Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium, Volume 21, No. 1, ISSN 1726-9679
ISBN 978-3-901509-73-5, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2010
Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird
Annals of DAAAM International

MOULDING TECHNOLOGY FOR SMALL ARTISTIC CAST PIECES IN CERAMIC FORMS WITH BOUNDARY SEPARATION

SIMIONESCU, G[heorghe]

Abstract: *The presented paper presents a technology for making small artistic pieces formed in ceramic shapes. Basically, the process consists in preparing a moulding compound with high fluidity properties; the obtained mixture is poured in the forming model. The fluidity of the moulding compound allows a good reproduction of the model geometry, so no external pressure is required. In case of complex pieces or larger pieces, it is recommended to vibrate the mould. After some time the moulding compound reaches the consistency of rubber is extracted from the moulding box. Pouring of the moulding compound can be done in cold or hot moulding box. Process can be applied to ferrous alloy casts. Castings with this technology give good dimensional accuracy so that their surface does not require any further processing on machine tools or grinding.*
Key words: *ceramic moulding, fluid compound, jellification*

1. INTRODUCTION

The moulding process in shell moulds with easy fusible models is characterized by the fact that mould shell does not have a separation surface and it is applicable for small pieces with complex configuration and is profitable especially for mass production.

In case of larger parts, having complex shape and good accuracy requirements the Shaw process is used. This process is appropriate for unique part or mass production. The Shaw process is used by foundries since 1951 and is well presented in the moulding literature.

Nevertheless, the Shaw process is still well protected by patents and licenses and many researches are cared on to improve it (Cernat & Simionescu, 2009).

2. DESCRIPTION OF THE MOULDING PROCESS

The technology is branded by the fact that the entire form is manufactured by pouring of the moulding compound which is fluid (pasty) over the model shape as is presented in figure 1.

The technological process includes the following stages:

-Preparing the moulding compound (preparation of pulp)

-Mounting of the model on the moulding bed (fig. 1, a);

-Mounting of the moulding flask around the model (fig. 1, b);

-Pouring of the liquid moulding compound over the model positioned in the moulding box (fig. 1, c);

-Waiting for jellification of the moulding compound (fig. 1, d).

The jellying duration is a function of ambient temperature as shown in Figure 2a. Figure 2b presents the variation of the strengthening required time function to the content of urotropin (hexamethylene tetramină - $(CH_2)_6N_4$. After the jellification, the obtained model is released from the moulding box (fig. 1, e).

Extraction of the obtained model is carried out manually, the ceramic mixture composition having the consistency of vulcanized rubber.

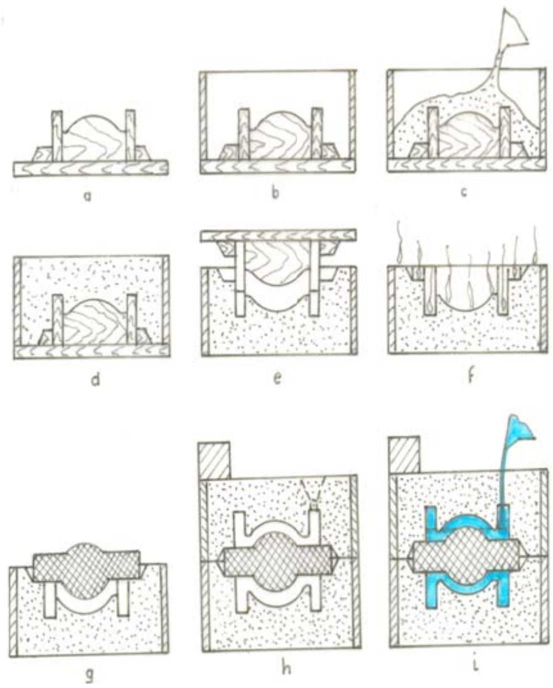


Fig. 1 Stages of the moulding process in case of small cast pieces in ceramic forms with boundary

The obtained form model will be fire up, and it is burning with open flame until all the volatile substances will be removed (fig. 1, f).

During this stage, in the form model is taking place the formation and stabilization of a micro-crack network (fig. 3).

Crack dimensions must be small enough to not allow to the alloy to penetrate, but large enough to overtake dilation and contraction of the model during moulding, and secondly to permit evacuation of the air and other gases from the form model (Simionescu & Cernat, 2000):

-Calcinations of the ceramic form model at temperature of 850...9000C

-Mounting of the moulding core (fig. 1, g);

-Assembly and consolidation of the resulted model (fig. 1, h);

-Pouring of the alloy (fig. 1, i) in the moulding model (the form model can be hot or cold).

-Disassembly of the moulding forms and cleaning of the resulted pieces.

In principle, the process consists in preparing a moulding compound with high fluidity to pour into the moulding box over the model. The fluidity of the moulding compound allows a good reproduction of the model geometry, so no external pressure is required. In case of complex pieces or larger pieces, it is recommended to vibrate the mould. After some time (between 2 and 15 minutes) when the moulding compound reaches the consistency of rubber is extracted from the moulding box. After full curing the moulding form is calcined.

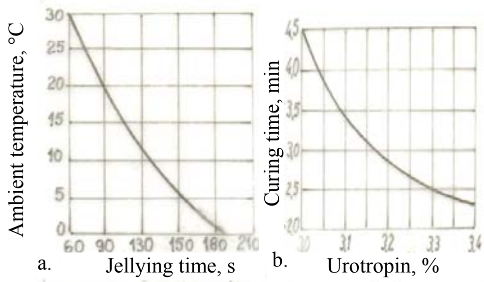


Fig. 2. a - jellying process; b – curing process

The noncalcined moulding from is not permeable, because it is dome by powder material and the binder fills the pores created between particles that form the base refractory material, so called ceramic material (Simionescu & Cernat, 2001).

During the calcination process on the active surface of the moulding form it is created a network of fine cracks that give to the moulding form the required permeability for alloy casting.

The alloys casting can be made in hot or cold moulding form using nonferrous alloys. The parts obtained by this process have high dimensional accuracy so that their active surface does not require any processing on machine tools or grinding.

3. THE EXPERIMENTS

The experiments have been done using a moulding compound with the following consistency: chamotte powder 200g, 200g powdered quartz, 140 cm3 solution of hydrolyzed ethyl silicate - 40 urotropin.

The technological process includes the following stages:

- making a very precise scale model, which should take in consideration in its geometrical dimensions the contraction coefficient of the cast part alloy.
- after solidification and cooling the moulding form is removed and casting part is cleaned.

The refractory of the ceramic forms depends on the refractory material used to prepare the moulding compound (preparation of pulp), so it can be controlled and adapt for different cases (Simionescu & Cernat, 2001).

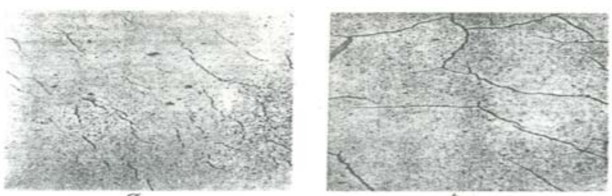
Permeability of the ceramic forms in raw state is theoretically zero because the refractory materials are finely ground and ethyl silicates occlude the produced pores.

A good permeability is obtained if the ceramic forms are calcined. During the calcined process, multiples micro crack are generated, and the form became permeable.

The existence of micro crack increases considerably the dimensional stability of the moulding forms when the liquid alloy is poured. This stability is explained by the fact that the granules can expand freely, this phenomenon does not take place in case of compact moulding forms.

For the calcined ceramic forms it is sufficient a permeability of 15 ... 20 units, because these forms do not emit gases during the casting process.

The size of the micro cracks depends on the paste hardening time. As the hardening time is longer, the crack are smaller, are more numerous and more uniform distributed.



a– fine cracks, evenly distributed; b – rough cracks, rare and unevenly distributed

Fig. 3 Micro cracks from ceramic moulding forms (X 10)

Increasing of the hardening time, it is possible by adding hexamethylene tetramină (CH2) 6N4 (or urotropin) in the moulding compound (Cernat et al., 2007).

Figure 2b. presents the variation of the hardening time function to the urotropin quantity, for a moulding compound made by 200 g of firebrick powder, quartz powder 200 g, 140 cm3 solution of hydrolyzed ethyl silicate - 40 urotropin.

4. RESULTS AND DISCUSSIONS

The analysing the obtained results we can present the following statements:

- The ceramic paste has high filling capacity so the finest details of the model can be reproduced;
- Good extraction capacity of the model from the temporary form
- The ceramic forms have a good behaviour in case of wide thermal variation
- Due to the micro crack network the moulding form has good dimensional stability, in fact there is no dilatation or contraction.
- The obtained parts have good dimensional precision, better that the precision obtained by normal machining processes. For instance: in case of parts having the biggest dimension 50 mm, the dimensional accuracy is ± 0,07 ...0, 1 mm; for parts with dimension around 500 mm, the dimensional accuracy is ± 0,6 mm; for parts with dimension around 1000 mm, the dimensional accuracy is ± 0,8...1,2 mm.
- The mechanical properties of cast parts are higher in comparison with part obtained by different process, because its have very smooth surface, so the cracks disappear and parts are very compact
- The cast parts do not have non-metallic inclusions and sulphuric constituents.

5. CONCLUSION

The quality ceramic moulding form depends very much by the technological process. The refractory of the ceramic forms can be controlled and adapt for different cases.

Permeability of the ceramic forms in raw state is theoretically zero. A good permeability is obtained if the ceramic forms are calcined. During the calcined process, multiples micro crack are generated, and the form became permeable.

The size of the micro cracks depends on the paste hardening time. As the hardening time is longer, the crack are smaller, are more numerous and more uniform distributed.

Increasing of the hardening time, it is possible by adding hexamethylene tetramină (CH2) 6N4 (or urotropin) in the moulding compound.

By adding a higher content of refractory materials it is obtained a pulp with higher viscosity and shorter hardening time.

6. REFERENCES

Cernat C. & Simionescu Gh. (2009). *High accuracy casting*, Ed. Politehnica PRESS, Bucuresti.

Simionescu Gh. & Cernat C. (2000). *Engineering of the moulding processes*, Ed. Elvarom, Bucuresti.

Simionescu, Gh. & Cernat C-tin. (2001*). Interaction between melted alloy and moulding box*, Ed. Bren, Bucuresti.

Simionescu, Gh. & Cernat C-tin. (2001). *Quality analysis of the technological materials used for casting processes*, Ed. Plumb, Bacau.

Cernat,C.; Simionescu,Gh. & Tiganila,E. (2007). *Technological materials for foundry. Methods of analysis*. Ed. BREN, Bucuresti.