INFLUENCE OF VACUUM ON ADJUSTING PARAMETERS OF HIGH PRESSURE DIE CASTING PARTS FROM ALLOY AlSi9Cu3(Fe)

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Abstract

In paper authors present the influence of adjusting key parameter, which is changeover point between first and second phase, on quality of casting from AlSi9Cu3(Fe) alloy. Technological tests were carried out in industrial conditions on a machine with a clamping force of 1200 Mg with variable parameters of the piston operation. Production practice has shown that with inappropriate selection of parameters, on the final products significant casting defects appear in the form of: drags, delaminations, sticking of castings on the mould and discoloration associated with uneven filling of the mould cavity. Based on the temperature distribution of the mould, the spray head was checked for correct operation and its impact on defects was eliminated. The filling of the mould was checked at the time of switching the second phase with the vacuum turned on and off in the mould cavity. It was shown that the key parameter is the appropriate selection of the changeover point of the second phase which is influenced by the vacuum in the cavity of closed mould.

Keywords: High pressure die casting, aluminum alloys, process parameters

1. INTRODUCTION

High pressure die casting is a process that is characterized by very high speed and pressure not found in other foundry technologies. Currently the most common in production of aluminum casting companies are cold-chamber machines to which liquid metal is supplied manually or automatically. The injection process is part of the casting cycle, which can be divided into three phases. The first phase (the slowest) leading the metal to the in-gate. The second phase (the fastest) feeding of the metal to the mould cavity and the third phase refining of the metal in the mould under high pressure. The selection of appropriate process parameters is a key to obtaining qualitatively appropriate castings [1]. In the era of increasing requirements for castings, it is necessary to use a vacuum to eliminate air from the mould cavity before injection. This has a significant impact on the selection of casting parameters, and in particular on the selection of changeover point between first and second phase. The work focuses on the elimination of casting defects by appropriate selection of the casting parameter which is the selection of the second phase changeover poing. The spraying process was checked first to eliminate its impact on the occurrence of defects. The castings were made of AlSi9Cu3(Fe) - ENAC 46000 alloy.

The aim of the research was to assess the impact of vacuum on the selection of technological parameters of the high pressure die casting process for automotive components. The correct value of the vacuum in the working chamber of the casting machine will also help to improve the material quality in terms of reducing the defects of finished products.

Table 1 Composition of alloy EN AC 46000 in wt% according to the PN-EN 1706: 2011 [2]

Range	Al	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb	Sn	Ti
Min.	Residue	8	0.6	2	0	0.15						
Max.		11	1.1	4	0.55	0.55	0.15	0.3	1.2	0.35	0.035	0.2

2. HIGH PRESSURE DIE CASTING PROCESS

The high pressure casting process in a cold chamber machine can be divided into 9 basic stages shown in the diagram below **Figure 1**:

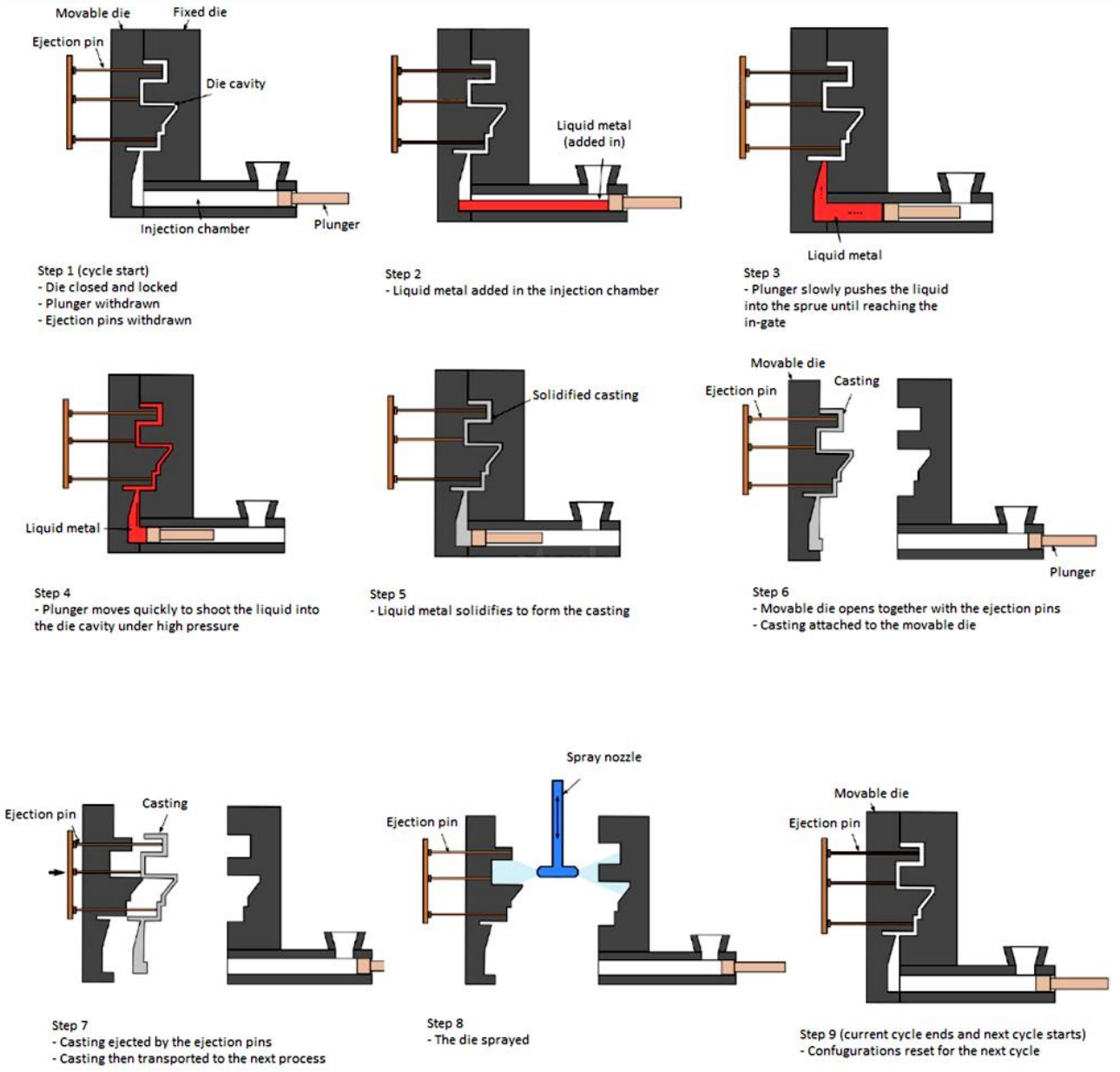

Figure 1 Diagram of the high pressure casting process

The applied vacuum is activated in stage 3 [3]. This is due to the liquid metal closing the air supply. Appropriate process control is key to achieving a stable process and qualitatively suitable castings.

3. INFLUENCE OF VACCUM ON PROCESS PARAMETERS

During casting on the initial parameters of the valve cover casting defects appeared which are presented in **Figures 2-4**.

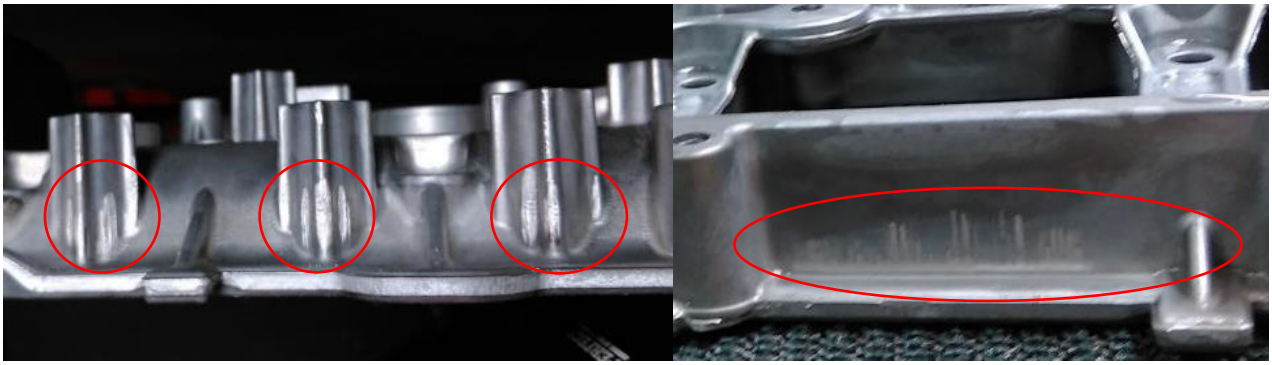

Figure 2 Drags on the part at the gating system

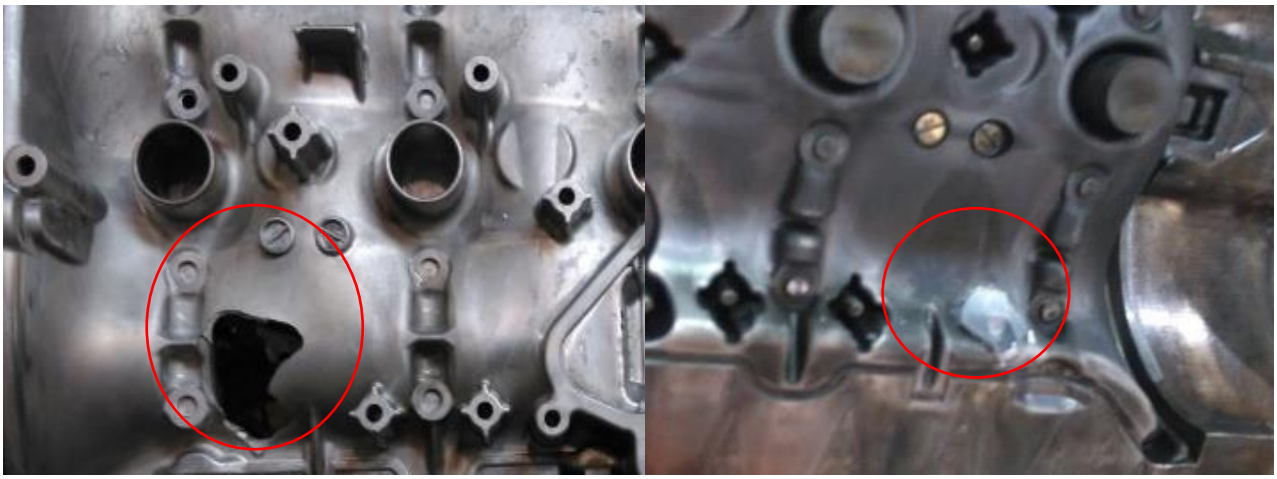

Figure 3 Casting sticks to the fixed die

Figure 4 Visible traces of metal joining and delamination

In order to eliminate defects, the efficiency of the spraying system was checked first. By observing mould temperatures in the production cycle, no deviations from production practice were observed. Irregularities of the spraying system were thus excluded. The next step was to carry out the mould filling test with / without vacuum. An important parameter affecting the process is the piston speed, all speeds were constant during casting [4]. The liquid metal should be at the height of in-gate to obtain the required quality of castings.

Figure 6 Mould filling test without vacuum, changeover point 450 mm

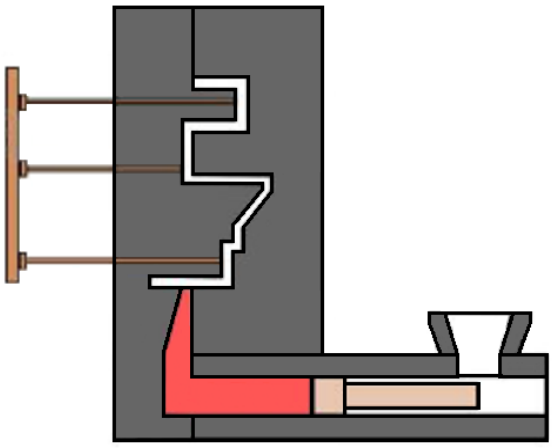

Figure 7 Mould filling test without vacuum, changeover point 500 mm

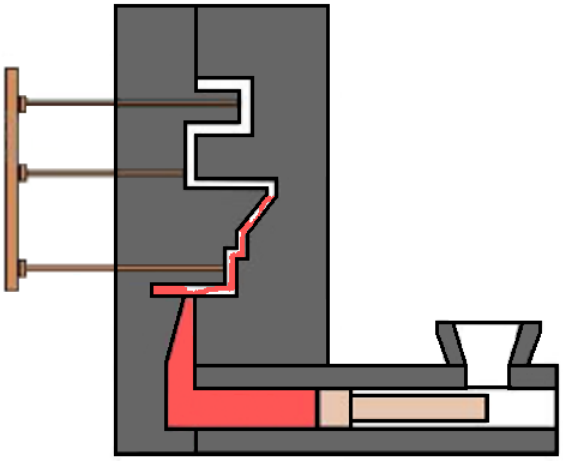

Figure 8 Mould filling test with vacuum, changeover point 500 mm

The results of the fill test are shown in **Figures 6-8**. For reasons of technological secrecy, the results are shown in the diagrams. If the vacuum was not used, the appropriate switching point would be 500mm, however, the effect of vacuum below 100 mbar causes metal to be drawn into the mould cavity (prefill) before switching the second phase. **Figure 8**. The final parameter of the switching point was 475 mm, which compensated for the impact of the vacuum on filling the cavity forms and gating system.

4. CONCLUSION

The selection of casting parameters is key to obtaining quality castings. Among the machine parameters multiplied pressure in the third phase, Plunger velocity in the second phase, die cavity filling time have significant effect on porosity formation in aluminum die castings which directly responds to mechanical properties of castings. In paper parameter changeover point of second phase was investigated.

Initial parameters resulting from theoretical calculations are an indication for the proper conduct of the process and test castings should be carried out to match the parameters to both the mould and the type of casting machine. As shown in the article, the type of pressure casting process (conventional or vacuum) has a significant impact.

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