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University of Belgrade - Faculty of Technology and Metallurgy Belgrade (TMF)

First Metallurgical & Materials Engineering Congress of South-East Europe (MME SEE 2013)

PROCEEDINGS AND BOOK OF ABSTRACTS

Editors:

Endre Romhanji
Milan T. Jovanović
Nenad Radović

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- SEE Associations of Metallurgical Engineers
- Balkan Union of Metallurgists
- Chambers of Commerce of SEE Countries

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- Association of Metallurgical Engineers of Serbia
- Serbian Foundrymen's Society
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- Processing and Structure of Materials
- Light metals and Composite materials
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PREFACE

The First Metallurgical & Materials Engineering Congress of South-East Europe is a meeting of scientists, professionals and specialties working not only in the field of processing of metals and materials, but also those engaged in research related to the production, structure and property relationship and applications of modern materials.

Time has shown a strong need for interdisciplinary research in metallurgical and materials engineering. Therefore, in order to cover all research fields, Congress represents fusion of following scientific events: Balkan Conference of Metallurgy, Processing and Structure of Materials, Light metals and Composite materials and International Foundrymen Conference. Regional significance is supported by South East Europe Associations of Metallurgical Engineers, Balkan Union of Metallurgists and Chambers of Commerce of SEE Countries, and organized by Association of Metallurgical Engineers of Serbia, Serbian Foundrymen's Society and Metallurgical Academic Network of SEE Countries

The Conference and Proceedings bring together a wide range of related topics and present the views from both academia and industry. Future of metal industry in South-East European countries, geology and minerals potentials for metallurgy production, new industrial achievements, developments and trends in extractive metallurgy, ferrous and nonferrous metals production, metal forming, casting, powder metallurgy, new and advanced materials, coating, galvanizing, corrosion and protection of materials, process control and modeling, recycling and waste minimization, nanotechnology, sustainable development, solvothermal synthesis, physical metallurgy and structure of materials, welding, environmental protection and education are all covered in the Proceedings.

The Editors hope that the Conference will help to improve the knowledge on the symbiotic topics as processing and materials properties.

The Editors would like to thank the Scientific and the Organizing Committee, the Conference Secretariat - CONGREXPO d.o.o. and all those who helped in making the Conference a success.

The Conference is organized jointly by the Association of Metallurgical Engineers of Serbia and the Faculty of Technology and Metallurgy at the Belgrade University. The Conference was sponsored by PRIZMA Kragujevac and TST Tesic, Germany.

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Editors

DEVELOPMENT OF MODERN TECHNOLOGIES OF COPPER ALLOYS CASTING

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Abstract

In this paper, results of investigation of casting technology of complex thin-wall copper alloy castings with accent on Lost Foam casting procedure are given. Phases of casting procedure were investigated, along with important process parameters and their influence on structure and properties of obtained castings. This technology enabled obtaining of the castings with complex construction and thin walls, and significant savings in casting procedure: expensive operations such are cleaning and machine processing of castings are minimized, while exploitation of metal is increased. Critical parameters of the process were investigated: casting temperature, types of refractory coatings, types of polymer models and their influence on formation of the structure. Results showed that new technology can be applied for obtaining of quality copper alloy castings which can be widely used in mechanical industry.

Key words: copper castings; Lost foam process; quality of castings; savings.

Introduction

Evaporative patterns casting (Lost foam casting process) is patented by H.F. Shroyer in 1958. Since then, up to today, development and practical application goes on with changeable success. Mainly, the problems of the development of this process are lack of appropriate materials for making evaporative patterns and refractory pattern coatings. Unlike casting in the sand moulds, the process uses patterns and pouring systems, which remain in the mould after its making until pouring of metal. This justifies the title "full mould casting", Fig. 1. In the contact with liquid metal, the pattern is split in a relatively short time. At the same time, the castings crystallization takes place. As the consequence of the pattern splitting, a great quantity of gaseous and liquid products is produced. If the conditions of their elimination from the mould are not fulfilled, many defects will appear on the castings, which are considered characteristic for this process. [1-5]

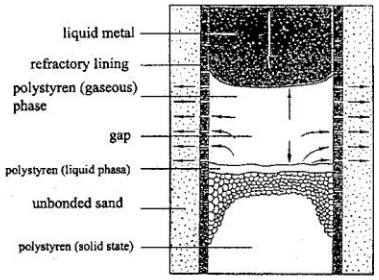


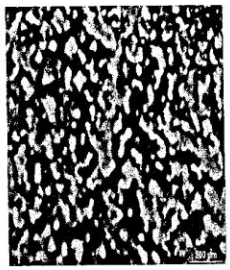
Fig. 1. System balance: liquid metal-refractory lining-pattern-sand

Important factors on pattern's decomposition and evaporation process, besides temperature and pattern's density, are also the type and refractory coat layer's thickness which the evaporable pattern is been covered with, type and size of sand grain for modeling, respectively permeability of sand for modeling, castings and gating of moulds' construction. The pattern's density and permeability of refractory coat and sandy cast determine polymers evaporation velocity. The velocity of liquid metal coming into the cast and its contact with the pattern is regulated by proper defining the gating of moulds. [6-9]

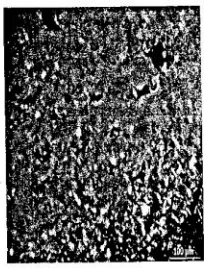
In order to obtain castings of a priori desired quality, critical process parameters should be determined for each particular polymer pattern, as well as the type of alloy for casting. That requires long-lasting researches with a goal to achieve optimization of Lost foam casting process and obtain the castings of a priori specified properties. In order to understand correctly the Lost foam process optimization it is necessary to know that various types of castings' structure determine their different properties. Besides this dependency for obtaining the castings of a priori specified properties there also should be determined the fundamental structure dependency on technology, which implies critical process parameters' control and control of useful castings' properties, and a special consideration in this paper was given to that matter. [10, 11]

Experiment

A two series of experiments were done with the goal of analyzing the possibilities for appliance of refractory coats based on talc (series mark: T) and cordierite (series mark: C) in Lost foam casting process. The coats' compositions were defined (table 1) and the coats components' preparation methods were determined. Grinding and fine grinding of refractory loaders of talc and cordierite was done in mill with balls of Cr-Ni steel, capacity 20 kg/h, with mill load of 70% and grinding time 45-60 minutes.



a) homogenous composition coats



b) non-homogenous composition coats

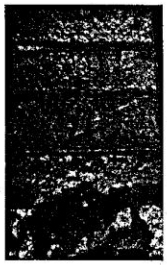
Fig.3. Refractory coats

In order to observe the effects of casting process, evaluation of certain operation phases and analysis of applied refractory coats' influence, a visual control of the obtained castings was done, testing their structural and mechanical properties. After pulling out the founded "clusters" from the cast, their surface is covered with coat layer which is easy to be broken and removed from it, so the cleaning is not necessary, which significantly reduces the production costs. The refractory coats of all series have demonstrated positive effects on the surface quality – shiny and smooth castings' surfaces were obtained. The castings are true copy of the patterns (dimensionally are precise) which indicates that the decomposition and evaporation of polystyrene pattern was in totality, and that the gating of moulds' solution was satisfactory. It was noted that the lower castings' parts of all series have flat and sharp edges, clean and shiny surface. At some castings from the series with coat layers of higher thickness (above 1,5 mm) the upper castings' surfaces are a bit uneven and folded, and also on certain castings' parts a surface roughness appears, and more often at the castings from the series with patterns' density above 20 kg/m^3.

The study results of castings' structural and mechanical characteristics were within the limits predicted by the standards for this type of alloys. That would be the castings from series with used polystyrene patterns up to 20 kg/m^3, refractory coats of less thickness layers, below 1 mm, applied quartz sand for modeling with its grain size above 0,26 mm, casting temperature within the limits of 1180°C and casting velocity which enabled even decomposition and evaporation of polystyrene, with complete elimination of gassy products from patterns' evaporation, without any cast falling in and liquid metal penetration into sand.

On the other hand, castings from the series with applied patterns of densities above 20 kg/m^3 and coat thickness above 1,5 mm have expressed subsurface and volumetric porosity too, Fig.4.

d) sintered sand



e) metal penetration into sand

Fig. 4. Errors on castings

This indicates that the reasons for these type of errors are primarily the polystyrene pattern, and next the refractory coat and high casting velocity.

Conclusion

In order to attain a quality and cost-effective castings production by the Lost foam casting process, it is necessary to attain the balance in the following system: evaporable polymeric pattern- liquid metal-refractory coating – sand mold during metal inflow, polymeric pattern decomposition and evapouration, castings formation and solidification. All this points to complexity of the castings solidification conditions by the Lost foam casting process, as well as to the necessity to determine the corelation between the casting parameters, structure and properties of castings.

Acknowledgement

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