Research Progress on New Technologies of Lost Foam Casting for Aluminum and Magnesium Alloys

Wenming Jiang*, Zitian Fan
State Key Lab of Materials Processing and Die & Mould Technology, Huazhong University of Science and Technology, Wuhan 430074, PR China
*Corresponding address: e-mail: wmjiang@hust.edu.cn

Abstract: Lost foam casting (LFC) is a precision green casting technology with some special advantages. However, there are some problems in aluminum and magnesium alloys lost foam casting, such as poor filling ability, serious hole defects, coarse solidification microstructure and low mechanical properties. In view of the above problems, this paper mainly introduces the latest research progress of several new technologies of aluminum and magnesium alloy lost foam casting. Vacuum and low pressure lost foam casting technology can ensure the stable filling of liquid metal, improve the aluminum and magnesium liquid filling and filling capacity, and protect the filling process. The vibration solidification and pressure solidification increased the compactness of the castings and refined the microstructure, thereby significantly improves the mechanical properties of the castings. The expendable shell casting technology could solve the pore, carburization as well as inclusion defects of the traditional LFC method, obtaining the castings with the good surface quality. Magnesium/aluminum bimetal lost foam compound casting technology can directly form complex magnesium/aluminum bimetal castings at low cost. These proposed novel LFC technologies will have positive effect for solving the current technological issues and promoting the technological progress for the LFC process.

Keywords: LFC under vacuum and low pressure; Vibration solidification; Pressure solidification; Expendable shell casting; Bimetallic castings

1 Introduction

The lost foam casting (LFC) process is a near net forming technology that represents 21st century casting technology. Currently, LFC technology is widely employed in the cast iron and cast steel materials. The applications of Al and Mg alloys on the LFC technology are relatively few, especially in the Mg alloy[1]. The technology and control of the LFC process encounter much difficulty because of the material properties of the Mg alloys; thus, the Mg alloy LFC remains on the test stage. The technical difficulties for the Al and Mg alloy LFC are as follows. Firstly, the loss of heat is largely due to the decomposition of the foam materials, leading to poor filling ability of the molten metal. On the other hand, the pouring temperature of the Al and Mg alloy LFC is higher (i.e., 30 °C to 50 °C) compared with that in the common casting process. As a result, the oxidation and burning of the Al and Mg alloys lead to a coarse microstructure, pore and inclusion defects, and poor mechanical properties. Basic studies on the foam pattern materials for the Al and Mg alloys are still lacking[1-3].

2 Experimental procedure

Some novel LFC technologies for the Al and Mg alloys are proposed and investigated to solve the aforementioned technical problems, including porosity defect, poor filling ability, and low mechanical properties for the Al and Mg alloy LFC technology.

3 Result and discussion

1) LFC under vacuum and low pressure

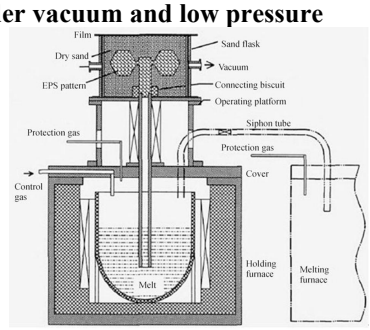

Fig. 1 Schematic of the LFC under low pressure and vacuum.

The LFC under vacuum and low-pressure technology combines the LFC process and low pressure casting (LPC). It possesses the advantages of the LFC and LPC processes. The schematic of this new casting technology is presented in Fig. 1. The filling ability of the melt is increased as the melt is filled with a control pressure.

2) LFC under vibration solidification

The mechanical vibration of the LFC under vibration solidification technology has been applied on the solidification process of the casting. The relevant schematic is shown in Fig. 2. During the vibration solidification process, the forced convection of the melt is caused by the vibration.

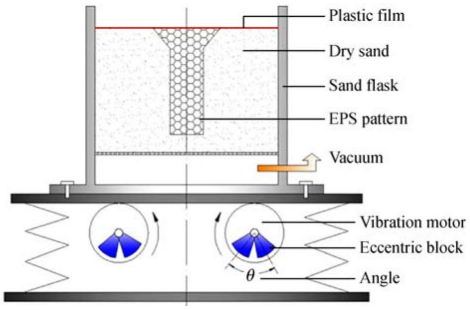

Fig. 2 Schematic of LFC under vibration solidification.

3) LFC under pressure solidification

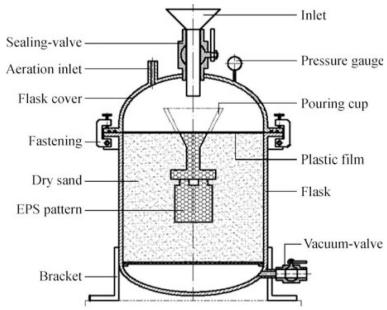

Fig. 3 Schematic of LFC under pressure solidification

The LFC under pressure solidification technology combines LFC and pressure solidification technology, which can increase the density and improve the mechanical properties of the castings. Fig. 3 illustrates the equipment and method of the LFC under pressure solidification for technology.

4) Expendable shell casting technology under vacuum and low pressure

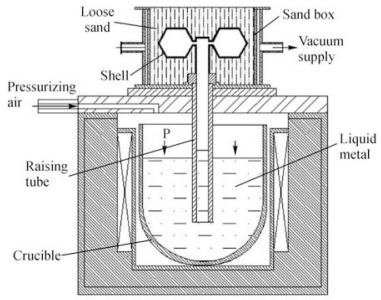

Fig. 4 Schematic of the expendable shell casting process under vacuum and low pressure

The expendable shell casting process combines the LFC and the investment casting technologies. The expendable shell casting technology under vacuum and low pressure simultaneously adopts the preparation of the foam pattern of the LFC process, the fabrication of the ceramic shell of the investment casting, and the vacuum and low-pressure casting based on the expendable shell casting. Fig. 4 presents the schematic of this casting technology.

5) Preparation technology of bimetallic castings based on the LFC method

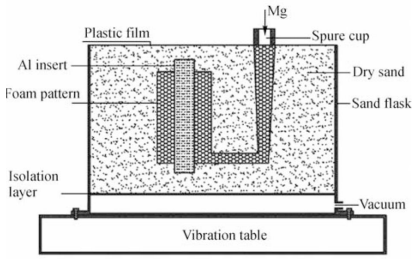

Fig. 5 Schematic of the preparation technology of bimetalliccastings based on the LFC method

Currently, a large number of methods to produce the bimetallic castings, such as casting, welding, and rolling, are available. In particular, the LFC method can be used to directly fabricate the bimetallic castings. The schematic of the preparation technology of bimetallic castings based on the LFC method is illustrated in Fig. 5.

Fig. 6 LFC castings

4 Conclusion

(1) The LFC under vacuum and low pressure, the vibration and pressure solidifications, the expendable shell casting technology under vacuum and low pressure, can reduce the pouring temperature, improve the filling ability, refine the microstructure and which is suitable for producing the complex and thin-wall castings.

(2) The Al/Mg and Al/Al bimetallic castings with acceptable metallurgical bonding can be successfully prepared by the LFC method.

(3) These proposed novel LFC technologies can solve the current technological problems and promote the technological progress of the LFC process. Finally, other important development directions for the LFC technology include foam materials, coating, and purification technology of the tail gas

References

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