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STUDY OF THERMAL STRESS INFLUENCE ON DIMENSIONAL STABILITY OF SILICONE MOLDS

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Abstract

The paper is focused on the study of temperature influence on dimensional stability of silicone molds used for spin casting of the low melting points alloys. The silicone material denoted as TEKSIL Silicone-GP-S was used to produce samples during *experiments. The samples were heated to temperatures in the range from 100 up to 250°C for 30 up to 120 min. Dimensional changes of the samples in the radial and axial directions aa well as their change of weight were evaluated. The results of experiments proved that thermal stress of silicone molds can influence the size and shape of mold cavities. These results can also explain the possible mechanism of degradation process of silicone molds under thermal stress.*

Key words

silicone mold, thermal stress, dimensional stability

INTRODUCTION

The foundry production is one of the most important industries. The research and development in this area are focused mainly on better material properties and technologies. One of them is spin casting of the low melting point alloys into vulcanized silicone molds. The mold material enables pouring the low melting point alloys such as zinc, tin alloys and even some plastics.

Very significant at spin casting is mold temperature. The pouring of molten metal into an overheated mold can cause a significant lifetime decrease of mold, misruns in parting line, deformation of mold cavities and a non-uniform size of castings during various casting cycles (1). There are various methods of increasing the low thermal conductivity of silicone molds (2 – 4). The disadvantages of all these cooling methods are longer and more complicated mold production, caused by adding the parts of complex shapes in order to increase thermal flow from the locations near mold cavities.

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Recently, many studies have been aimed at the influence of chosen parameters of spin casting on precise dimensions and shape of castings (5). However, there are not available data about the influence of thermal stress on dimensional stability of silicone molds. It is supposed that higher thermal stress can lead to the change of shape and dimensions of the silicone molds cavities. These changes subsequently influence the final dimensional and shape precision of castings.

Following are the most significant factors influencing thermal stress of silicone molds: temperature of molten metal, time of pouring cycle and number of subsequent pouring cycles.

MATERIALS AND METHODOLOGY OF EXPERIMENT

For samples production, TEKSIL Silicone – GP-S silicone material was used. The silicone rubber was vulcanized at the temperature of 170 °C and pressure 24 MPa during 60 min. Fig. 1 shows the samples of vulcanized silicone rubber prior to experiments. The samples were heated in an electric resistance furnace to the temperatures of 100, 150, 200 and 250 °C during 30, 60, 90 and 120 min, respectively. From the measured values of height, diameter and weight of three samples for each combination of temperature and time, the mean values of their changes were calculated. The resulting changes were compared in graphs.

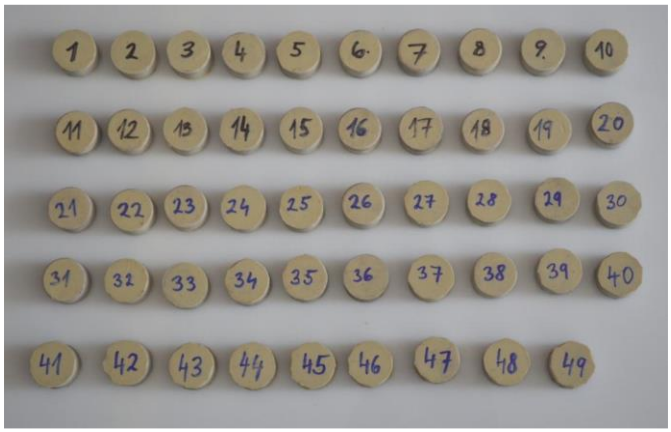

Fig. 1 *Samples of vulcanized silicone*

ATTAINED RESULTS AND DISCUSSION ON RESULTS

Fig. 2 shows the dependence of change in height on temperature and time. At the temperature of 100 °C, the mean values of height change were in the range from 0.3 % to 0.7 %. At increased temperature of 150 °C, the mean values of height change of were in the range from 1.3 to 1.6%. At both temperatures, only a slight increase of height change was observed with increasing the time. In the samples heated to 200 °C, the increase of height change was steeper with the time then in the samples heated to lower temperatures. The increase was in the range from 1.8 to 2.5%. The samples heated to 250 °C had a decreasing curve of height change in time. These changes were in the range from 3.2 to 2 %.

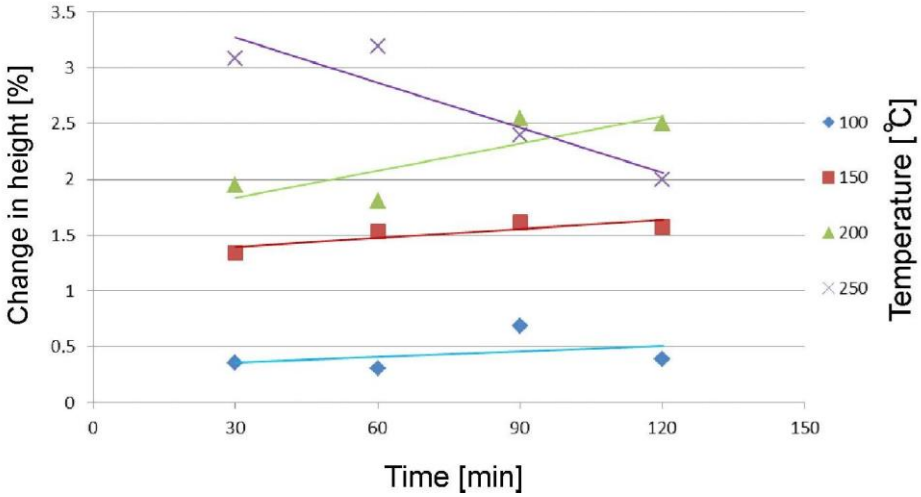

Fig. 2 *The percentage change of height versus temperature and time*

Fig. 3 shows the relation of change of diameter versus temperature and time. The samples were heated to 100, 150 and 200 °C during each time, and the changes of diameter were in the close range from 0.3 % to 0.8 %. The only negative change of diameter was measured on the sample heated to 100 °C after 60 min. Such value was probably caused by incorrect measurement. Higher increase of diameter changes were measured only on the samples heated to 250 °C after 60 min and more. The changes of diameter measured at this temperature reached the values from 1 to 2 %.

The measured positive changes of weight and diameter show a possible increase of the samples volume under heat stress, which led to the change of cavities size and subsequent change of castings size.

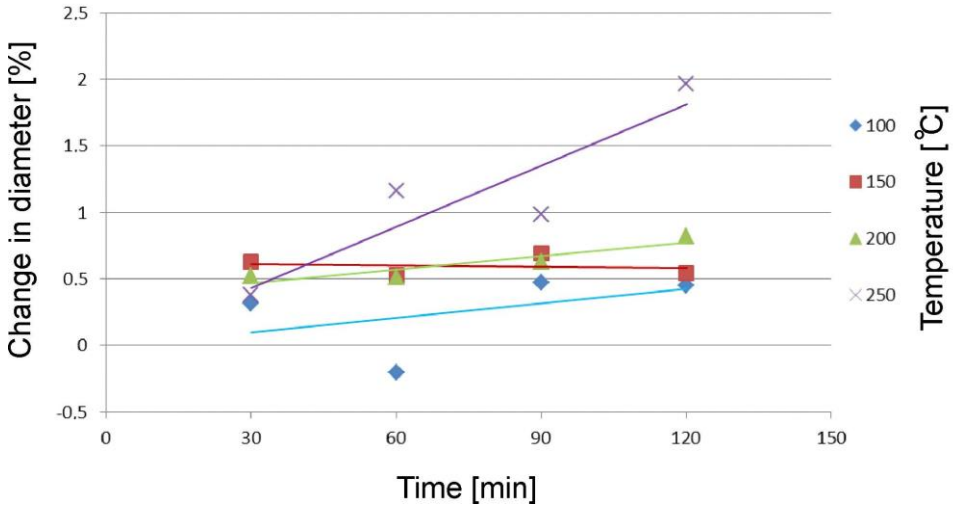

Fig. 3 *The percentage change of diameter versus temperature and time*

In Fig. 4, the influence of temperature and time on change of weight can be observed. All measured changes were negative, which meant a weight loss. The most significant weight loss was observed in the samples heated to 250 °C. The largest weight loss of the sample heated to 250 °C was 0.7 % after 120 min.

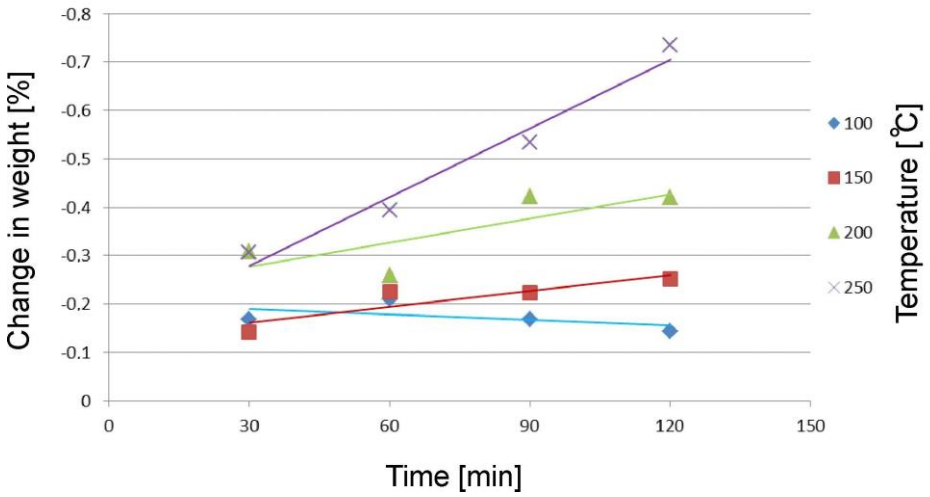

Fig. 4 *The percentage change of weight in dependence on temperature and time*

Fig. 5 shows samples of vulcanized silicone rubbers after experiments. The visible change of exterior is probably caused by silicone burning off at high temperatures. The darkest samples were heated to 250 °C. The time had no significant influence on surface at each temperatures.

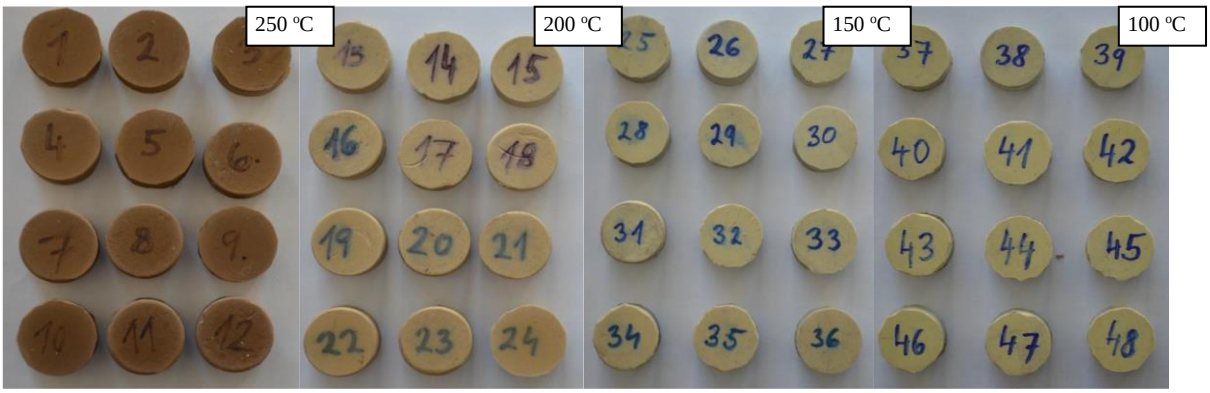

Fig. 5 *Samples of silicone rubber after experiments*

CONCLUSION

It can be concluded from the experimental results that thermal stress of silicone molds can significantly influence the dimensions and shape of mold`s cavities. This can lead to the decreased dimensional and shape accuracy of castings cast by spin casting into silicone molds. The greatest changes were observed at 200 and 250 °C, the largest measured change of height was 3.2 %, and the largest measured change of diameter was 2 %. A weight loss, significantly influenced by temperature was also observed. Significant changes of weight versus time were observed only when the temperature reached 200 or 250 °C. The maximum change of weight reached -0.7% at 250 °C after 120 min. Such weight loss is caused by gradual burning off the silicone sample, which can be observed also visually on the sample surface.

The results of experiments can explain the possible process of the silicone molds degradation under thermal stress. This process is characterized by increased volume of silicone despite the decreasing weight.

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