Inductive-Variothermal Tempering Of Injection Moulding Tools

Context

Processing of compounds with a high melt viscosity by means of injection moulding demands advanced production techniques. Especially when using compounds with high filler rates of materials having a high thermal conductivity such as graphite, soot or metal powder, the process conduct is highly dependent on the compound´s melt viscosity. Consequently a high injection pressure combined with high injection rates is needed. In order to obtain a complete mould filling with parts having a high aspect ratio, a dynamic mould tool temperature is necessary. In this context, the variothermal process by induction heating with its high dynamics is a capable alternative to fluid-tempering systems.
A rised temperature - restricted to defined parts of the cavity wall - improves the mould filling. For example high gloss surfaces without noticeable joint lines can be generated.

Design

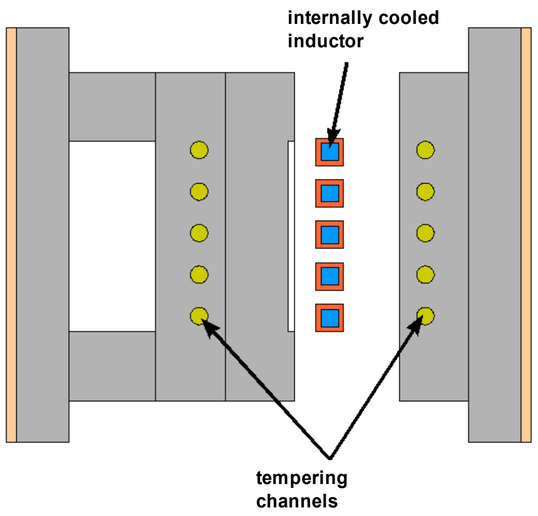

Fig. 1: injection moulding tool with external induction heating

Tool tempering by means of induction heating can be grouped in two basic designs.
In order to achieve a direct heating of the mould cavity surface an **external inductor** is deployed facing the opened mould. The advantages of this method of variothermal tool tempering using an external inductor are:

- usually negligible adaptions to the mould design as the system is not directly engaged with the moulding tool
- direct heat generation in the mould cavity, thus heating rates up to 50 K/sec achievable
- inmould preheating of metal insertion components for overmoulding possible

However, the disadvantages are:

- the cooling stage is bound to start prior to the injection as the inductor has to be retracted before closing the mould
- principle only suitable for rather small planar geometries without salient topology
- actually only sytems heating one half of the mould are applied

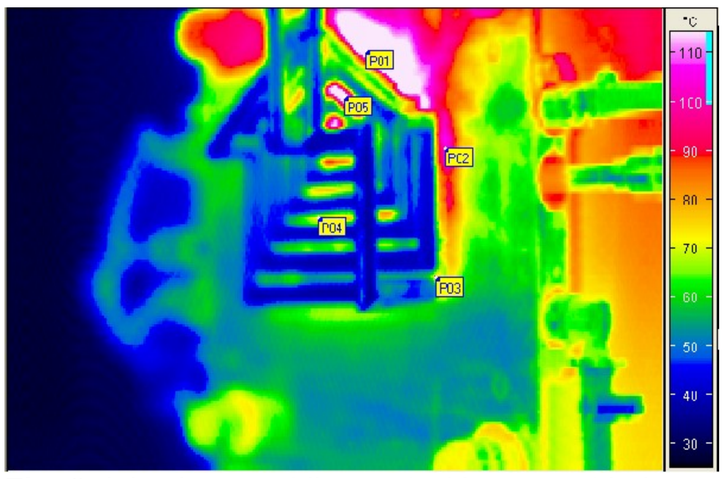

Fig. 2: injection moulding tool with external inductor for manufacturing bipolar plates

A different concept is heating the cavity by a **mould-integrated inductor**. The inductor is placed back to back to the cavity, forming a fixed element of the moulding tool. The electric insulation between tool an inductor ist granted by ceramic grout.

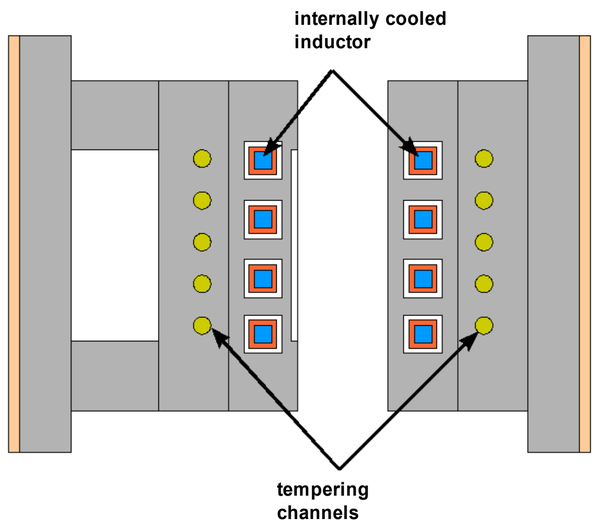

Fig. 3: injection moulding tool with fully integrated induction heating

The resulting advantages over systems using an external inductor are:

- cycle-independent heating – e.g. through the holding pressure phase – is possible
- the water cooled inductor can be used for cooling the part. If conditions warrant, a contour-approximating cooling can be waived
- as the cavity is heated from behind by thermal conduction, this concept is also suitable for large surfaces with salient topology
- heating both mould halves is possible without difficulties

But there are also disadvantages of an integrated induction heating:

- lower performance than induction heating with an external system due to the need of thermal conduction
- demanding tool design as the integration of an induction heating system has to be taken into consideration right from the beginning

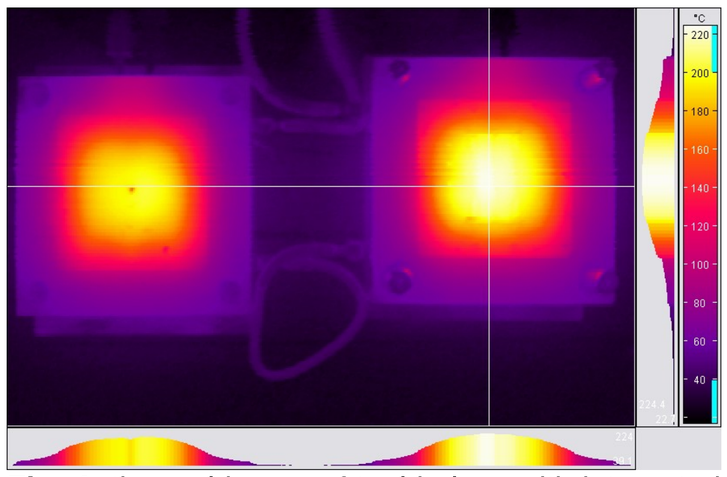

Fig. 4: thermal image of tool halves with integrated induction heating and changeable cavity inserts

Integration in SELOGICA

A temperature-controlled injection moulding process using the Arburg SELOGICA control unit is possible both with external and internal induction heating.

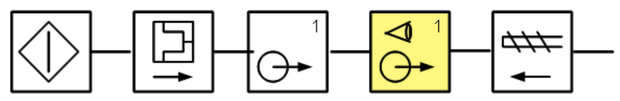

Fig. 5: integration in the Arburg SELOGICA sequence control
(excerpt concerning the induction heating)

The signal of a mould-integrated temperature sensor is interpreted as a monitoring input, switching the induction generator on and off according to the temperature level. Status or error signals of the peripheral generator can be used as feedback so that the process monitoring works conventionally.

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