MINING AND METALLURGY INSTITUTE BOR
and
TEHNICAL FACULTY BOR, UNIVERSITY OF BELGRADE

IOC 2022
International October Conference

53rd International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Ana Kostov
Milenko Ljubojev

3 – 5 October 2022. Hotel "Albo" Bor, Serbia

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TABLE OF CONTENTS

PLENARY LECTURES

GEOLOGY, MINING AND MINERAL PROCESSING

METALLURGY, MATERIAL SCIENCE, TECHNOLOGY AND CHEMISTRY

ENVIRONMENTAL PROTECTION

RELATED FIELDS: MECHANICAL ENGINEERING, CIVIL ENGINEERING, ARCHITECTURE, ELECTRONICS, INFORMATICS, MANAGEMENT, ETC.

INFLUENCE OF CHEMICAL COMPOSITION ON THE QUALITY OF CASTINGS OBTAINED BY THE EASY MELTING MODELS

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Abstract

This work presents the results of influence the chemical composition on the quality of castings, obtained using the wax models. After molding the wax models and melting the wax in a dryer, the mold cavity was filled with liquid metal. Four series of castings with the following chemical composition were cast: first series (Cu=90.5%; Sn=6.5%; Zn=3.0%), second series (Cu=83.7%; Sn=7.0%; Zn=9.3%), third series (Cu=90.2%; Sn=1.5%; Zn=3.0%; Pb=3.3%; Fe=2.0%) and fourth series (Cu=85.0%; Sn=5.0%; Zn=5.0%; Pb=5.0%). Based on the obtained results, a lack of filling was observed on a candlestick from the fourth series of castings. The quality of other castings is satisfactory, which refers to the external look. Faults in the form of voids are present, but minimal surface finishing allows obtaining the castings with relatively smooth surfaces.

Keywords: *Easy melting models, castings quality, wax model*

1 INTRODUCTION

Casting with easy melting models is a relatively new technology for making complex castings, which offers a number of advantages over other casting methods. This method of casting for a large number of products achieves considerable savings in processing, and sometimes this method is the only possible way to make castings. They are usually small castings that, in terms of their dimensions, shape and surface, must completely satisfy all technical regulations. The principle of this manufacturing process consists in making a model from wax, which is then covered with quartz sand scrum and covered with molding material. After blowing the mold with CO_2 gas, its complete hardening occurs. The mold prepared in this way is taken to the dryer and placed so that the bottom of the mold is facing upwards, and the pouring system is facing downwards. The mold is then exposed to an elevated temperature (wax melting point 80 ºC) to melt and drain the wax through the pouring system, thus forming a mold cavity, which is filled with molten metal and after solidification, the desired object is obtained.

The advantages of wax models are as follows: they keep their shape and dimensions well in high humidity, they are not hygroscopic, and they have a low cost.

The wax model is made in the following order: first, a prototype is made, then either a plaster mold or a sand mixture mold is made according to the prototype using the CO_2 process, then the model composition (melt) is prepared and poured into the mold. After hardening of the melt, up to 5 mm thickness, the model is removed from the mold, the surfaces of the finished model are cleaned and processed [1-3].

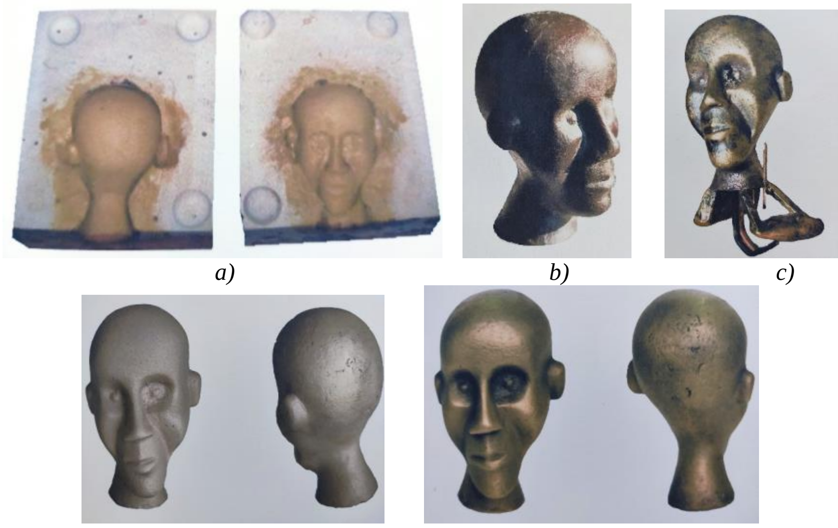
2 EXPERIMENTAL

The experiment was carried out in the following stages:

- preparation the sand mixture for the CO_2 process,
- molding the prototype, setting up the pouring system, vents and guides,
- making cores and obtaining the internal cavities, depressions, openings on castings,
- blowing with CO_2 gas until complete hardening,
- separating the upper and lower chassis and removing the prototype,
- filling the mold cavity with wax,
- removing the wax model,
- molding the wax model, setting the pouring system, casting feeding system, vents and guides,
- core making (for castings that have depressions and cavities),
- blowing with CO_2 gas,
- forming the mold cavity by melting the wax in the dryer,
- filling the mold cavity with liquid metal,
- shaking out and destruction of the mold and removing the casting after the metal solidification,
- removing the pouring system of the feeder,
- sandblasting of castings, and
- patination of castings.

Four series of castings with the following chemical composition were obtained: the first series (C_u=90.5%; S_n=6.5%; Z_n=3.0%), the second series (C_u=83.7%; S_n=7.0%; Z_n=9.3%), the third series (C_u=90.2%; S_n=1.5%; Z_n=3.0%; P_b=3.3%; F_e=2.0%), and the fourth series so called the red cast (C_u=85.0%; S_n=5.0%; Z_n=5.0%; P_b=5.0%).

Figure 1 shows the appearance of the wax model mold, wax model, casting with the pouring system, casting after sandblasting and casting after patination.



a) *b)* *c)* *d)* *e)*

Figure 1 *a) Appearance of the wax model mold; b) Appearance of the wax model; c) Appearance of casting with pouring system; d) Appearance of the casting after sandblasting; e) Appearance of the casting after patination*

3 RESULTS AND DISCUSSION

The obtained castings from the first, second and third series are of satisfactory quality, where the external appearance is primarily concerned. Faults in the form of voids are present, but minimal surface finishing allows obtaining the castings with relatively smooth surfaces. In the case of these castings, underfilling did not occur.

Castings from the fourth series are of similar quality as the previous ones. The only difference is that the candlestick from this series of castings has an underfill. The observed error in the casting is the cause of insufficient drying time of the mold, whereby the entire wax was not melted and removed from the mold. When pouring the metal, the residual wax reacted with the metal, i.e., there was the so called "cooking", which is the main cause of underfill occurrence.

Figure 2 shows the castings obtained by series.

a) b) c) d)

Figure 2 *Appearance of the obtained castings by the series: a) The first series of castings; b) The second series of castings; c) The third series of castings; d) The fourth series of castings*

4 CONCLUSION

The wide practical application of copper alloys with tin and zinc for obtaining the shaped castings is explained by the good mechanical and anti-friction properties, good corrosion resistance and good machinability. Another characteristic feature of these alloys is that they have a wide solidification interval, even up to 150-160°C. A wide solidification interval significantly affects the casting properties, fluidity, appearance and distribution of dents and porosity. Due to their properties, these alloys can be used for the complicated castings with sharp transitions from thin to thick walls. On the other hand, these alloys cannot be used for castings that require greater hermeticity, since the castings are usually permeated with porosity. The porosity that occurs in these alloys is a positive feature for bearing type castings, because the lubricant circulates through the pores and extends the life of bearings.

The content of iron in copper-tin-zinc-lead alloys, up to 0.03%, is useful, because it increases the mechanical properties, reduces the structure and strongly prevents recrystallization. With a further increase in iron, the corrosion resistance and technological properties of these alloys decrease, so it must be maintained within the prescribed limits [4].

The application of the red cast (alloy of copper with tin, zinc and lead) is very wide and varied. Very good casting and technological properties of the red cast have contributed to the production of castings from these alloys ranging from 50 to 70% of the total production of castings from the copper-based alloys. The quality of castings made of the red cast does not significantly differ from the quality of castings made of tin bronzes, but that is why these products are cheaper, because zinc and lead are used instead of expensive and scarce tin.

The quality of castings also depends on the quality of the model. All errors that occur during the model making process are reproduced on the casting. Wax model castings have a smooth surface and are characterized by dimensional accuracy. The only deficiency of castings obtained from wax models is the possibility of underfilling, which is a consequence of a worker's error during the experimental work due to the insufficient holding of mold in a drier.

Based on the appearance and quality of castings obtained by the casting technology according to easily melting models, it can be concluded that the chemical composition of the used alloys was well chosen, because the castings were with satisfactory quality. The results of experimental research and advantages have showed in practice that the applied casting procedure can be considered successful for obtaining the castings of this type [5].

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