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FUSIBLE MODELS USED TO CASTING SMALL DIMENSIONS SCULPTURES

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ABSTRACT

During the study regarding the obtaining of artworks using light fusible models it has been highlighted the possibility of dividing the process of casting-molding in simple, separate operations, whose execution becomes accessible even to people with no high qualification in the field.

An important realization during the study is represented using the dental molding- packaging mass, which has ensured the obtaining of the smoothness of the surfaces and the clarity of form's configurations.

Designing the casting network has been the main preoccupation, in order to ensure the complete action of emptying the wax from the mould and filling it correctly with metal.

A special attention has been granted to cleaning and finishing the surface of the sculpture, this operation ensuring the texture of the future artwork.

KEYWORDS: model, packaging mass, bronze, mould, casting network, cleaning, finishing

1. Introduction

Obtaining cast pieces using fusible models has its origins in the activity of those working in the field of art and today, among other casting technologies, it is a widely used technique in the foundries.

Due to its age of practice, it is difficult to give a precise period of discovery of the casting with fusible models and it is impossible to know the origin and the way of its birth.

Sources point at Egypt and China as countries where this technique has been invented around 3000 B.C. Initially the method was used to cast metals having low melting temperatures (gold, silver, bronze) and in casting jewelleries or artworks.

Having on its side the manufacturing aspect, the technique has special advantages to offer for the nowadays sculptor.

Fusible models can offer the possibility of casting pieces with intricate forms, reduced thickness of the walls and a special look of the surfaces, offering in the same time a great freedom in realizing of forms inviting the artists to unleash his imagination.

The advantages of this method are unquestionable: perfect copying of the tiniest details, obtaining trenches directly from casting, outstanding state of surfaces, mechanical or chemical easy finishing of the cast pieces, aligning with the environmental protection regulations. Adding to these the disappearance of other technologies' imposed constraints as the possibility of obtaining artworks with complex forms or the possibility to obtain the finest details, absolutely necessary for an artwork, or using less quantities of material during the process of moulding-casting the utility of this casting technique regarding sculptures is obvious.

Besides, the technique is as simple as it could be, but a little costly. The casting worker is as important as the sculptor and could contribute to the fame of the sculptor [2, 4].

2. Studies Regarding the Casting of Sculpture Works with Fusible Models

It is well known the fact that casting one piece requires a model, its realization being done by the modeler who builds it following the instructions from a drawing. Concerning the artwork, the sculptor is the one who builds from wax a model which must be the same as the final sculpture, his activity being the warranty of a quality original artwork (Fig. 1 and Fig. 2).

Fig. 1. *"Samurai"*

Fig. 2. *"Knight IV"*

For the study undertaken, I have realized two models, replicas of the desired sculptures, which would be the basis of two statues with the help of fusible models realized in wax (Fig. 3 and Fig. 4).

Fig. 3. *Wax Model for the Casting of the "Samurai"*

Fig. 4. *Wax Model for Casting of "Knight IV"*

The reason for choosing the casting method using moulds with fusible models was not to obtain geometrical precision (low tolerances) but obtaining a clear copy of the artwork' configuration.

The fusible models had to correspond to all requirements of this technique (building the mould, evacuation of the wax, and pouring of the alloy, etc.), the quality of the cast piece depending on accomplishing these requirements [1, 3].

Realizing the channels of the casting network to fill the mould with molten metal and the gases evacuation from its interior is a very important operation because its good functionality is the key to successfully fill the cavities with bronze as well as evacuating the gases from its interior. The elements of casting network were modeled also from wax, being added afterwards to the fusible model. A special attention needs is required when doing this operation, any mistakes being able to lead to overheating and deformation of the model.

The cross section of the feed channels is usually circular, their diameter being particularly important and having to be in correlation with the size of the piece to be cast [5].

In the industrial practice, in series casting, there are calculations done to obtain the right dimensions of these, according to dimensions, walls' thickness and type of alloy. In the case of artworks, another way of doing the calculation is made, based on experience, intuition and a correct approximation of its dimensions. For artworks with dimensions similar with my models', sculptors considering this calculation system appreciate the diameter of the cross section being approximative 0.8 cm.

Fig. 5. *Casting network for the casting of the "Samurai"*

Fig. 6. *Casting network for the casting of the "Knight IV"*

Feeding channels have been realized with variable cross sections, decreasing towards the contact zone with the main piece in order to assure normal filling speed. At the contact point with the mould cavity, the cross section of the feeding channels is not supposed to be much larger than the thickness of wax wall, casting defects being favoured to appear in the cast piece otherwise due to contractions differences [7].

Many principal feeding channels have been utilized connected to the casting funnel, considered enough compared to the sizes of the cast artworks, these channels having ramifications connecting with the wax model at different levels.

Another important component of this casting network necessary to casting is the channel is the ventilation duct. This one, or these ones, supposing that there is one or many, vital for successful casting, have the role of evacuating the gases accumulated in the mold's interior when the molten metal is in contact with the mould. They have been built also from wax, having reduced diameters, serving only for evacuating the gases.

Plaster moulds have been chosen to cast the pieces because of the advantages over the classic ones, and because of the fact there was no casting mixture to be mechanically pressed which could lead to deteriorated models, plaster getting hard by itself, chemically. Other advantages are linked to obtaining cast pieces with very smooth surfaces, they are cheaper compared to other precision methods, and finally they offer the possibility of casting pieces with thin walls [6, 8].

The plaster as moulding material commonly used in foundries has a series of features which make the moulds to have some advantages. The pieces have a rough structure, so they have mechanical features which are reduced, and, in the case of an artwork, they do not matter because of reduced thermal conductivity and low permeability, so leading to a raised possibility of appearance of sulphides.

During the study I have used investment material used in dental technology which assures supplementary advantages compared to the industrial one: high fluidity, good resistance, minimal changes in volume due to temperature variations.

In the case of industrial gypsum, the moulds need to dry in the air for 24 hours in order to solidify. The other operations linked to obtaining the mould like melting and evacuation of the wax, getting the moulds dry and the calcination require a period of 30 hours.

On the contrary, the dental investment mass gets to fully solid mould and at a resistance level in humid state high enough in order to be put in the oven in a period of only few hours. Even if the wax melting temperature is around 63-70 °C, its complete removal from the moulds requires higher values of the temperatures. If the evacuation is not complete, the small particles of the residues retained on the finest zones of the moulds are an obstacle in obtaining a real artwork. The longer the time in the oven, the better the evacuation of the residues from the mould cavity.

It is desirable for the wax evacuation to be done in 2 stages. The wax evacuation would be done having the casting funnel facing downwards, and when the wax has been evacuated almost entirely, the mould should be positioned with casting funnel facing upwards in such a way that the oxygen (from the oven) should circulate more easily reacting with the wax and realizing gases, which are evacuated, and not Carbon particles.

Time to be exposed in the oven should be longer if the temperature in the mould is lower and the size of wax larger. In the case of dental investment material, it could be introduced in the pre- heated oven even if the temperature is 500 °C without the danger of cracks appearance.

In the Figures 7 and 8 are presented the moulds used for casting the two statues.




***Fig. 7, 8**. The moulds used for casting the two statues*

The alloy casting has been done gravitationally, this method being the most used one in the foundries. The estimated quantity of metal necessary for the casting has been done considering the model’s volume having as data calculation the weight and density of the wax being used.

The alloy has been melted in an oven with induction, its temperature being 1200 °C. After the casting and cooling, the hammering followed. The casting funnel and network have been removed the first, the pieces being afterwards finished through sanding.

In order to ensure that the surfaces and the parts with large bumps (Figures 7 and 8) are perfectly smooth and to ensure the model’s configuration after cleaning, I realized a finishing with the chisel, the rasp and abrasive discs.

Final touch has been realized in several stages, starting with a preliminary processing with a new rasp, followed by successive sanding stages done with different sandpapers of different granulations in descending order (large, medium and fine respectively).

This finishing has been of extreme importance, the final aspect of the artwork depending on it, requiring a large amount of working and patience. As a casting worker and a sculptor, the surface smoothness must be compared with the metallographic samples.

3. Conclusions

The mould mixture used to build the mould has been a dental investment material, a little expensive which ensured a high quality level of the cast piece as well as a shorter period of time on the entire cycle of utilizing it, starting with building the mould and ending with removing the artwork from the mould.

Realizing the moulds from plaster, which hardens chemically, creates the conditions to avoid the action of tapping the sand mixture and deteriorations of the model or leading to vibrations during moulding.

Slower solidifying of the alloy as a result of low thermal conductivity of plaster moulds and the ore pronounced tendency of the artworks to form voids and rough structure have been prevented by a casting network where the stress was on the feeding channels.

References

[1]. Radulescu C. Gh., Albita Gh., *Retele de turnare*, Editura Tehnica, Bucuresti, 1976.

[2]. Florea Gh., *Procedee performante de punere in forma*, Editura Europlus, Galati, 2008.

[3]. Buzila S., *Procedee speciale de formare*, Editura didactica si pedagogica , Bucuresti, 1978.

[4]. Florea Gh., Chiriac Al., Marginean I., Croitoru Gh., *Turnatoria de Arta Foundry*, Materiale metalice, Partea I si II: Editura Europlus, Galati, 2008.

[5]. Robert G. Craig, *Materiale dentare restaurative*, Editura All, Bucuresti, 2001.

[6]. Simionescu Gh., *et al.*, *Ingineria proceselor de formare*, Editura Alvarom, Bucuresti, 2000.

[7]. Carcea I., Matei Gh., *Aliaje neferoase de turnatorie*, Editura Performantica, Iasi, 2000.

[8]. Elisabeta Vasilescu, Ana Doniga, *Modern Approaches in Design Optimization of Parts and the Development Trend of Surface Treatments*, Analele Universitatii Dunarea de Jos din Galati, Fascicula IX Metalurgie si Stiinta Materialelor, nr. 9, p. 30-36, 2012.