ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume IX (XIX), 2010, NR2

STUDIES CONCERNING THE DESIGN OF THE RUNNER, GATE AND VENTING SYSTEMS IN THE CASE OF THE HIGH PRESSURE DIE CASTING TECHNOLOGY

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Keywords: high pressure die casting, runner, gate, overflow, mold design

Abstract: This paper describes the main type of runner systems used in the high pressure diecasting technology, the design of the runner, gate and venting systems wich are important factors in the quality of the high pressure diecasted parts.

1. Introduction

The runner system has the role to conduct the molten alloy from the shotsleeve in the cavities of the high pressure diecasting mold with the main scope of the forming of the part.
The runner system has to allow the guiding of the material to the ingate section on the shortest possible way. The runner should have the cross-sections as square as possible

2. Main runner types and runner design

The main type of runner systems used in the high pressure diecasting of aluminium are the following:

- Vertical runner system
- Runner system with V shape
- Horizontal runner system

In the figures 2.1.and 2.2. are presented the vertical gating systems and the determination of the different cross sections of the gating system.
The disadvantage of this type of runner systems is that the filling of the cavities is consecutive, wich can give differences from quality point of view for the parts resulted in the different cavities.

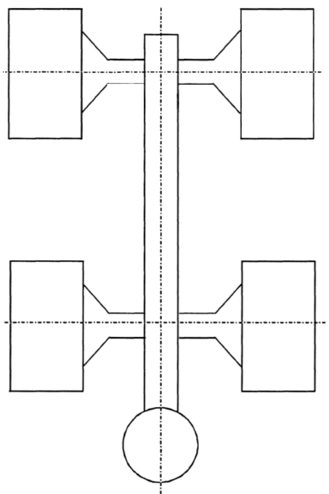

Figure 2.1. Vertical runner system designed incorrectly [7]

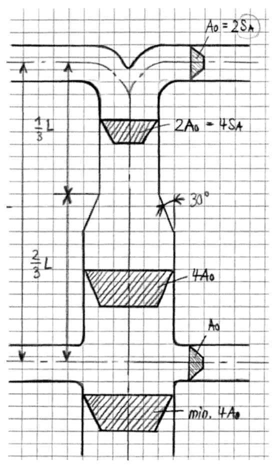

Figure 2.2 Correctly designed vertical runner system

In the figure 2.3. is presented the runner system with V shape wich is mostly used for the parts wich requires compact structure and high precision. The disadvantage of this type of runner system is that it requires the melting of a bigger quantity of alloy for the realize of the gating system.

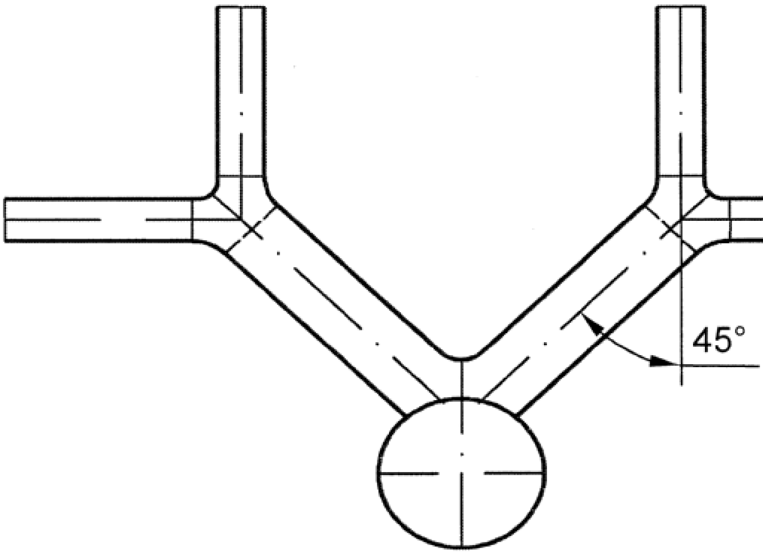

Figure 2.3. Runner system with V shape [7]

In the figure 2.4. is presented the runner system with V shape for a four cavities mould used to diecast a transmission bracket.

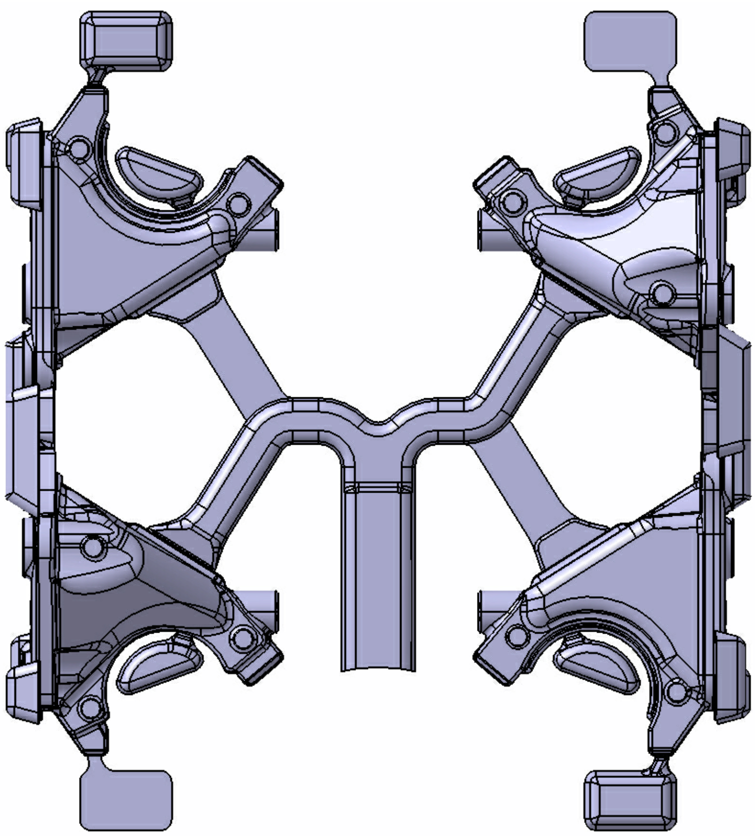

Figure 2.4. Runner system in V shape for a transmission bracket

In the figures 2.5. and 2.6. are presented the horizontal runner systems: horizontal runner system with four cavities with two ramifications in V shape and horizontal runner system with four alligned parts.

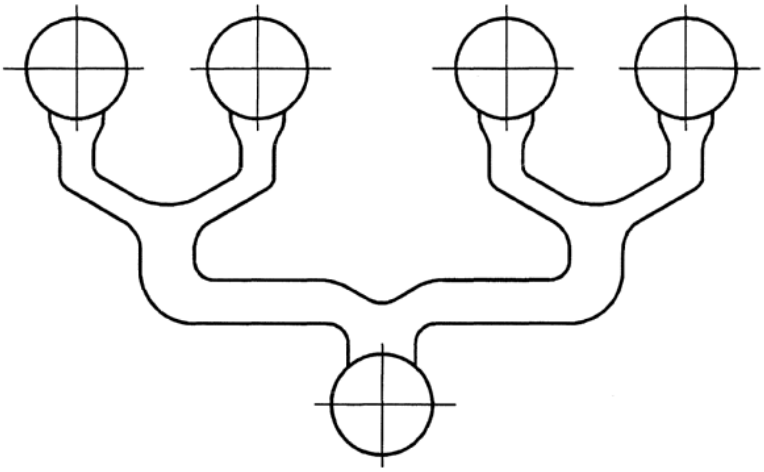

Figure 2.5. Horizontal runner system with four cavities with two ramifications in V shape [7]

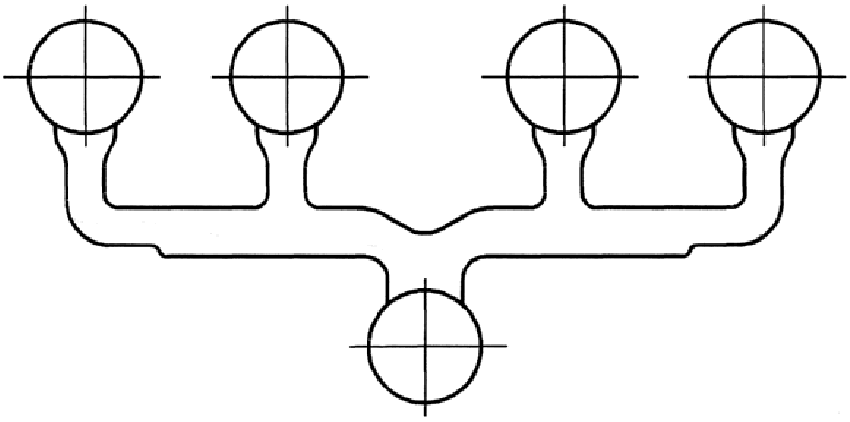

Figure 2.6. Horizontal runner system with four alligned parts [7]

In the figure 2.7. is presented a horizontal runner system with four alligned parts for an engine suspension bracket.

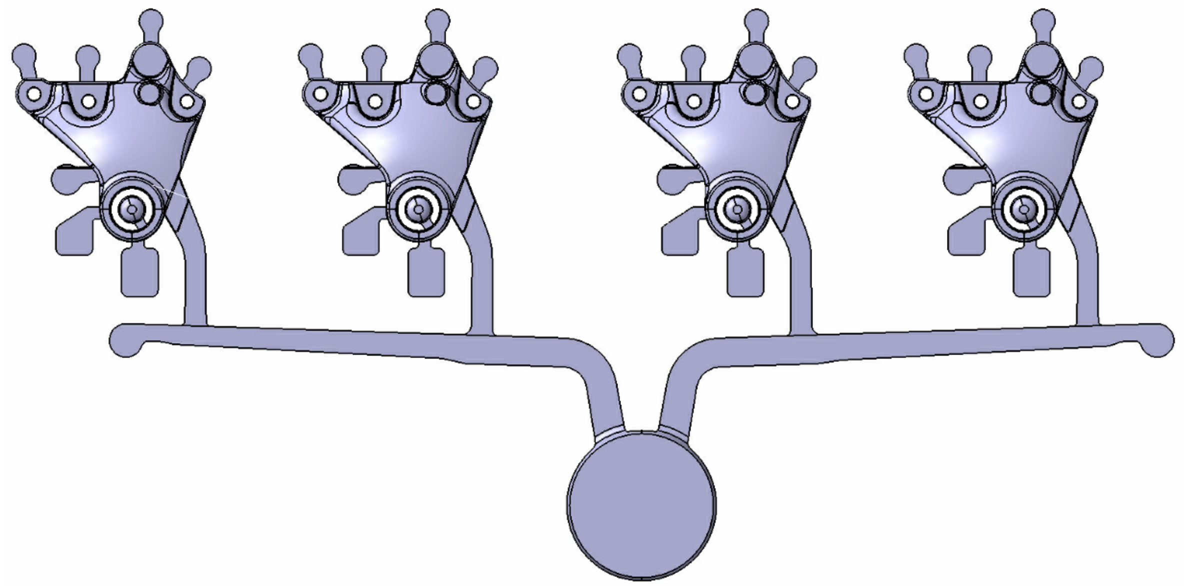

Figure 2.7. Horizontal runner system for a four cavities mould for a suspension bracket

The ideal shape of the runner cross section is the circular one because this shape allows the smallest temperature lost of the molten alloy during the injection.
In the figure 2.8. is presented the temperature distribution chart in the runner system in function of the shape of the runner cross section.

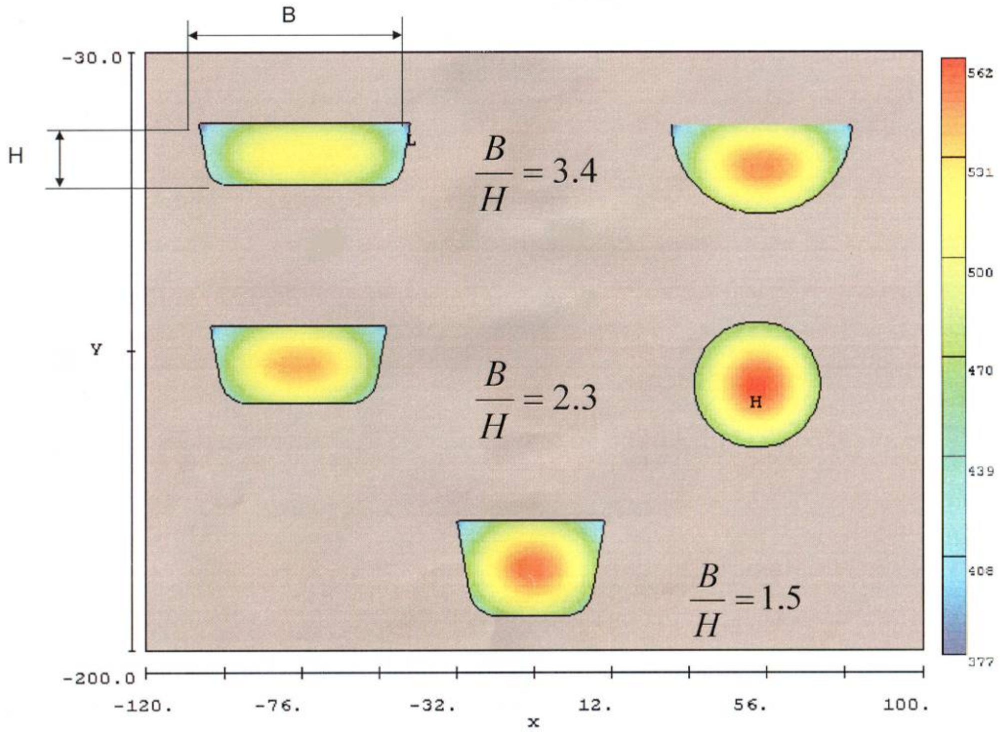

Figure 2.8. Temperature distribution chart in the runner system in function of the shape of the runner cross section [7]

3. Design of the gate system

The design of the gate system usually starts with the determination of its sections surface. In order to determinate gate cross section the filling speed and the tilling time must be choosen.

The filling speed v_{MA} [m/s] can have values between 30 -50 m/s.
The filling time t_{med} [s] depends and it is choosen in function of the medium wall thickness s [mm] of the part, according to the Table 3.1.

Table 3.1. Medium filling time in function of the wall thickness of the part [5]

s	1.5	1.8	2	2.3	2.5	3	3.8	5	6.4
t_{med}	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.12	0.19

Knowing the specific density $\rho[g/cm^3]$ of the alloy and the volume of the part $V_A[cm^3]$ the weight of the part is going to be determinated $m_A[g]$.
The choosen filling speed v_{MA} has to be transformed in [cm/s] and the gate cross section $S_A[mm^2]$ is determinated with the formula:

$$S_A = \frac{100 \cdot m_A}{\rho \cdot t_{med} \cdot v_{MA}}$$ [5, formula 3, page11]

The calculated cross section is increased with 20-50%, and after choosing the thickness of the section (between 1-3,5 mm) the lenght of the gate can be calculated.
The diameter of the piston should assure a filling rate of 40-70%.

4. Design of the venting system

In order to obtain a good quality of the diecasted parts in terms of health of material the cavities of the mould must have an efficient wenting. In most of the cases the wenting of the cavities is done within the overflows. In the figure 4.1. is presented schematic the shape of the overflows recommended by the company Bühler.

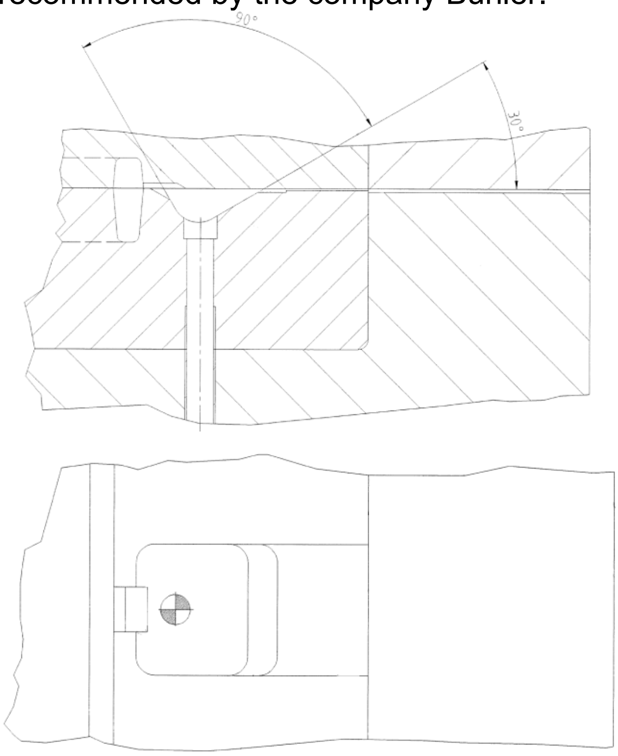

Figure 4.1. The shape of the overflows recommended by the company Bühler [7]

5. Flow and solidification simulation

The first activity of the flow simulation preparation is the ingate channel and the overflows design. The ingate channel has the role to conduct the molten aluminium from the shot sleeve to the cavities and the overflows have the role of evacuation of the air and gases resulted from the lubriffication of the mold.
The purpose of the flow simulation is to develop and improve the shape of the part and also of the ingate channel to have an optimum filling of the cavities and to identify the last filled areas where the overflows have to be placed in order to assure good wenting of the cavities and minimize gas porosity defects.
For the flow simulation can be used softwares as Procast.
In the figure 5.1. is presented the flow simulation of two cavities of the mold of the transmission bracket.

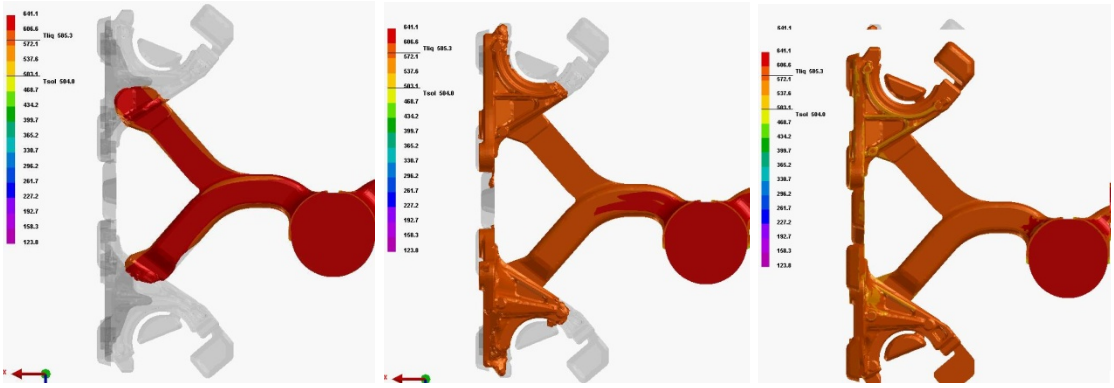

Figure. 5.1. Analyse of the cavities filling wih Procast software

With the same software is performed the solidification simulation wich has the role to identify the areas where the part presents areas with liquid fractions after the optimum solidification time wich can cause shrinkage porosities. The shrinkage porosity apears in areas where is concentrated big mass of aluminium, where the thickness of the walls is to high.

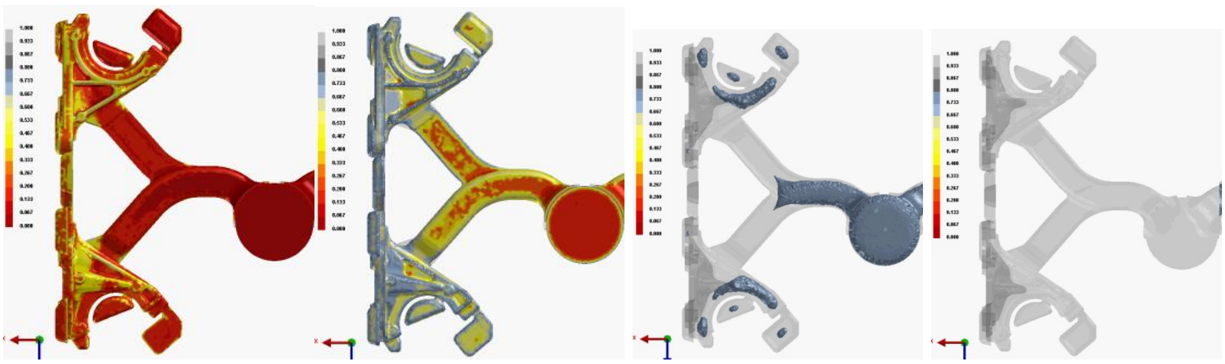

Figure. 5.2. Solidification simulation with Procast software

6. Conclusions

The design of the runner, gate and venting systems in the case of the high pressure die casting technology requires a high qualification of the design team members, performant and expensive softwares for simulation. Even by fullfilling these requirements in many cases after the real trials during the serial production the runner, but mostly the gate and wenting systems has to be continuosly improved.

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