

OPTIMAL DESIGN FOR THE CASTING PROCESS OF THE LOWER CASE OF GEARBOX

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Abstract: The lower case is part of a gearbox to support the hub or bearing. The material of this casting is ductile iron. Process design is based on the paste-like solidification of ductile iron and the self-expanding characteristics of graphite[1]. The pouring system is designed according to the theory of large hole outflow. The cavity is filled with liquid metal fleetly and reposefully. Ultimately, the acquired casting has compact structure and no obvious shrinkage. By way of sand casting, furan resin sand is used as sand - type material. Throughout the design process, software such as UG、VE、PROcast and CAD are used to support simulation. The parameters of casting process have been optimized to get better results.

Introduction

The lower case is a part of gearbox which is used in machines such as cars, boats and compressors (Fig. 1). Bearing socket and gear fixed socket can be found on the picture. Inside the lower case, there is a large cavity which is used to install and locate grooves and pits. On both sides of the box, stiffeners are provided to enhance the stability of structures.

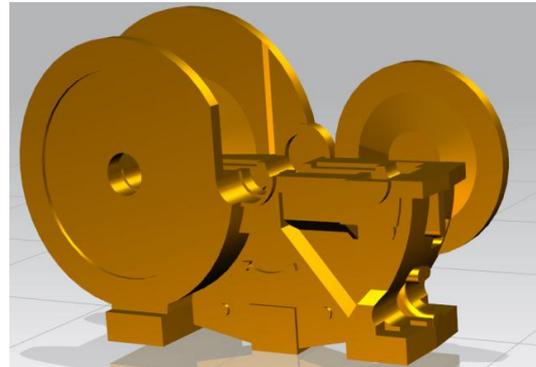


Fig.1 shape of the lower house

Material and properties of the casting

The material is ductile iron and its model number is EN-GJS-400-18. The specific ingredients of the material are shown in Table 1. Ductile iron casting products have the characteristics of higher strength, toughness, wear resistance, Etc. By spheroidizing and inoculating, the mechanical properties of ductile iron have been effectively improved.

Tab1 EN-GJS-400-18 chemical composition

element	C	Si	Mn	P	S	Cr	Ni	Cu	Mg	others
content /wt%	2.63	3.43	0.182	0.547	0.0043	2.93	4.46	0.062	0.137	/

Casting Structure Analysis

The outline of the case is 1550×540×960 mm. Since the casting structure size is large, there will be a risk that the molten metal may not fill the mold cavity completely during casting. The bottom

of the lower case is thick, therefore a hot knot is easily formed at the corner which may lead to shrinkage and other defects [2]. In consideration of the complicated shape of the casting and the maximum cross section that is not at the end of the casting, two case molding way is adopted.

Design of casting process

Pouring position of the casting

The pouring position of the casting means its position in the mould. It can affect the solidification sequence and the quality of casting [3]. Pouring position of the casting is chose as showed in the Fig.2.

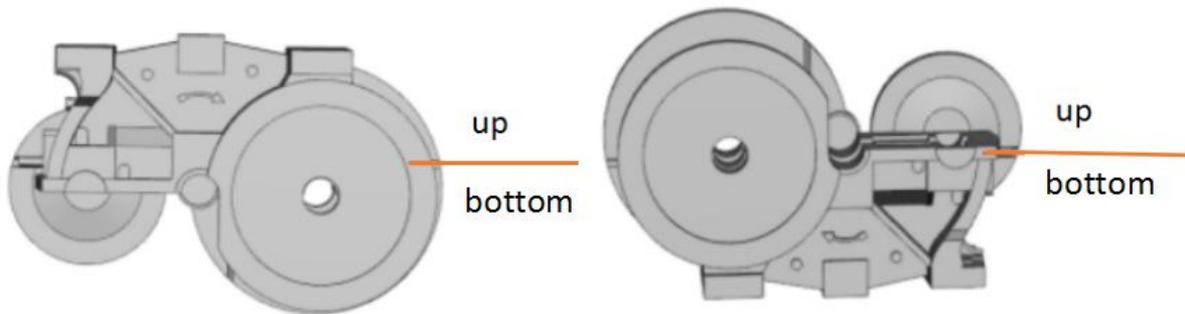


Fig.2 position of the casting

Design of gating system

The parting surface is selected in the middle of the casting by two-part moulding. The case is located between the upper and lower sandbox and its height is 1212 mm. The sizes of the gate, sprue and runner are calculated respectively, and the sprue shape is determined corresponding to them.

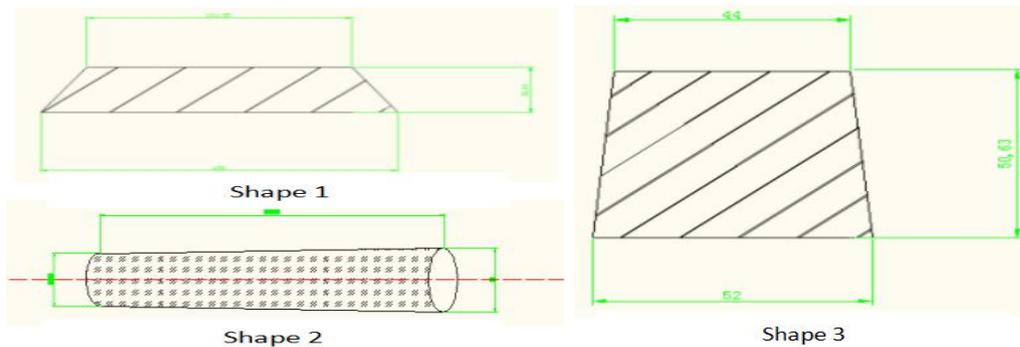


Fig.3 shape of the gates

As shown in Fig. 3, the size of gate is 47.76 cm^2 in shape 1. The size of sprue is 95.32 cm^2 in shape 2 and the size of runner is 28.82 cm^2 in shape 3. A sprue base is designed at the turning of the sprue to avoid sand shakeout which is caused by molten metal falling from the sprue.

Design of risers and cold iron

In order to obtain high-quality castings, not only a reasonable casting system, but also the appropriate feeding capacity is required. Nodular cast iron is characterized by "mushy solidification". There will be precipitation of carbides during solidification. The expansion of the precipitated carbons can reduce the total amount of the required supplemental metal. This feature is

also called the ductile iron self-feeding [4]. For large castings, it is impossible to rely on the self-feeding of the material. Consequently, it is still necessary to add risers to the casting. According to the hot circle method, three risers are designed on the casting.

By the adding of cold irons, local metal liquid is rapidly solidified to improve the surface hardness and wear resistance of the casting. Three cold irons are added to avoid the partially shrinkage cavity.

So the pouring system was designed as shown in the Fig4.

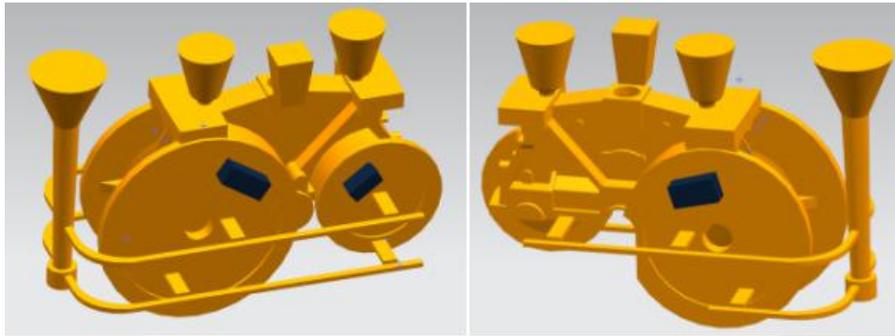


Fig4. pouring system

Design of sand core

The role of sand core is to form the cavity of the casting. Because of the complex of case shape ,the sand core is designed in the form of coordination with each other. Eleven sand cores are designed to help casting forming. The sand core is placed in the cavity in the sequence of 8/9/10/11→8→3/4/5→1/2→6/7

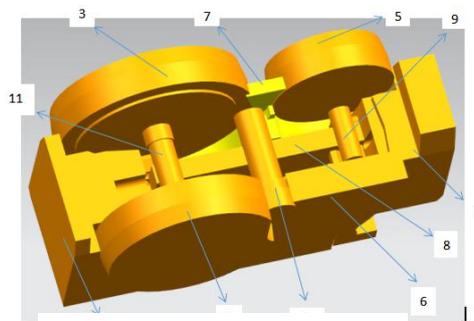


Fig5.sand core assembly

PROcast simulation

Meshing of the casting

Firstly, the mesh size of solid sand box is set to 100 mm and the casting's mesh size is set to 40 mm. In the process of division, some grids are irregular. Automatic repair and manual trimming are used to obtain the desired mesh shape for the casting simulation. The mesh result is shown in Figure 6.

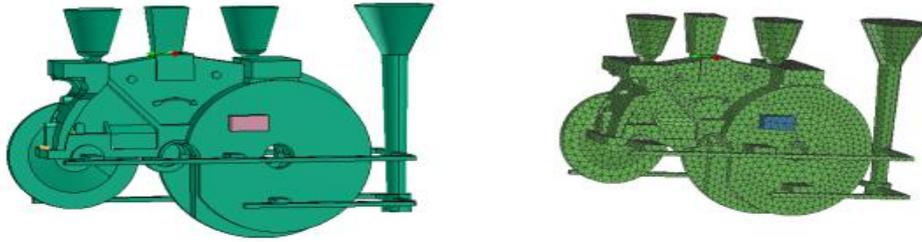


Fig6.the meshing result of the casting

Subsequently, parameters are set up as Tab.2.

Tab.2 Parameters of the casting

Material	Heat 1	Heat 2	casting temperature	Gravity	pouring speed	Casting type	Initial temperature
Nodular cast iron	400W/M ² /K	500W/M ² /K	1420°C	9.8m/s ²	81mm/s	Gravity filing	20°C

Simulating result

The molten metal is filled to the cavity at the speed of 81mm/s. Casting filling process is smooth. During solidification, cold iron plays a very important role in chilling the thick wall [5]. Combined with the final gas and shrinkage porosity diagram, it is found that the concentrated parts of shrinkage cavity and shrinkage porosity have been basically eliminated. As the filling process is more stable, the phenomenon of wrapped gas is basically eliminated, and no turbulence is found. The simulating result can be found in Fig7.

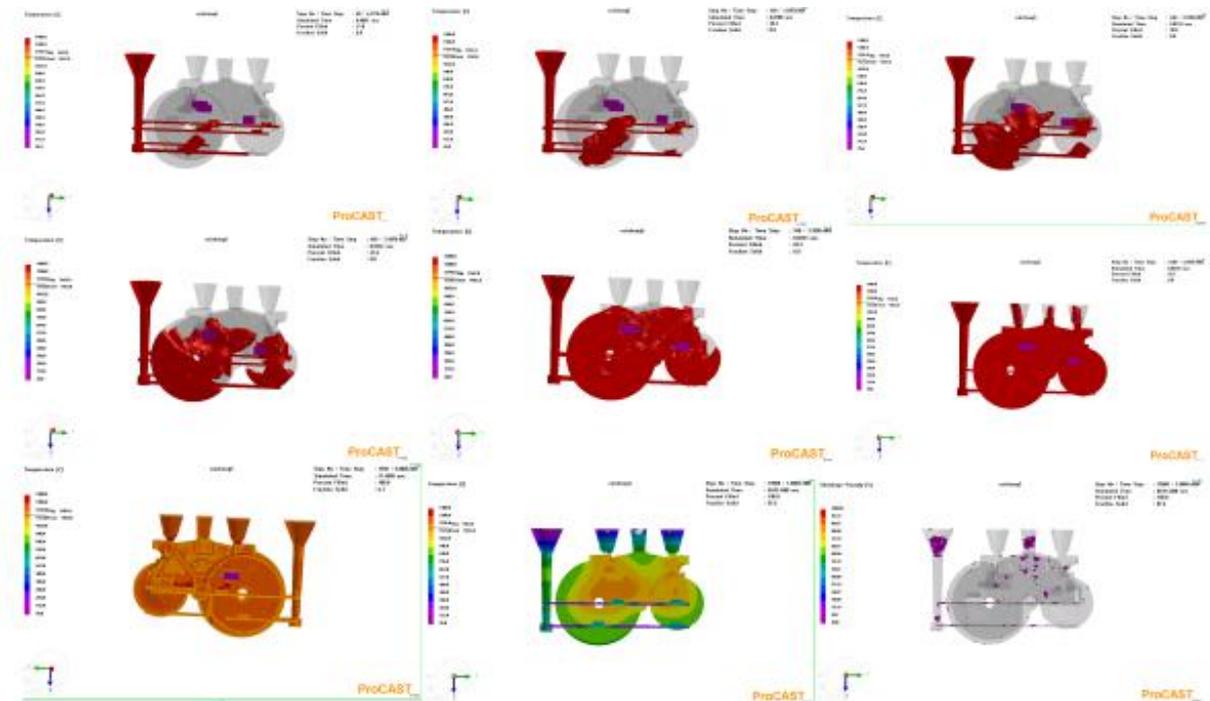


Fig7.the meshing result of the casting

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