

Thermal Simulation of a Heat Pipe Tempered Plastic-Injection-Mould



Bundesministerium
für Wirtschaft
und Energie

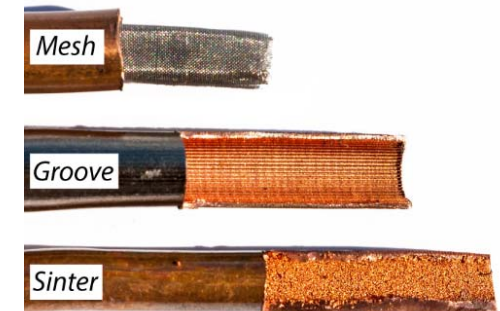
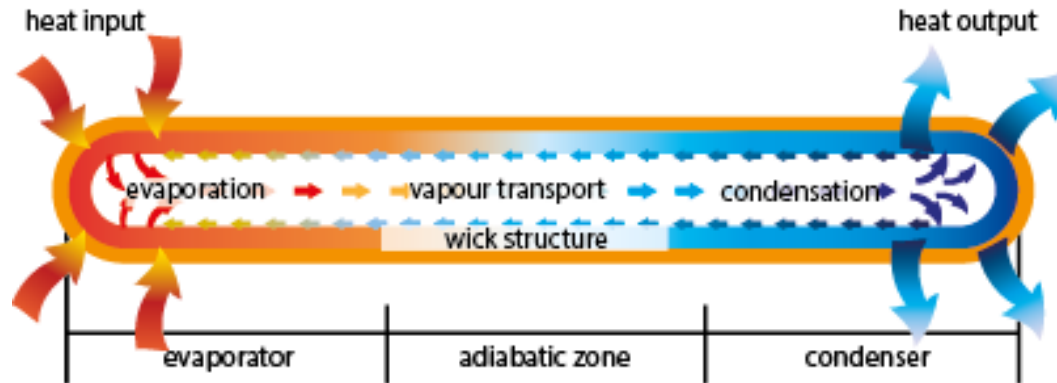


Curriculum Vitae

Stephan Kartelmeyer, M.Sc.

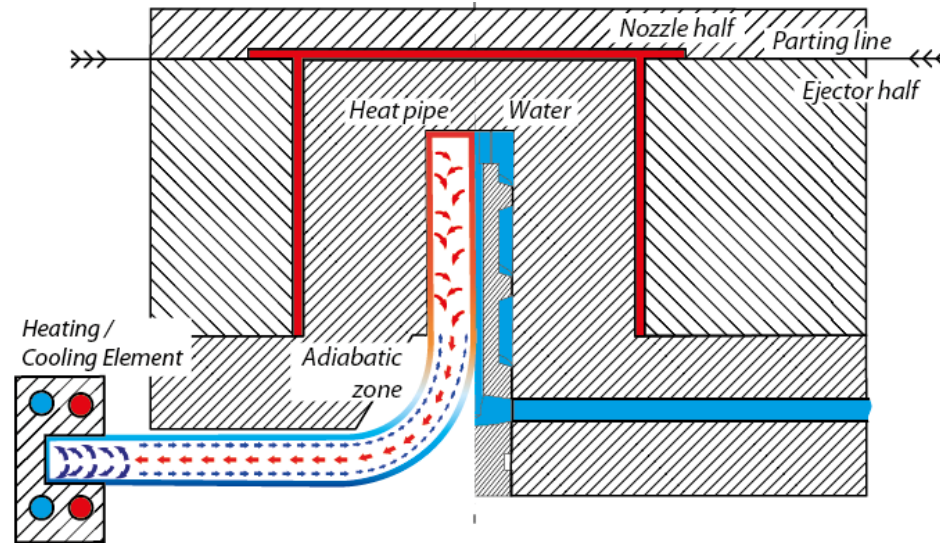
- Scientific Assistant at the University of Applied Sciences Bielefeld
 - Doctoral Student at Plastic Technology Paderborn (KTP) of Paderborn University
 - Focused on injection-mould tempering strategies.
 - PhD topic: Plastic-injection-mould tempered and simulated with heat pipes
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- Apprenticeship for Mechatronics
 - Bachelor Studies Mechanical Engineering (University of Applied Sciences Bielefeld)
 - Bachelor Studies European Engineering Business Management (Coventry University / England)
 - 3 Years working experience in Industry as a mechanical designer
 - Master Studies Mechanical Engineering (Paderborn University)
 - Further experience abroad in China and USA (during the Master Studies)

What is a heat pipe?



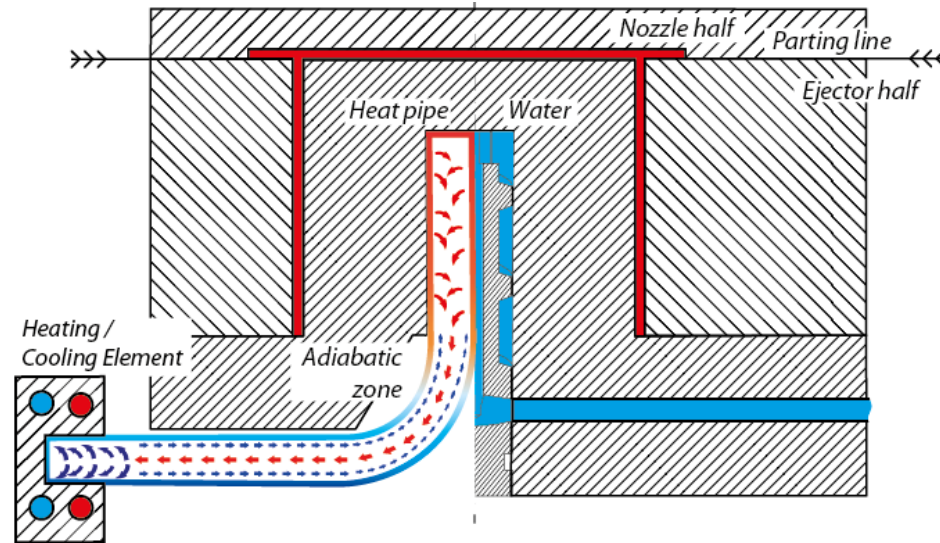
- Hermetically closed tube with low pressure and fluid
- Phase change of the Fluid in lower temperatures (Water: e.g. 30 °C instead of 100 °C)
- Very fast and dynamic heat transfer
- Heat transfer against gravity because of capillary structure inside
- Very low price

State of the Art: Water based tempering



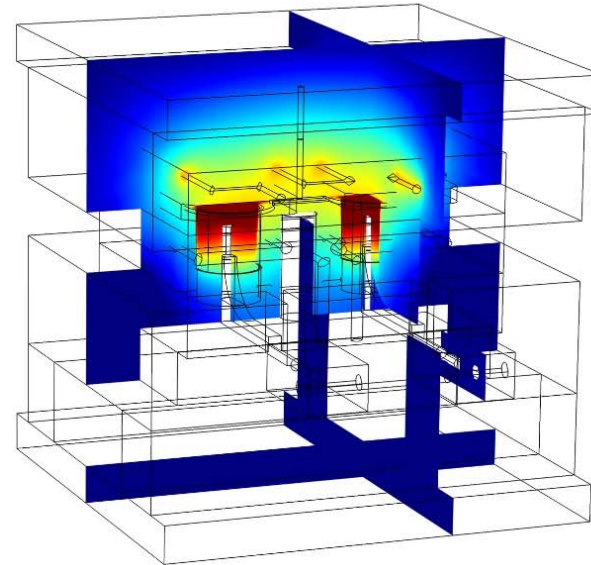
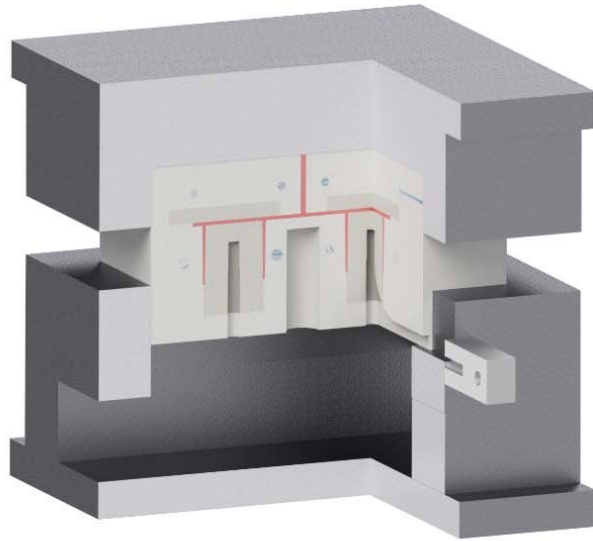
- Water based tool tempering:
 - Heating up to production temperature
 - But also cooling thermal critical areas (HotSpots: plasticized plastic compare to local tool material mass)
- Disadvantages of water:
 - cost expensive (peripheries and heating)
 - design and manufacturing-intensive
 - Rust and dirt contamination in the channels

Heat pipe tempered Plastic-Injection-Mould



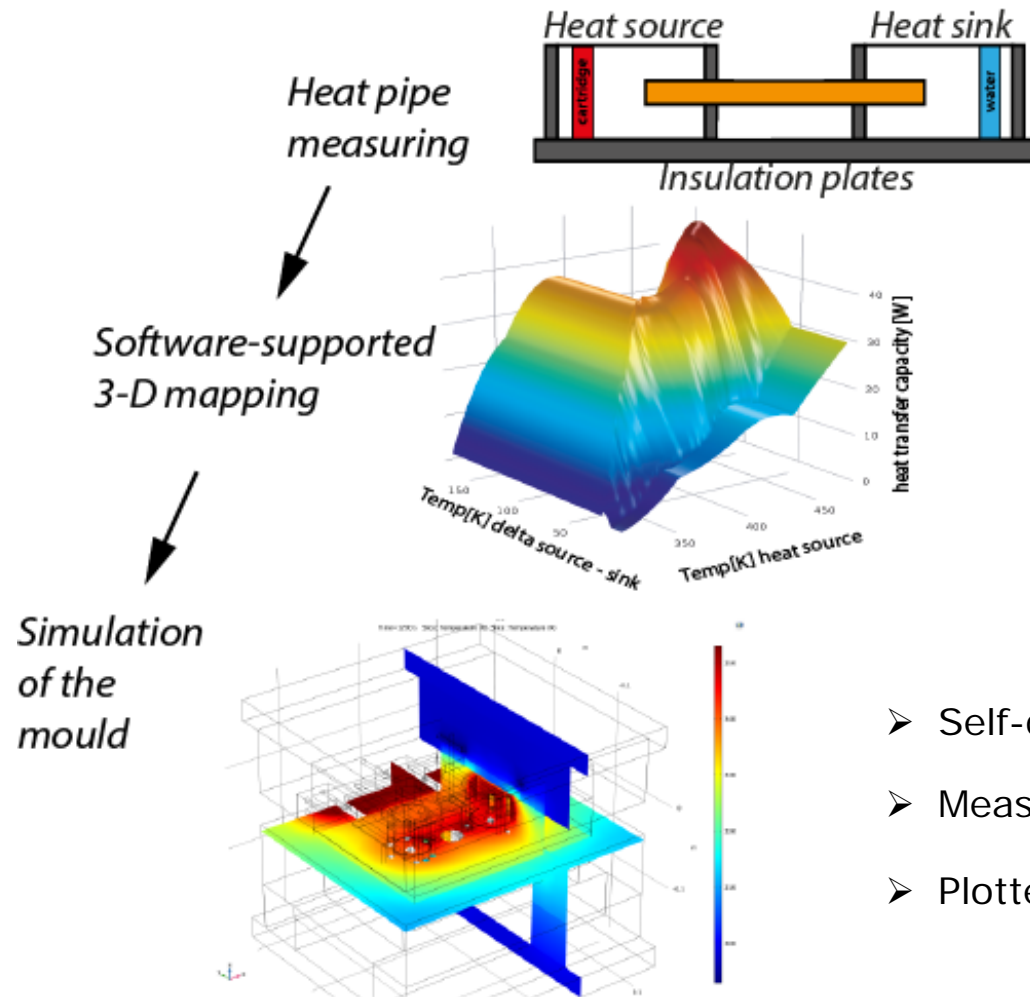
- Heat pipes are cooling the tool in thermal critical areas
- The rest of the tool is heated by the plasticised plastic
- Heat transfer reversible: heating up the tool

Thermo-simulation with heat pipes



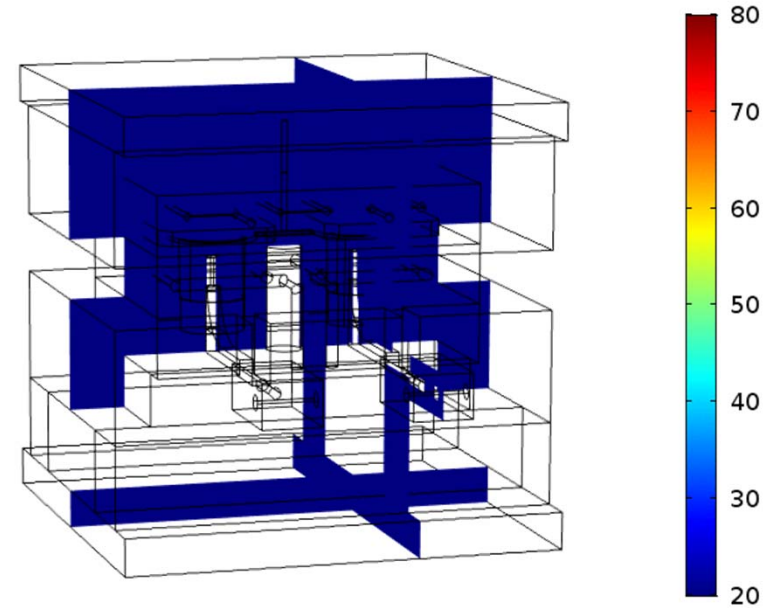
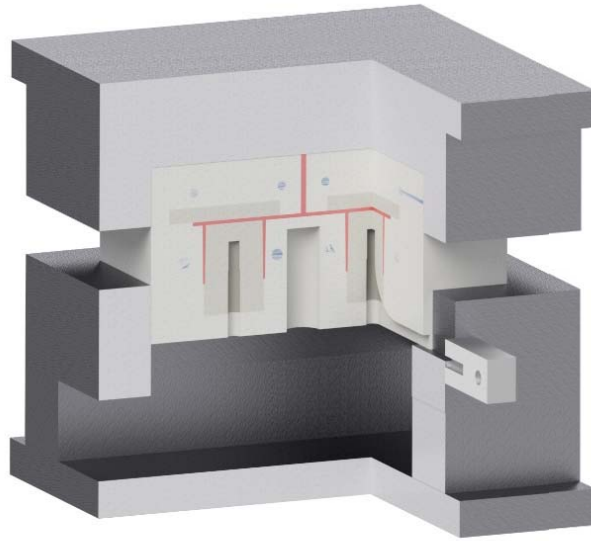
- Not the heat pipe is simulated -> *Simulation with a „heat pipe black box“*
- The realistic heat transfer rate is implemented in the model
- A measured 3D plot of the heat transfer rate is linked to a heat flux node

Methodology for „black box heat pipe simulation“



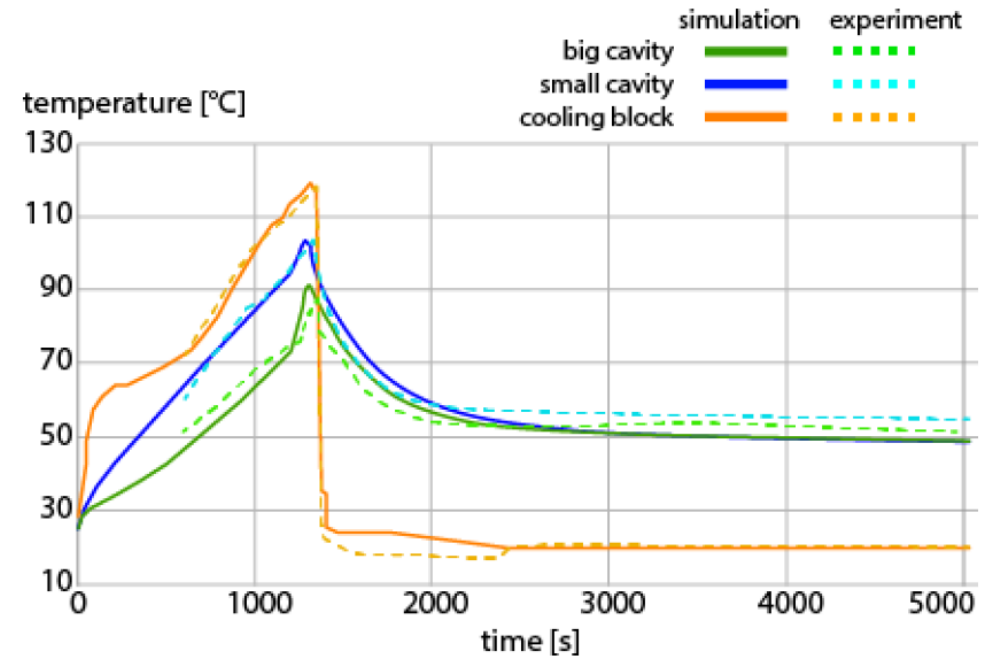
- Self-designed testing-stand and testing methodology
- Measuring of heat pipes
- Plotted in a 3D map

Thermo-simulation with heat pipes



- Calculation of the temperature with every plastic-injection cycle
- In dependence of the current heat transfer rate of the heat pipe
- Allows a cyclic simulation of the mould heating

Real process validation



- Validation in the real plastic-injection-mould process
- Focus on the core of the ejector half
- Quasi steady-state process: The temperature difference between simulation and real process is 5 K

Thank you very much for your kind attention!

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