Dynamic Injection – Made Easy

Improved Setpoint Calculation of the Injection Speed Profile

Injection is the process step in injection molding that is most quality critical. The injection speed profile and its reproducibility have a direct influence on the internal and external properties of a part. The adjustment of the injection step is therefore of particular importance. Engel injection-molding machines with electrical injection units now feature optimized setpoint computation of this profile, with clear visualization, which increases the process transparency and ease of operation.

With immediate effect, Engel is equipping all injection-molding machines with electrical injection units with an optimized setpoint computation for the injection speed profile (© Engel)

In automotive technology, it has long been normal to adjust the driving behavior from the cockpit. Various driving programs, from comfort to sport, are generally available. The vehicle electronics change the characteristics of the engine, gearbox, chassis and steering, depending on the desired program. Driving pleasure is thus just a matter of making simple settings.

Smooth or Dynamic?

Engel Austria GmbH, Schwertberg, Austria, is now making it just as easy and convenient for users to set the profile dynamics of their injection molding machines in the CC300 control system. With an intuitively operable slider, the dynamics of the profile set by the machine operator can be adjusted – from smooth to highly dynamic (**Fig. 1**). The injection movement can thereby be individually adapted to the process requirements, from the production of optical lenses with high requirements to smooth transitions for filling, through to highly dynamic packaging application.

At the core of the new setpoint computation is an optimized algorithm. From the setpoint profile specified by the user – taking into account the physical limits, such as the permissible acceleration and changes of acceleration – this algorithm computes a feasible speed profile. The algorithm thus intuitively implements the operator's settings as a target speed. In the development of this new function, particular attention was paid to the transparency of the machine behavior.

Expected Speed Profile before the First Cycle

Even in the CC200 predecessor control system, the injection speed profile was input either numerically or graphically by sliding profile points on the touch- »

Fig. 1. The precalculated speed profile (broken line) shows the expected speed profile based on the set setpoint values. By changing the profile dynamics, the movement can be made more gentle or more dynamic. The effect is visible directly during the movement of the slider (© Engel)

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Technology in Detail

With tutorials that are available in the CC300 control and therefore directly at the workplace, Engel took a further big development step at Fakuma 2018. The aim of these crash courses is to support plant operators in exploiting the full potential of the injection molding machine without needing to invest much time in training or research. A tutorial is also available for the newly optimized setpoint computation. On a few pages, it guides machine operators in an easily understandable way through the operating principles, the application and the benefit of the new solution.

Service

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screen. However, in the detail views, the actual value curve was first shown separately from the setpoint values on different screen pages. The relationship between the setpoint and actual values was consequently not immediately apparent.

A new feature is that the algorithm pre-computes an actual value profile, which, before the first cycle, gives feedback to the plant operator about the effects of changes of setpoint values and profile dynamics on the injection speed. This increased transparency considerably simplifies the setting of the application-specific optimum injection profile. Where the machine operator makes the setting, he is already provided with information about the effect of his action and thereby achieves his goal faster.

In the case of a position-dependent changeover from injection to holding pressure, the injection time to be expected is additionally displayed (**Fig. 1**). The injection time can thus be aligned with a target value by adjusting the speed profile. This eliminates the need for laborious preliminary trials, which take time and produce reject parts. The target value may be an empirical value or else a recommendation by the mold maker. If set-

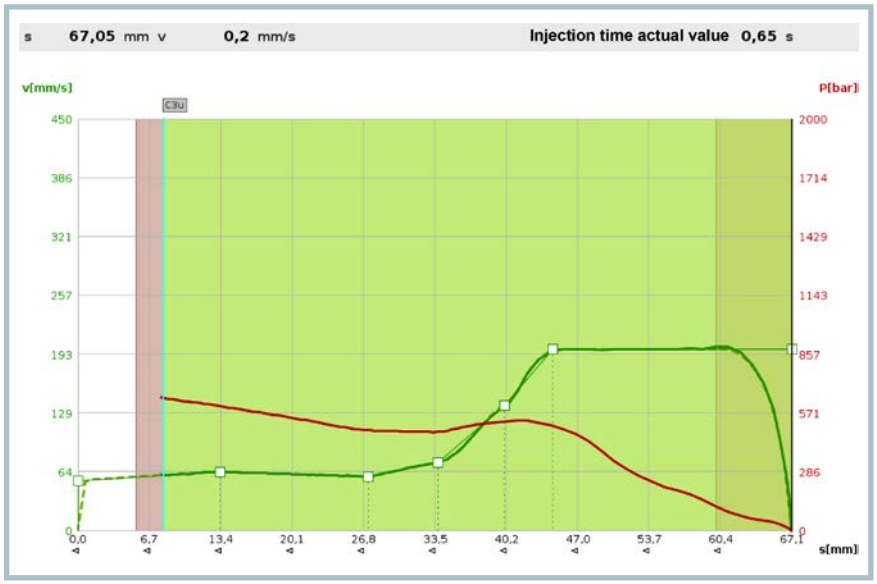

Fig. 2. The graphic display in the CC300 shows all the important information at a glance. The injection profile is displayed from right to left, corresponding to the direction of movement of the screw. The green lines represent the speed curves and the red line, the pressure curve (© Engel)

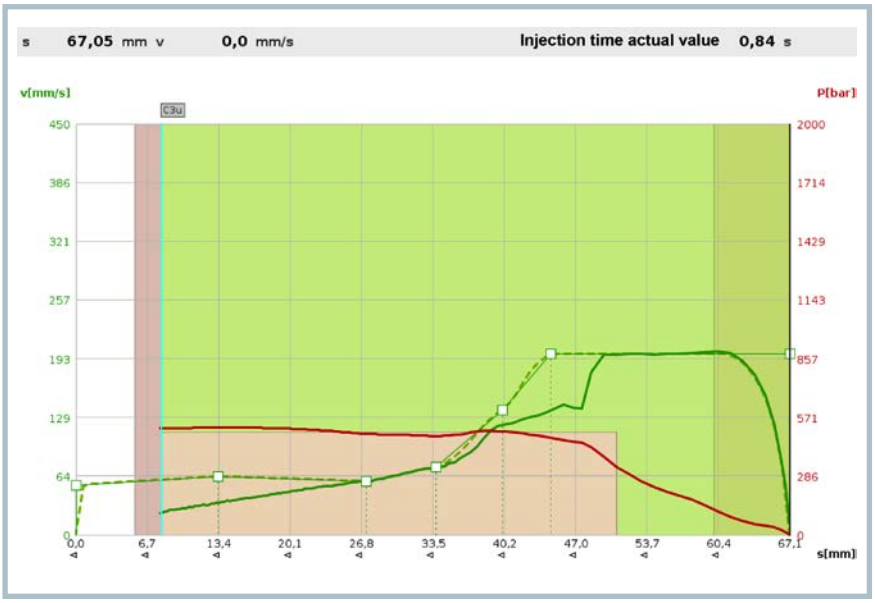

Fig. 3. The red area stands for the pressure control. It illustrates the holding pressure phase and possible intervention by the pressure limit controller (© Engel)

ting data are transferred from one machine to another, the preliminary calculation of the injection time also offers a valuable help.

Input Merges with the Output

Before the first cycle, where an actual value curve is of course not yet available, the speed profile to be expected is displayed. Immediately after the first cycle, the setpoint profile is compared to the actual value profile. In practice, it has been found that, thanks to the precise speed control, the actual value profile is almost identical to the calculated profile: the input merges with the output (**Fig. 2**).

The graphic display in the CC300 shows all the important information at a glance. The injection profile is displayed from right to left, corresponding to the direction of movement of the screw. The green lines represent the speed curves and the red line, the pressure curve. Setpoint values, actual value curves and calculated profiles are differentiated from one another by means of different line types. Colored background marks provide valuable additional information. Here, green also stands for the speed control.

The dark-green area at the start of the injection stroke visualizes the elapse of the decompression step. Mold filling generally does not occur here. In this area, the speed influences the closing of the non-return valve. The red area stands for the pressure control. It illustrates the holding pressure phase and possible intervention by the pressure limit controller. Perceptible deviations then only occur if, because of the high injection pressure requirement, the speed is reduced via the pressure limit controller. This case is immediately displayed in the machine control and the plant operator is notified of possible problem areas. (**Fig. 3**).

The changeover point actual value is marked by a line (light blue in the picture). To the left of this, in the holding pressure range, the speed setting only acts as a limit. The current position of the screw is represented as a vertical line, which the profile passes through. From the graph, it can therefore also be seen which stroke the screw passes through in the holding phase, or whether it "springs back."

Summary

With an intuitively usable slider, the dynamics of the profile set by the machine operator can be adapted to the specific requirements of the particular application. The detailed visualization of the precalculated speed profile, as well as the actual values, means a higher information content and opens up greater potential for optimizing the injection profile. This Engel solution thus simplifies and speeds up the commissioning of new molds. ■