A R C H I V E S O F M E T A L L U R G Y A N D M A T E R I A L S
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THE RESEARCH OF PROPERTIES OF EXPERIMENTAL CERAMIC LAYERS

BADANIE WŁAŚCIWOŚCI DOŚWIADCZALNYCH WARSTW CERAMICZNYCH

In the evaporative pattern casting process, the surface of a polystyrene pattern (Styrofoam) is coated with a ceramic layer. This ceramic layer, which coats the evaporative pattern, should have specific physiochemical properties including: resistance to thermal, chemical, and erosive activity of molten metal and proper permeability for gases which are produced by the evaporative polystyrene pattern. The article presents the research results of properties of experimentally selected ceramic layers applied on a polystyrene pattern in the evaporative pattern casting process.

Keywords: evaporative patterns, Lost Foam, ceramic layer, properties

W procesie wytwarzania odlewów wg metody modeli zgazowywanych na modele polistyrenowe (styropianowe), nakładana jest warstwa pokrycia ceramicznego. Pokrycie ceramiczne, które jest nanoszone na model zgazowywany powinno charakteryzować się określonymi właściwościami fizykochemicznymi w tym: odpornością na termiczne, chemiczne i erozyjne działanie ciekłego metalu oraz odpowiednią przepuszczalnością gazów wytworzonych z zgazowywanego modelu polistyrenowego. W artykule przedstawiono wyniki badań własności, wytypowanych doświadczalnych powłok ceramicznych, nanoszonych na model polistyrenowy w procesie modeli zgazowywanych.

1. Introduction

The present article presents the research results of refractory materials used for making ceramic layers. The following parameters decide about the accuracy of the selection of ceramic refractory layers which are applied on evaporative patterns, e.g. foam polystyrene: the composition, properties, the method of preparation and application of a ceramic layer on a pattern. Technological properties of a ceramic layer are significant: permeability, mechanical strength and refractoriness. A ceramic layer consists of several ingredients such as refractory material, dispersant, binder, thixotropic agent and carrier. The type of utilised refractory material depends on the type of metal, pouring temperature, the thickness of castings' cross-sections, as well as on the granularity and the shape of grains of the sand used for sprinkling. The most commonly utilised materials for fine-grain warp of ceramic layers applied on e.g. a foamed expandable polystyrene pattern are: quartz powder, zircon powder and graphite. Water-alcohol solutions are most often used as binders and recently more and more often these are binders which contain colloidal silica.

Own research

The research of selected ceramic coatings applied on a polystyrene pattern was conducted. Examined were their heat resistance, e.g. up to 1750°C, mechanical strength and the ability to filter gases from the mould cavity outside the mould.

After the analysis of coatings, available from the market, and their properties for the application research Kerntop L87 coating was chosen (a product by Ashland) and Cyrkonkar (developed by the Foundry Research Institute). Cyrkonkar coating constitutes a mixture of zircon refractory material and binder consisting of silicic acid sol and a composition of surfactants and organic latexes.

The determination of thermophysical parameters of samples of a ceramic mould was made with the use of an apparatus for determining characteristic temperatures PR-25/1750, also commonly called a high-temperature microscope within the temperature range of 800-1750°C (Fig. 1).

At the Foundry Research Institute practical research methodology was developed as well as a model device thanks to which the measurement of mechanical strength of the ceramic layer made of Kerntop L87 coating and Cyrkonkar coating was carried out. The examined ceramic sample has the dimension of 30×8 mm, the thickness of the sample equalled no more than 0.5 mm (Fig. 2, 3).

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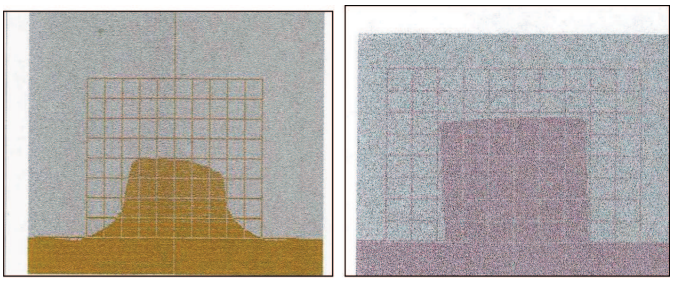

Fig. 1. A picture of coating sample deformation under the effect of temperature: A) Kerntop L87; B) Cyrkonkar

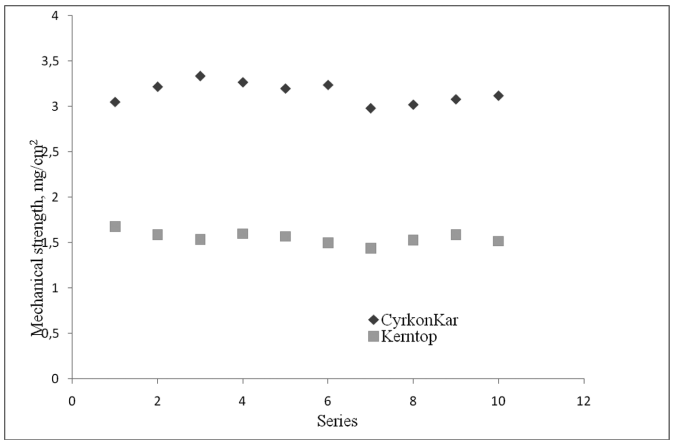

Fig. 2. The distribution of tear strength of thin ceramic layers prepared with the participation of coatings, Cyrkonkar and Kerntop L87

In the conducted research the aim was to determine a manner of measuring filtration (permeability) of a ceramic layer applied on an evaporative pattern, e.g. polystyrene. The measurement of permeability is made with the use of standardised samples made of moulding sand with the diameter and height of 50 mm.

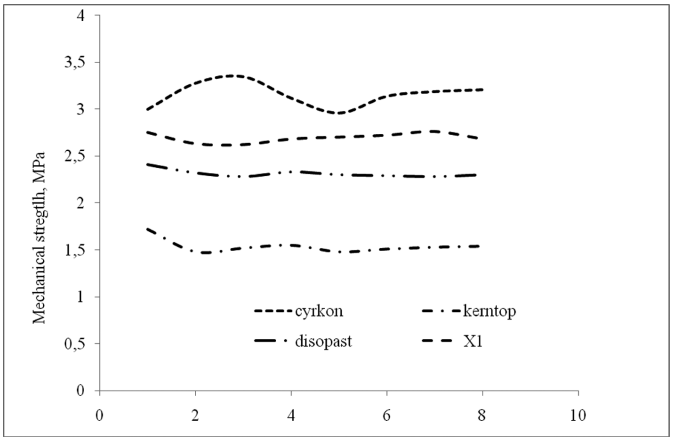

Fig. 3. The distribution of tear strength of thin ceramic layers

This method does not fully work in case of measuring permeability of thin layers of ceramic coating. To examine the filtration of ceramic layers an apparatus was designed and produced, which allows cooperation with the apparatus for determining permeability of moulding sands (type LPiR1, Fig. 4). The rule underlying measurements consists in applying a layer or a few layers of ceramic coating on a section of standardised brass or steel mesh, with a particular diameter of wire and apertures. Thanks to this device a measurement of filtration can be made. The thickness of coatings was from 1.0±0.1 to 3±0.1 mm. The mesh with the applied ceramic layer is placed in a developed measurement device which cooperates with the apparatus for measuring permeability. The measurement set is mounted on the apparatus for measuring permeability. Measurements of filtration of ceramic layers made of different ceramic materials were conducted. The result is presented in Figures 5 to 7.

Fig. 4. A device used for measuring permeability and mechanical strength of ceramic layers: a – disassembled, b – assembled at the measurement stand

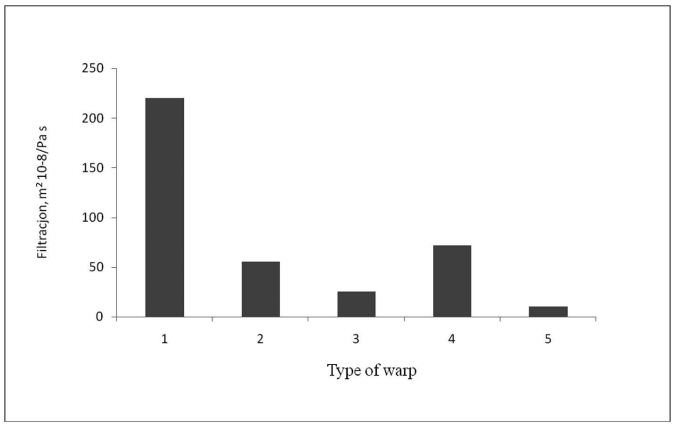

Fig. 5. The relation of filtration of one coating layer; the type of warp: 1 – Al_2O_3, 2 – quartz powder roasted at 1000°C, 3 – mullite, 4 – quartz powder roasted at 600°C, 5 – zircon

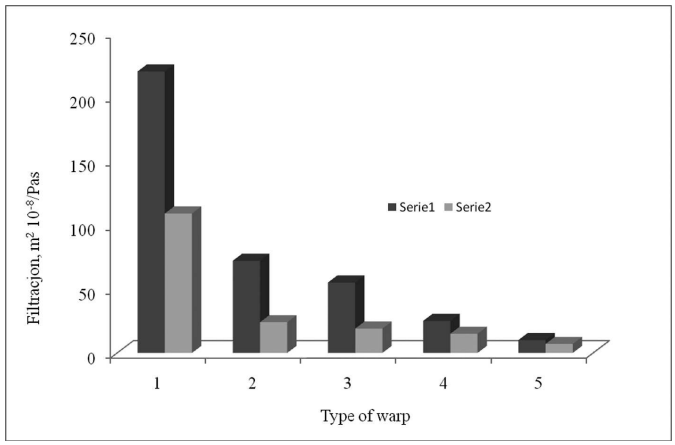

Fig. 6. The relation of filtration 1 and 2 ceramic layers; the type of warp: 1 - Al_2O_3, 2 – quartz powder roasted at 1000°C, 3 – mullite, 4 – quartz powder roasted at 600°C, (from the left – one layer, two layers), 5 – zircon

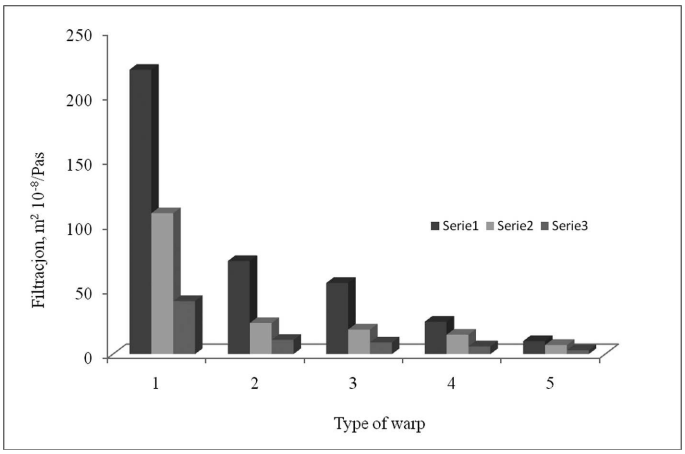

Fig. 7. The relation of filtration 1, 2 ,3 ceramic layers; the type of warp: 1 – mullite + silica binder (colloidal silica), 2 – quartz powder + silica binder, 3 – quartz powder + water-alcohol binder, 4 – Al_2O_3+10% bentonite + water-alcohol binder, 5 – zircon

2. Summary

Examined were the available coatings and the experimental composition of a ceramic layer (Cyrkonkar coating) applied on a polystyrene pattern in the evaporative pattern casting process – lost-foam process. The developed composition is a result of a conducted research cycle, thanks to which interrelations between the qualitative and quantitative composition of liquid ceramic coating and its physiochemical and technological properties were determined.

On the basis of the conducted research-experimental works it can be stated that mechanical strength of a ceramic layer depends on the composition and the type of coating as well as on the utilised ceramic material.

With increasing numbers of layers applied on a pattern and increasing temperature the filtration ability of ceramic coating changes.

The type of utilised ceramic material and its granularity influence the filtration of ceramic coating, whereas ceramic coatings which utilise zircon are characterised by higher heat resistance.

The coating developed at the Research Foundry Institute has higher refractoriness and can be used for producing castings at a high temperature of pouring.

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