Reliable production: Quality assurance for metal powder injection molding

Resource-conserving production and the minimization of scrap help companies safeguard their future and to cut costs. A high level of quality creates trust between customers and suppliers and is a precondition for a long-term cooperation.

The goal: Zero-defect production

Metal powder injection molding has in the meantime developed into a mature technology for the large-scale injection-molding production of metal parts. It is therefore of the greatest importance for the industry to minimize scrap at all stages of the process: from feedstock production through the injection molding up to sintering.

The dimensional stability and quality of sintered parts depend greatly on the choice of process parameters at each step of the process. Deviations in the injection molding parameters may, for example, result in dimensional deviations or defects such as cracks, warpage or voids that in the worst case are only discernable after sintering. Therefore the aim must be to obtain information on the anticipated quality of the parts during the respective process step, and to be able to evaluate the influence of deviating process parameters.

Looking at the whole process, zero-defect production requires:

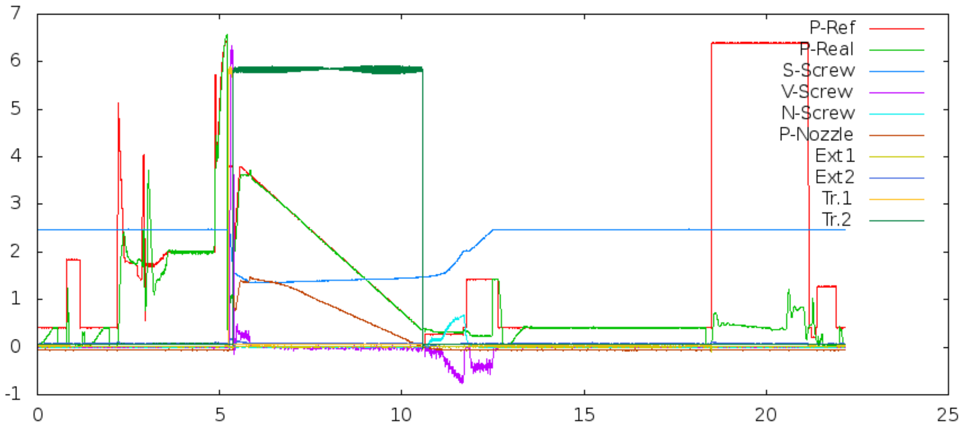
- Recording and assessment of the quality of both the powder and binder components, and of the feedstock preparation
- Assurance of the best possible injection molding process by simulating the mold filling process and constant process data recording and evaluation
- Analysis of the interactions of atmosphere, binder constituents and the metallic powders directly in the debindering and sintering process for reproducible setting of material and part properties

The road: Recording and evaluating processing parameters

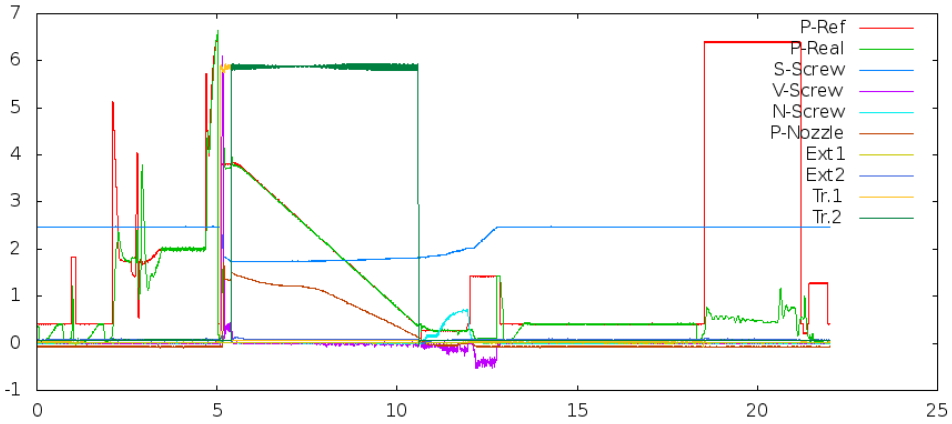
A major quality-influencing production step is the forming, e.g. by injection molding. Manufacturers of injection molding machines offer extensive possibilities. However, these possibilities have to be properly used in order to control this production step.

The same or merely similar? The following two recordings of an injection molding cycle differ in the feedstock quality: Ultimately crucial for the part quality, but not perceivable at first sight during processing, is the influence of different feedstock qualities, which becomes visible from the recorded process data.

Only by matching the part quality to the individual cycle records in the example shown revealed a relationship between differing feedstock qualities and the properties of sintered parts.



Feedstock "Batch A": Rapid plastication, relatively high scrap rate



Feedstock "Batch B": Slower plastication, significantly reduced scrap rate

A closer look at the recorded data shows that with the same machine settings, the feedstock from "Batch A" could be plasticated far more quickly than the feedstock from "Batch B".

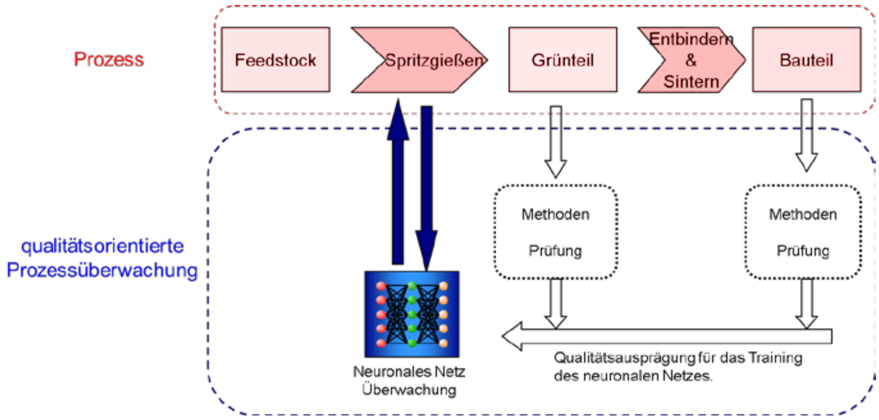
In a production environment, such minor differences, whether attributable to the feedstock or caused by external influences, can only be detected using an electronic data acquisition and an evaluation system, allowing the parts to be selected in good time, i.e. before debindering and sintering.

The future: Quality assessment during the process

As depicted in the example of the process data recording from the injection molding process, the goal is to use the recording and evaluation of all the process data from feedstock preparation, forming, debindering and sintering and to match part qualities to the data sets, which then allows the operator to define corresponding tolerance limits and predict the finished part quality.

This can be achieved i.a. using neuronal process control systems that are expedient for the injection molding process, in particular in view of the data volumes involved and the possibility of recycling green parts.

In future and with appropriate training, a self-teaching system such as the neuronal network with its knowledge base will be able to intervene in the process in response to the current process data and to influence selected parameters and thereby increase the quality:



Effect of process monitoring by a neuronal network taking the example of injection molding

This type of process control system has already been tested in practice for injection molding and, in combination with an IR-spectroscopic online gas analysis system and the recording of process data from the kiln system, is also conceivable for use in thermal debindering and sintering.