

An Eye on the Process – a Handle on Quality

A Process Monitoring Platform Monitors Several Hundred Parameters Simultaneously

iQ process observer, the new process monitoring platform from Engel monitors hundreds of parameters from the injection molding cell in the background and presents deviations in such a way that the injection molder can easily identify them and their cause. In many cases, the new assistance system from the iQ product family even suggests a solution itself. In this way, the data analytics solution helps to reduce rejects and downtime.



The injection molder is truly not a friend of changes – if they occur in the running process. The iQ process observer helps him to keep an eye on the process and thus keep a handle on the quality © Engel/background picture: iStock

The injection molder knows how varying environmental conditions, sudden changes in the material properties and increasing wear on the mold and machine result in continually new boundary conditions. In addition not infrequent problems with material feed and automation lead to short production interruptions. They disturb the thermal equilibrium in the melt cylinder and mold. On the other hand, newer injection-molding machines feature control of many parameters, e.g. axial movements, tempera-

tures and pressures. In addition, water manifolds are increasingly used in mold temperature control to ensure controlled conditions [1]. Recently, process controllers such as iQ weight control are even ensuring that the injection volume remains constant [2].

The fact is that they can correct many, but not all, changes. When “non-controllable” process changes occur, they are often recognized too late, or not at all – the production of rejects is predestined. The search for the causes is time-con-

suming and requires experts. But experts with process knowledge and experience are in short supply.

One hundred percent quality control is expensive and therefore only appropriate for special applications. In general, it is thus advisable to monitor the process instead. A stable process that does not vary is not a guarantee, but an indication of and prerequisite for uniform part quality. But when is the process stable? Until now it was normal to choose particular process parameters, provide them with toler-

ances and monitor them. But it is not so simple: while there are clearly defined specifications and tolerances for the quality of parts, in process monitoring the choice of parameters and specification of tolerances is usually performed subjectively based on individual experience. Once again, this requires the expert and time, though different experts usually reach different results.

Data Analysis – Replacement or Aid for the Experts?

A solid data-analysis approach, which at first sight looks a little paranoid, now provides a remedy. It works like this: you take all the relevant parameters, which can be captured and monitor them. It is better to monitor everything than overlook something. This gives you a holistic view of the process, a kind of fingerprint. However, "all the relevant parameters" can mean very, very many, and this approach therefore poses two problems:

- The effort for setting monitoring limits increases with the number of monitored parameters.
- The effort for interpreting the results increases as well.

iQ process observer, a new product from Engel Austria GmbH, Schwertberg, Austria, eliminates these problems in an impressive way: although hundreds of parameters are monitored, the effort for adjustment approaches zero:

- The available parameters are factory preconfigured. The actually installed plant equipment is already taken into account.
- At run time, the software recognizes which zones of the cylinder or mold heating, or how many points of a velocity profile, are actually being used and are therefore worth monitoring.
- Tolerance limits are learned automatically based on the current process. However, the learning process is monitored by the "built-in expert knowledge," and corrected if necessary so that impracticably narrow or very wide tolerances do not arise as a result of very small or very large scatterings.

Now to the interpretation of the results: let us assume that 40 parameters changed simultaneously. How should the user best be notified of this? Should



Fig. 1. The overview page of the iQ process observer summarizes all the information about the current process state © Engel

he receive 40 messages on his smartphone or only a list with the names of the 40 changed parameters? Should he be shown the profiles of the 40 parameters over time as curves, so that he has all the information at his fingertips immediately?

Neither one nor the other, since with too much detail, you risk losing sight of what is essential. The iQ process observer provides the injection molder with the results of the monitoring in the form of a bird's eye view first, a kind of executive summary (**Fig. 1**). The four process steps plasticizing, injection, cooling and demoulding are summarized as traffic light symbols. All green means everything is OK. A yellow signal means that there are currently changes or deviations from the reference state.

Traffic Light Symbols for the Four Process Steps

When the plant manager sees a yellow signal, he wants to know: what exactly is deviating? How did it occur? A click on the traffic light leads to a detailed view showing the profile of occurrence through the last cycles. However, all that is shown is what is relevant at that moment.

The degree of detail of the visual language is ideal for getting to the bottom of changes and their causes in many cases. For everyone who wants to know very precisely, it is of course possible to drill down to the individual parameters affected in order to see the curve profiles or to read the exact numerical values from them. »

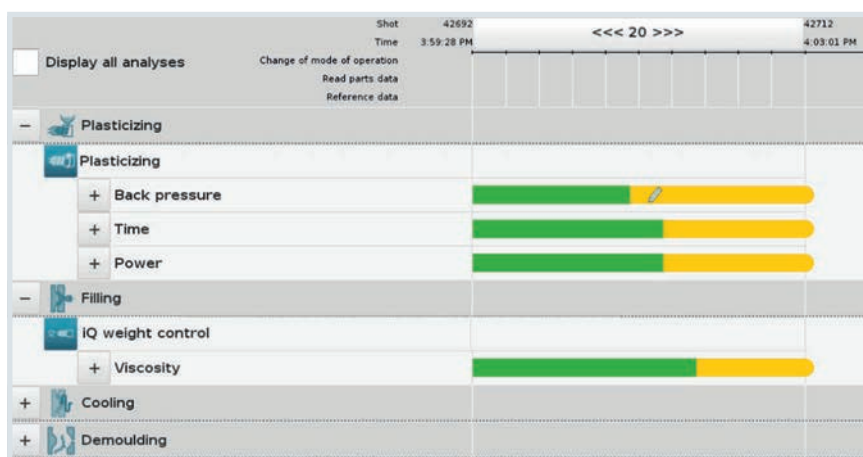


Fig. 2. Example of the profile of process changes in the last 20 cycles: the specialist recognizes immediately that the actual value (yellow) changes were a consequence of the user changing the setpoint for backpressure – as can be seen from the pencil icon © Engel

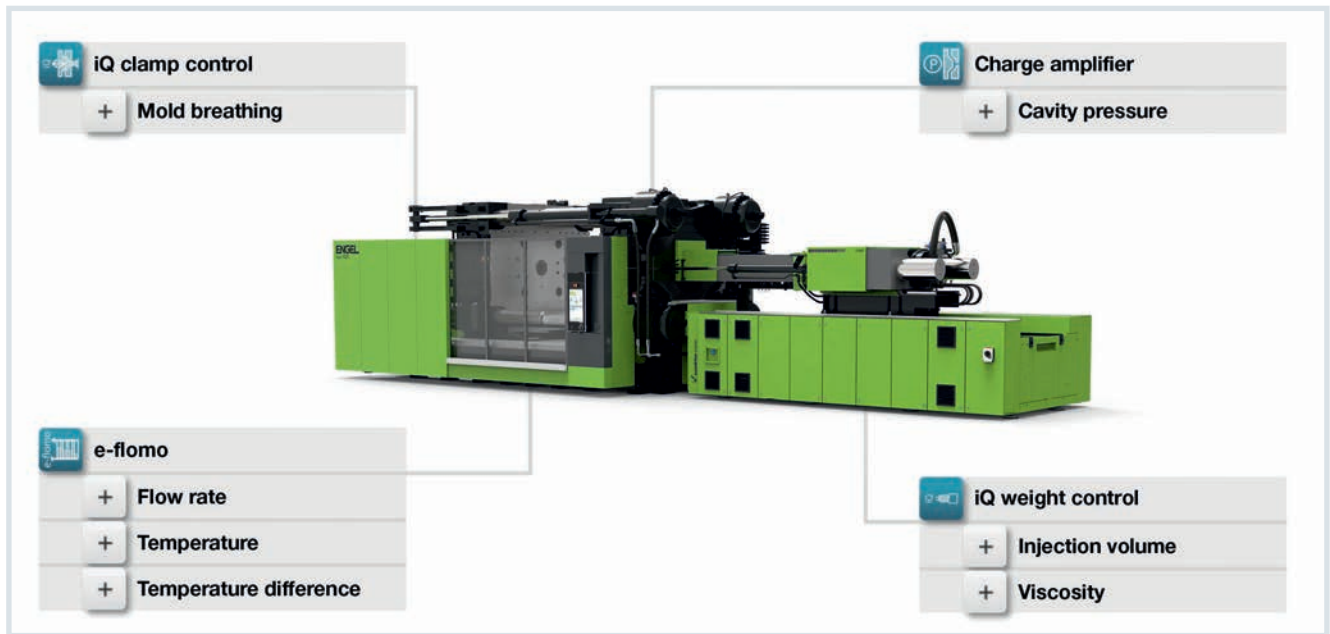


Fig. 3. When the process is looked at holistically, some of the machine extras offer an additional benefit alongside their actual use due to their integration into the monitoring software © Engel

In the example shown here (Fig. 2), the yellow regions signal the time range of the change of actual values. In the “plasticizing” step, actual values from the group comprising backpressure, dosing time and dosing capacity have changed. The specialist can immediately deduce that the actual value changes were a consequence of the user changing the setpoint for backpressure – as can be seen from the pencil icon. Thanks to the software, it can be seen that the backpressure change also resulted in a change of the melt viscosity.

The iQ process observer does what a process technician would do when analyzing a problem, namely preparing data so that something can be read from them. However, doing this can be very time consuming. The software does it much faster of course, and continuously after each shot. The process technician can concentrate completely on interpreting the history told to him by his reliable injection molding assistant, and concern himself with finding possible problem solutions. Recognizing the problem is

more important than recognizing the solution, since the exact representation of the problem leads to the solution – that is how it Albert Einstein formulated it.

The Injection Molding Assistant Puts It in Plain Language

Manufacturers of injection-molding machines are developing ever more solutions with the aim of achieving a more constant or better adjusted process. At first glance, the question thus arises of why we need another monitoring solution like the iQ process observer. The answer is: all these assistance systems – called iQ products at Engel – complement one another and are merging with the iQ process observer. Optional sensors in the mold or in the cooling water circuits complete the picture of the process that the iQ process observer can deliver. The iQ weight control process controller and the setpoint assistant iQ clamp control, with the injection volume, the viscosity change or the mold breathing, provide valuable additional indicators for the process without the need for additional sensors (Fig. 3).

As described above, the basic principle of the monitoring assistant consists in the user visualizing the data in such a way that he can interpret them as effectively as possible and use them to deduce conclusions and actions. However, the

The Principle of the Assistant

The iQ process observer opens a new chapter in intelligent assistance. Assistance systems have so far been able to optimize individual work steps of the injection molding process, but now this system optimizes several hundred process parameters across all four phases of the injection molding process – plasticizing, injection, cooling and demolding.

- **Monitoring everything:** all the relevant parameters from all available sensors are assessed for a potential change or deviation from the reference state and identified with the colors green (okay) or yellow (not okay).
- **Start with a bird's eye view:** the parameters are logically grouped together so that the user does not always have to deal with each one individually, but is given an overview.
- **Telling a story:** the assessment profile is represented over previous cycles in order to show the user the time sequence over which the changes occurred.
- **Filtering for what is essential:** the user only sees what has changed in order to direct his view at what is essential.
- **Providing additional information:** everything is shown that could serve as an explanation of changes, i.e. Including the setpoint changes or production interruptions deliberately performed by the user.

software goes a step further and assists the user when he may not recognize possible solutions at once: in each cycle, it is checked whether known fault patterns or optimization possibilities can be identified from the current monitoring image and whether it would be advisable to employ measures. If such a state is rec-

ognition is therefore continually expanded with new error images and optimization proposals, so that the product grows over time and becomes ever more powerful.

As a result, special attention was paid to the fact that the software can be easily updated. The calculations are performed

tion. No data leave the machine or the Edge Device without special clearance.

The Benefit of Networking

The step toward connectivity is often not easy. In many cases the prerequisites – such as a network cable to the system – are not present. Many companies have security concerns and questions about their data autonomy. Here, Engel stands by its customers with advice and support. The benefit to be obtained from networking the plants increases year by year, and the necessary investment very quickly pays off.

Connectivity forms the basis of future products. With the iQ process observer, too, networking offers the user huge advantages, well beyond easy software updates. In the future, the software will also be available as a web version. Here, the user will not only be able to view the individual machine but all machines are clearly represented, with all the necessary information. In addition, there will be a wide range of additional useful features, which cannot exist on the machine. ■

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Albert Einstein

ognized, the digital assistant comes to the aid of the user. With one click, the user obtains an indication of the cause or proposals for process optimization or eliminating the problem.

A “Living” Product

The teams of developers at Engel has set itself the goal of further developing the iQ process observer. The process in-

in dedicated hardware, Engel's Edge Device. This keeps the processing load for data analysis away from the machine control (Fig. 4). The calculation results are returned to the machine control, where they are visualized.

The iQ process observer uses the modern and secure IoT infrastructure of the Edge Device. After release by the user, the Edge Device automatically looks for available updates via an Internet connec-



Fig. 4. The algorithms of the assistant run outside the machine on the Edge Device. The external computer also supplies data to web applications if required, and thus acts as a gateway to the world of digitalization © Engel

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