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[1.] JIŘÍ TECHNIK

INJECTION MOLD COOLING CONFIGURATION

Abstract:
The correct design and setup of cooling channels of injection molds make possible a small energy loss during an injection process. The cooling channels are designed yet in design of tool and it is not easy changing them by complete tool. But what is possible to change by complete tool, is a setup and a connection of circuits. It means a flow rate and water temperature at system. To optimalization is possible use cooling simulations which works on FEM principle. The article describes an optimalization of a cooling setup for real part

Keywords:
Reynolds number, cooling channels, simulation, temperature, flow rate

INTRODUCTION

The tools cooling is longest section of injection cycle and his optimalization is possible achieve of a short injection cycle. It is profitable main from an economic aspect and also from a part quality aspect.
The cooling channels in an injection mold can be series or parallel. At parallel circuit is fed by water several parallel circuits from one or several sources. An ideal case is when water is uniformly distributed in all circuits by same temperature and flow rate. The series circuit does not contain any sub-circuit and has one inlet and one outlet. In result has it relative long cooling channel.
For a correct circuit setup should be keep:

1. *Water temperature different between inlet and outlet should not be overrun 5°C.*
2. *Reynolds number at a circuit should be at intervals from 10 000 to 20 000.*

By higher Reynolds number is growing up a hydraulic gradient and a heat removal is not growing up from the tool cavity. The Reynolds number depends on channel diameter, dynamically viscosity and flow rate.

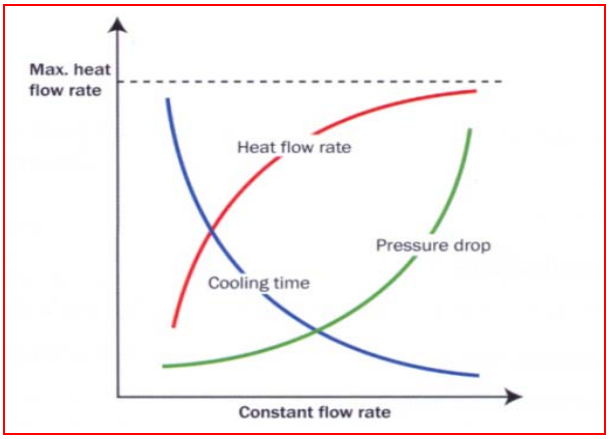

Fig. 1: The relationship of heat flow rate and coolant flow rate

OPTIMALIZATION

By the help FEM simulation was optimized a cooling channels setup of an injection mold for a dish. Main target was effective channels flow rate (Reynolds number) and a homogenized temperature distributed by plastic part. The original flow rates setup of six circuits was unachieved and no effective. Re number was in interval from 5 783 to 43 569. In a core were occurred tree circuits, whereas in two circuits was flowed a water with temperature 11°C and in third circuit with temperature even 50°C. Thereby it was happened to no uniform heat off-take. A matrix was cooled by four circuits, whereas it happened to same effect as by the core (no uniform heat off-take).

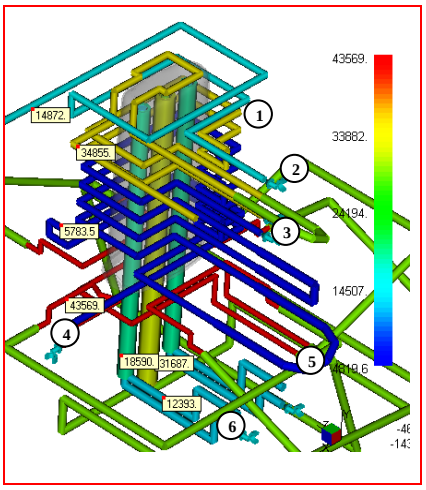

Fig. 2: Re number in circuits – original variant

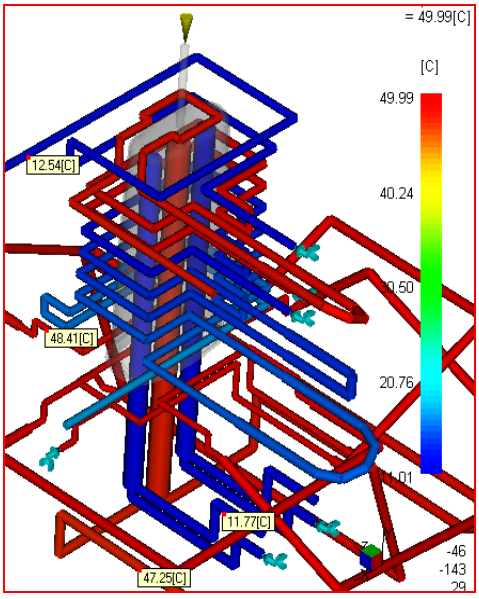

Fig. 3: Water temperature in circuits – original variant

The temperature distribution on the part was not homogenous and so in the part by next cooling was happening to internal stress. The different in the fig. 4 achieve even 27°C. In the fig. 4 right is increased temperature from second baffle and so rise next temperature different.

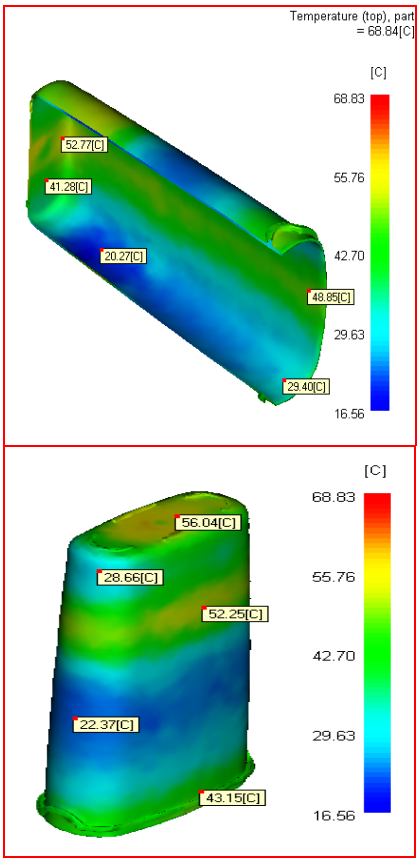

Fig. 4: Temperature – top distribution by part (temperature different is 27°C) – original variant

Tab. 1: circuits settings

Circuit	*Temperature [°C]*	*Flow rate [l/min]*
1	*11*	*9*
2	*11*	*3.5*
3	*50*	*9*
4	*50*	*9*
5	*11*	*9*
6	*11*	*9*

The setting modification consisted in a preferable modification of flow rate, temperature and in reconnection of circuits. The circuits 1, 2, 3 and circuits 5, 6 were merged into one circuit. The circuit no. 4 stayed unmodified, so tree circuits were arisen. The three circuits have optimal flow rate and temperature.
Reynolds number is now in ideal interval 10 000 to 20 000. The temperature distribution after modification is yet homogenized. The

temperature different in distribution is 10°C. The heat is most concentrated in part cavities and higher temperature is so on the top of the core (opposite to hot runner). Therefore is the core cooled on 22°C. For the homogenize temperature distribution is the matrix tempered on 30°C. The circuit cooling slides (has smaller cooling channel diameter) has the flow rate 5,5l/min. So doesn't it happen to high pressure losses.

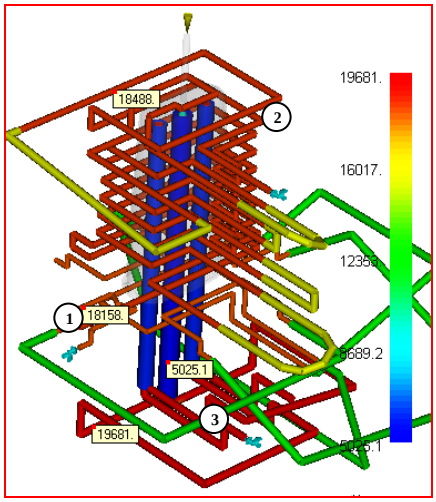

Fig. 5: Re number in circuits – new variant

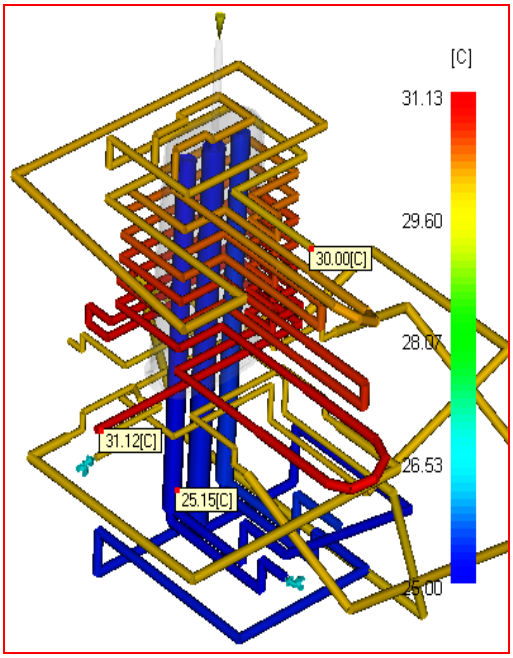

Fig. 6: Water temperature in circuits – new variant

Tab. 2: circuits settings

Circuit	*Temperature [°C]*	*Flow rate [l/min]*
1	*30*	*5.5*
2	*30*	*7*
3	*22*	*7*

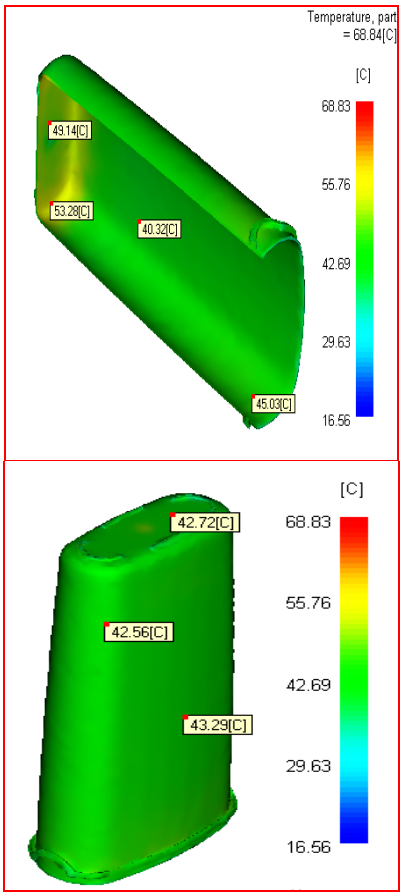

Fig. 7: Temperature – top distribution by part (temperature different is 10°C) – new variant

CONCLUSION

By modification of a cooling system setting can be achieve to improve of mold cooling. Re number should be in the interval 10.000 to 20.000. Thereby we achieve more efficient mold cooling. The water temperature different should be between inlet and outlet max. 5°C. Minimally should be a turbulent flow in cooling channel. Often of that is not possible achieve because we have a low power pump by temperature controller. For a mold design is necessary make sure what will be the pump power of temperature controller and the cooling channels design accordingly. The control of cooling system in FEM software can easy choose fails in connection and it also by molds, where would we it nonscheduled.

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[4] http://www.wittmann-robot.de/index.php?idp=85&lang=1
[5] http://www.gwk.com/de/produkte/temperiertechnik/temperiertechnik_ausgabe.phpconnection and it also by moulds where would we it nonscheduled.

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