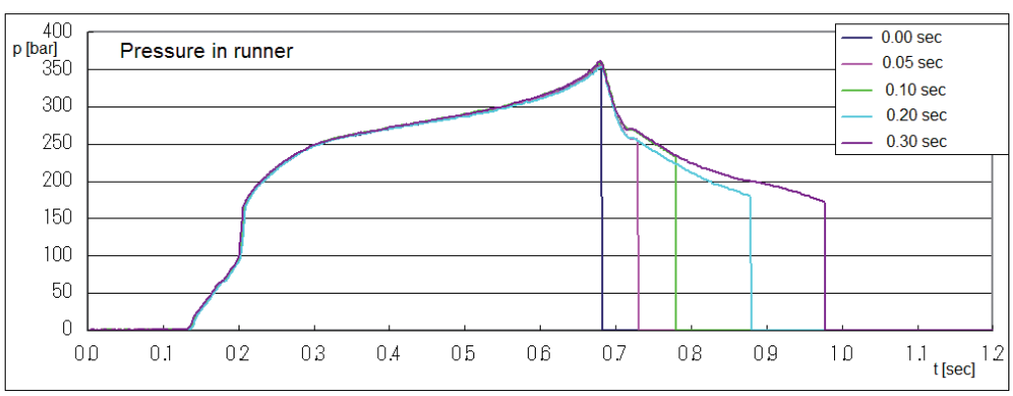
Compression balance in the melt system (without hold pressure)

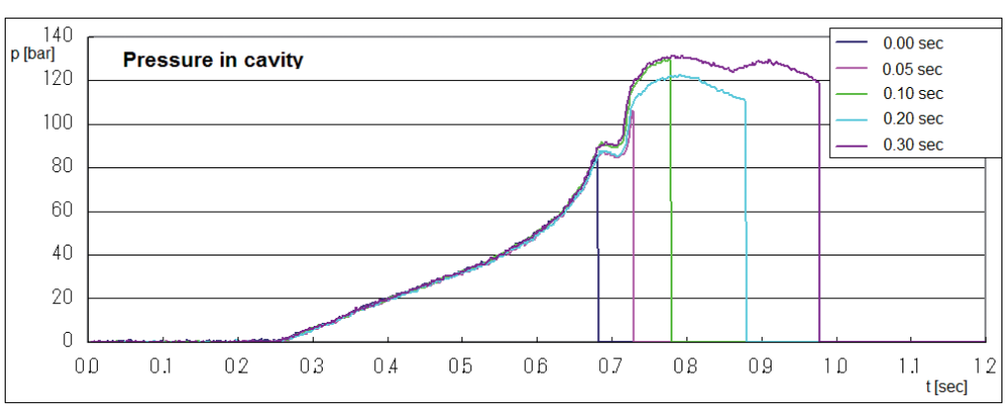


Duration of aFB

Reduction of pressure in cylinder
Cutoff → aFB 0.3 s
1220 bar → 300 bar



Reduction of pressure in distributor
Cutoff → after aFB 0.3 s
370 bar → 180 bar



Increase of pressure in the cavity
Cutoff → after aFB 0.3 s
90 bar → 130 bar

Operation of activeFlowBalance

The three pressure curves record the compression balance in the melt system over a period of time (activeFlowBalance) of 0.3 s. The operation of the activeFlowBalance function is simple and clearly laid out. In the case of multi-cavity moulds, the starting point it usually the stroke position of the screw, at which point the first cavity is filled volumetrically. As a rule of thumb, it can be estimated that the activeFlowBalance time amounts to approx. 30% of the injection time. The exact parameters have to be determined through sampling via fill study without hold pressure. The duration period of activeFlowBalance can be deducted from the hold pressure time (activeFlowBalance already acts as a part of the hold pressure). This means activeFlowBalance does not have any negative effect on the cycle time.

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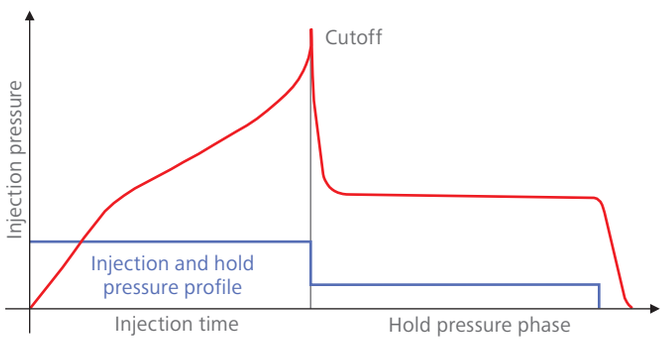
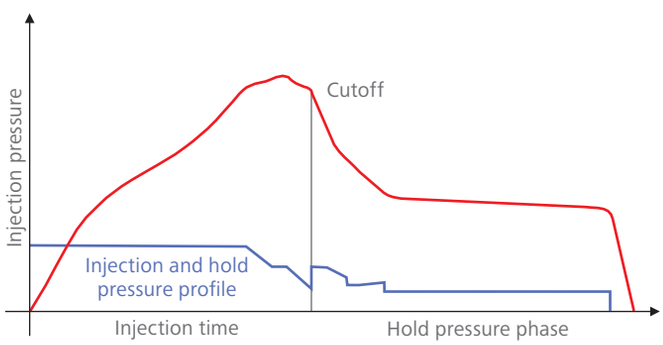
The advantages of activeFlowBalance

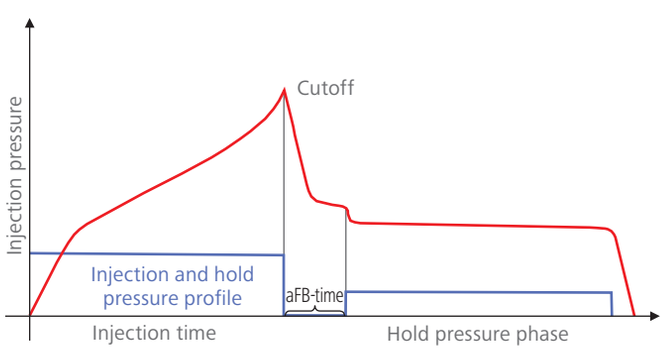
- **Avoidance of injection pressure peaks** by actively stopping the screw movement before the end of the conventional injection process
- **Balancing of the pressure ratios** (near the runner and end of fill) in the part, producing fewer inner tensions and warpage
- **Avoidance of burrs** by eliminating of injection pressure peaks listed above
- **Avoidance of short shots** (conventionally, cutoff and hold pressure have to be adjusted very narrowly so as to avoid short shots) → activeFlowBalance provides a "fill reservoir" for this
- **More even pressure level** in different cavities of a mould, producing more even morphology and therefore better measurements, weights and warpage properties
- Potential for reducing the clamping force through lower max. injection pressure thus and therewith cavity interior pressure
- **Better ventilation** in the mould due to low melt front speed (more ventilation time) and the possibility of reduced clamping force (easier ventilation) → longer intervals between mould maintenance
- **Simple and clear operation**, (2 parameters) instead of complicated injection/hold pressure profiles
- Avoidance of screw bounce at cutoff and the sudden pressure erruption and process fluctuations associated with this



Standard injection moulding with quick reduction in pressure and pressure peak.



Smooth transition of pressure through use of injection and hold pressure profiles (complex programming over 7 steps).

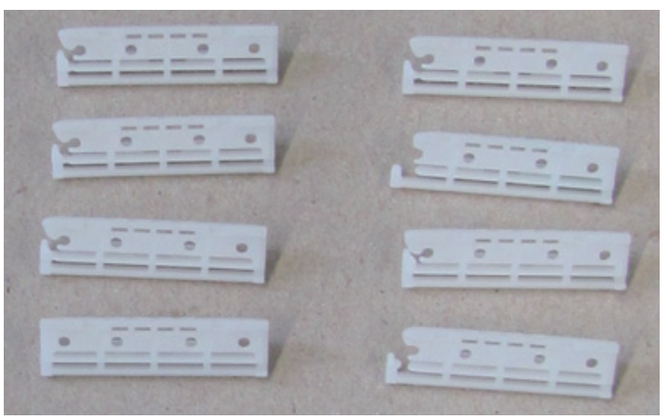


Pressure transition with activeFlowBalance

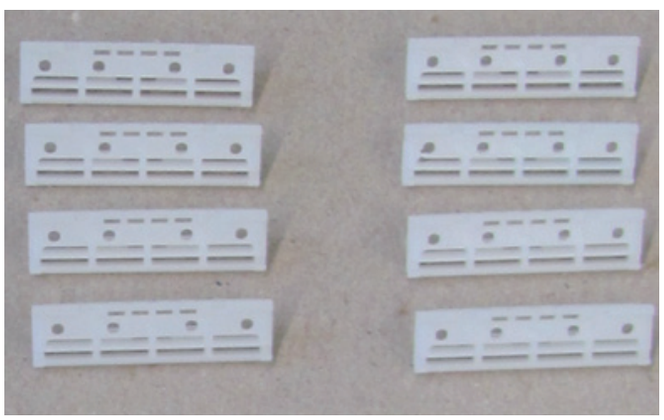
Results:

Trial with 64-cavity blade holder (here a selection of 8-cavity sub-gate)

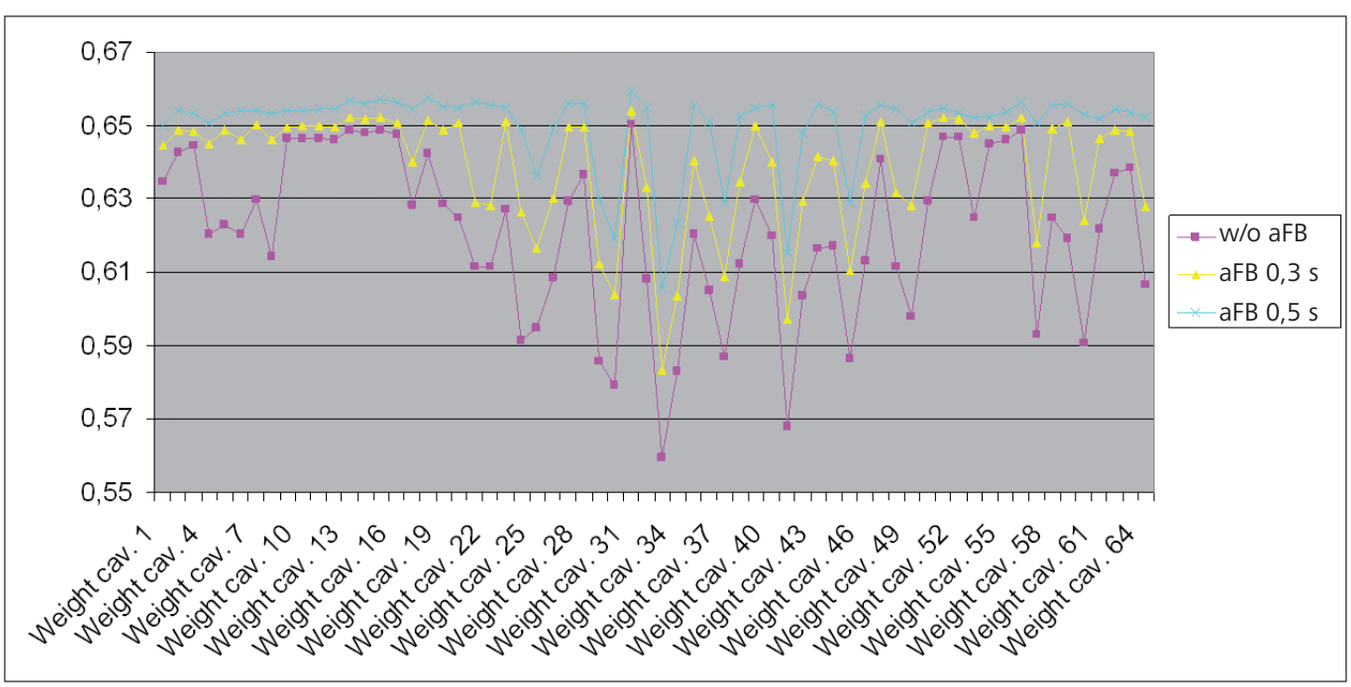
Conventional fill study



Fill study with 0.5 s activeFlowBalance



Under-filled cavities



Weight distribution of all 64 cavities

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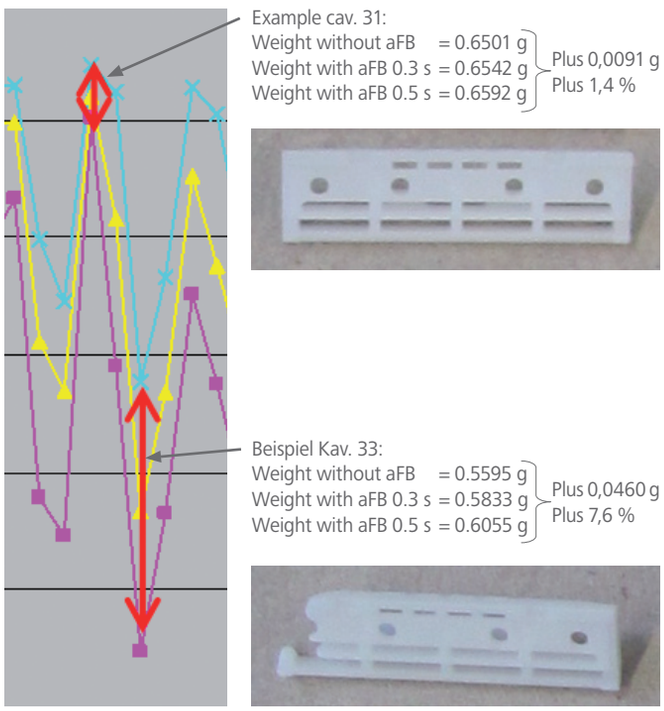
The fill profile of the different cavities shows considerably higher evenness with the use of activeFlowBalance.

In detailed terms, this can also be seen in the fact that the increase in weight is considerably lower in the case of a part which has already been filled (Cav. 31 only 1.4 %) in comparison with a still strongly under-filled part (Cav. 33 with 7.6 %). This means that activeFlowBalance improves precisely those cavities, which lag behind.

The pressure level as a whole could be lowered during injection, which has a positive effect on the avoidance of injection burrs and reduces the clamping force level.

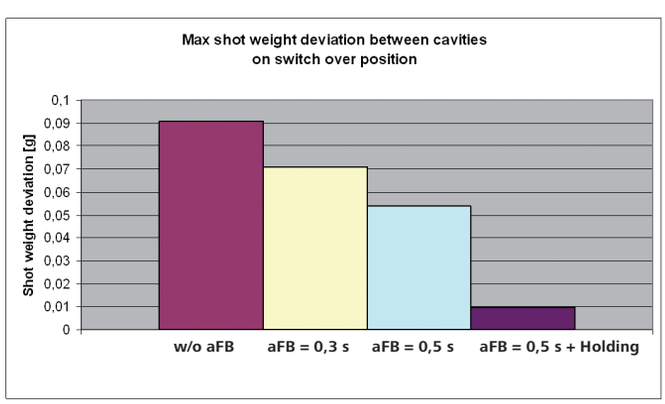
The reduced clamping force results in improved ventilation of the mould when considered over a longer production period and thus allows the intervals between maintenance of the mould to be extended.



The weight consistency of all 64 parts with hold pressure showed a similarly narrow spread both with and also without activeFlowBalance. This means that the hold pressure at least balances the spread at cutoff as regards these parts. The transition phase from injection to hold pressure and a homogeneous holding pressure effect of the individual cavities through activeFlowBalance does, however, have a decisive impact on the structural arrangement (molecular structure).

Properties such as size accuracy, warpage and mould shrinkage are crucially affected.

When using activeFlowBalance, a smaller spread of the properties of parts with regard to the criteria named above can be presumed due to the melt pressure balance.



Use/retrofitting

activeFlowBalance can be used with the IntElect Smart. Retrofitting is possible.
The basis is formed by activeDynamics, as the reaction time of the machine, a high level of dynamics and exact reproducibility are crucial for the precise regulation of the activeFlowBalance function.

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Summary

The activeFlowBalance function represents a technological unique selling point. The advantages of activeFlowBalance can be used for injection processes with sensitive transition from injecting to hold pressure. That means it can used for a very broad range of applications. Due to the simple operating mode, this module can be accessed by a broad range of mould setters and does not require having any prior specialised process knowledge.
A crucial advantage is the avoidance of unnecessary peaks in the injection pressure and in the melt front speed plus a balancing out of pressure between the cavities. This results in the avoidance of burrs, improved ventilation and more consistent processes. The more homogeneous distribution of pressure between the cavities or also in an individual cavity means that internal and external component part properties such as tensions, mould shrinkage, warpage, weight consistency, optical features etc. are impacted in such a way that a considerably smaller spread can be achieved.

activeFlowBalance brings out all the advantages of an electric injection moulding machine.

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Product Manager Electric Injection Moulding Machines
peter.gladigau@dpg.com • +49 911 50 61 625
www.sumitomo-shi-demag.eu

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