THE POSSIBILITIES OF RUNNER PLACEMENTS FOR CASTINGS PRODUCED BY SPIN CASTING INTO SILICON RUBBER MOULDS

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Abstract

The aim of the experiments was verification of various runner placements for castings casted by Tekcast method into silicon moulds. The influence of mould's rotation speed and direction of rotation were observed on mould cavity filling by molten metal for various runner placements. It is experimentally determined that not all the kinds of runner cutting are suitable for this technology. This is in contradiction with casting machine producer's statement in the machine's manual.

Key words

runner, mould, silicone, casting, zinc

Introduction

The foundry production is one of the main branches of engineering industry. The research and development in this area is focused mainly on improving material's properties and technologies of their processing.

This method is high tech in spin casting technology and it allows to cast structural parts (high strength, high precision parts) not only jewellery and artistic castings. The technology uses Teksil, material developed especially for this technology, for mould making. This material enables casting of low melting point alloys as zinc alloys, tin and lead alloys, Sn – Sb- Pb alloys (so called "white metals"), some polymer materials and in rare cases also thin walled aluminium alloy castings. Recently is this technology in many cases used as effective replacement for rapid prototyping technologies [4].

The principle of the technology

The principle of spin casting is application of increased forces. Applied forces are higher than gravitational force. This allows better mould's cavity filling with decreased gas bubbles and microporosity presence in castings. In this technology centrifugal forces make molten metal flow against the mould walls and its pressure achieve close contact between metal and mould. The castings are produced by pouring of molten metal into rotating mould or the mould's rotation begins after pouring.

Fig. 1. *The Tekcast workshop*

Every workshop for Tekcast method (Fig. 1) must be equipped with three basic equipments: precisely controlled hydraulic vulcanizer, melting furnace with temperature control and electronically controlled casting machine. Casting machine contains patented fixing system, which centers and holds mould in horizontal plane and simultaneously pneumatic valve presses the two parts of mould together during casting without a possibility of mould's shifting [3].

The material of mould is Teksil – silicone rubber. The mould's material ensures high precision of casting, excellent precision of details and relatively long lifetime of moulds. Their lifetime is influenced by thermal loading and number of casting cycles. One of the methods of elimination of mould's failure by thermal loading is mould's cooling during casting [1].

Experiments

Moulds for experiments had diameter 230 mm and they were made from silicon material TEKSIL Silicone – DW. Moulds were vulcanized at 160^{o}C 100 min. The casted material was ZAMAK 2 zinc alloy (Table 1). The rotational speeds of the mould were selected in range from 100 to 600 rpm. Moulds rotated in clockwise and counterclockwise direction, clamping force during casting was 241,5 KPa and casting cycle 30 s. The runners were cut in places of possible placements in mould after TEKCAST Industries manual (Fig. 2). The patterns shapes can be seen on Fig. 3. They were polished by electrolytic – plasma technology [5].

THE CHEMICAL COMPOSITION OF ZAMAK 2 ALLOY Table 1

Chemical element	Al	Cu	Mg	Fe	Pb +Cd	Zn
[wt.%]	4	2,8	0,04	0,075	0,004	balance

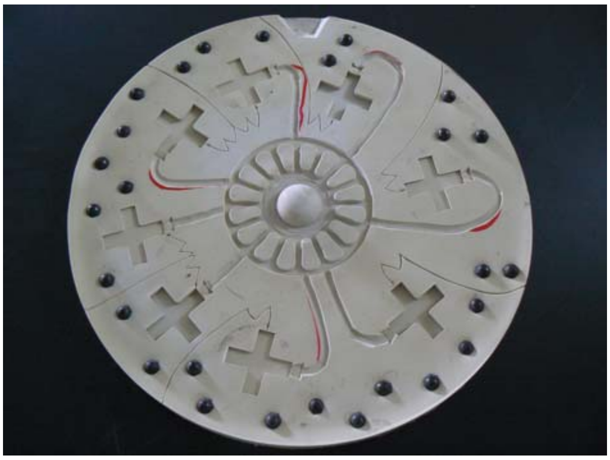

Fig. 2. *Methods of runner cutting in silicon moulds*

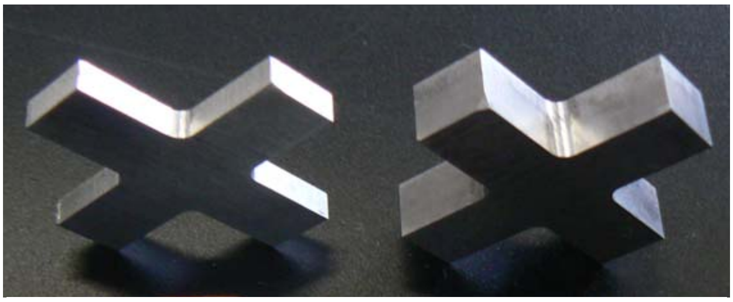

Fig. 3. *Patterns for mould cavity creation*

The results of experiments with rotational speeds 100, 200, 300, 400, 500 and 600 rpm for clockwise and counterclockwise direction of rotation are shown on Figs. 4 to 9. The castings were casted on TEKCASTER Series 100-D spin casting machine. The temperature of moulds cavities during casting was 90 ± 3 ^{o}C.

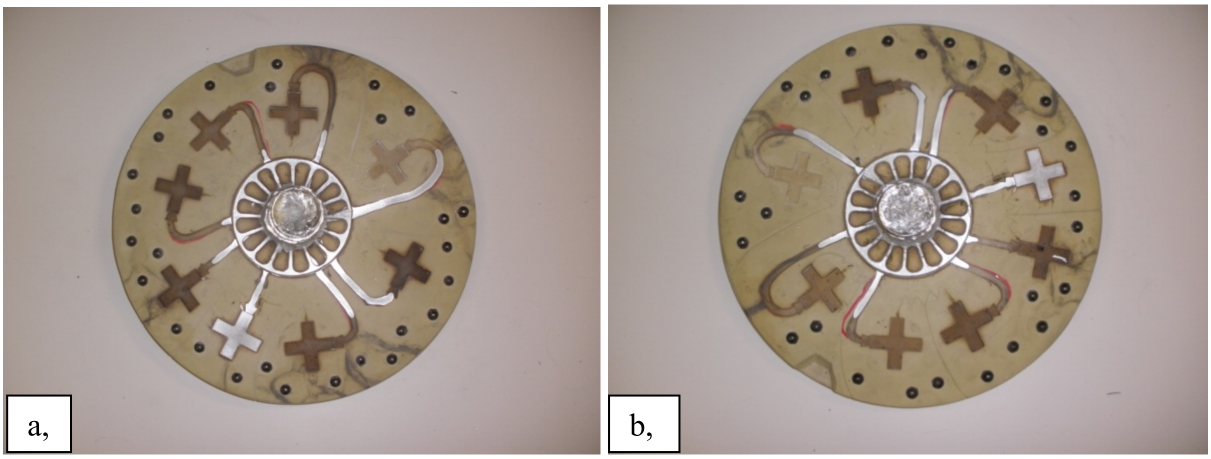

Fig. 4. *Casted at 100 rpm a, clockwise rotation b, counterclockwise rotation*

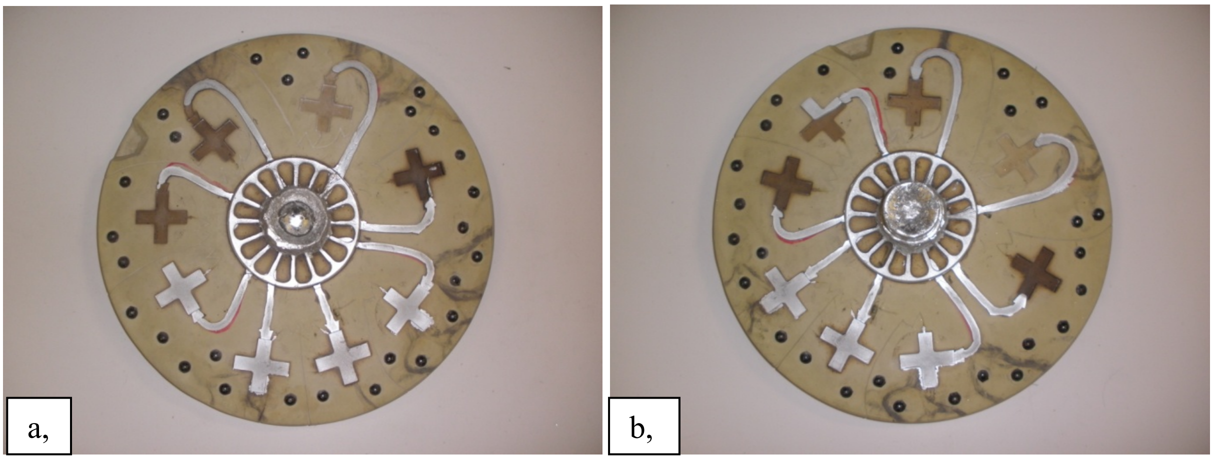

Fig. 5. *Casted at 200 rpm a, clockwise rotation b, counterclockwise rotation*

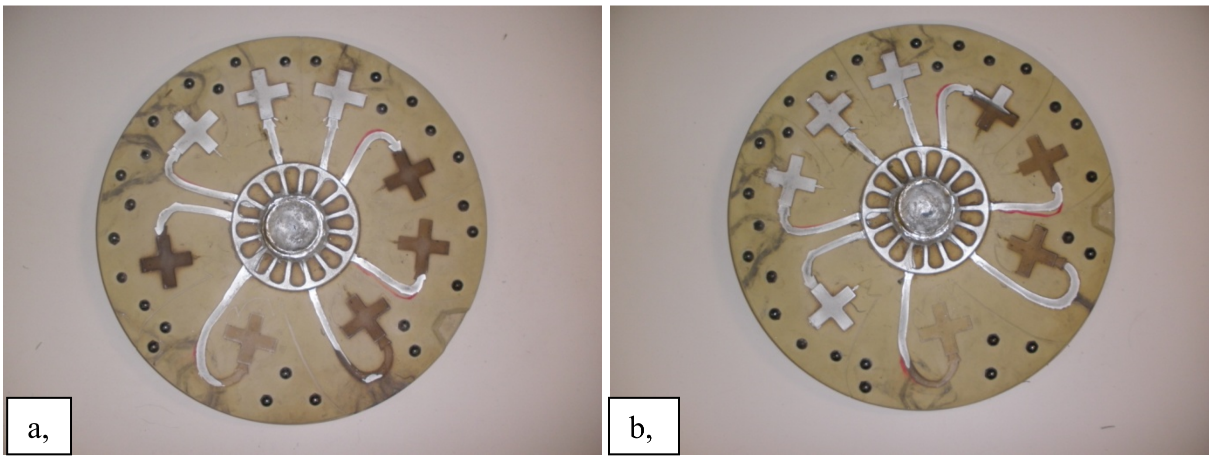

Fig. 6. *Casted at 300 rpm a, clockwise rotation b, counterclockwise rotation*

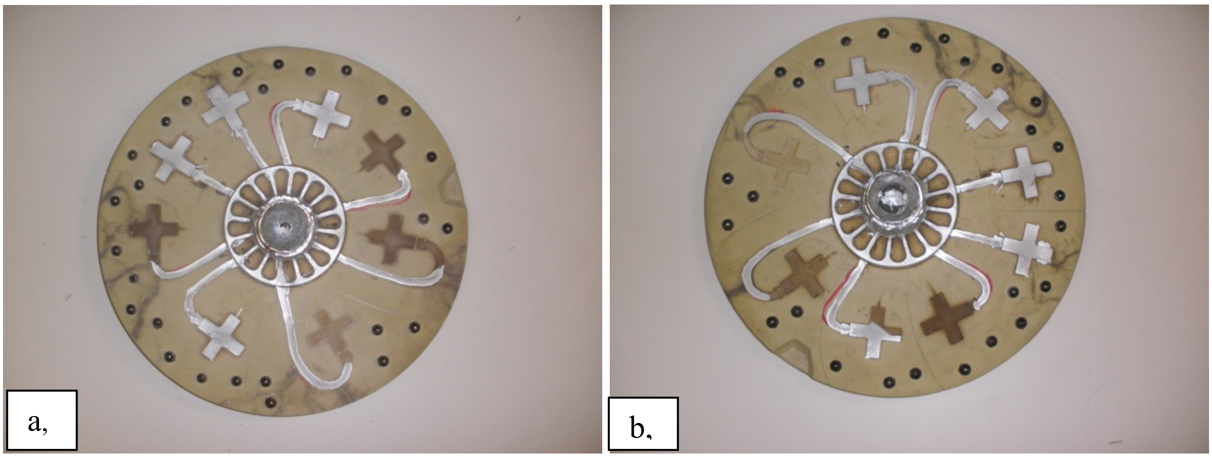

Fig. 7. *Casted at 400 rpm a, clockwise rotation b, counterclockwise rotation*

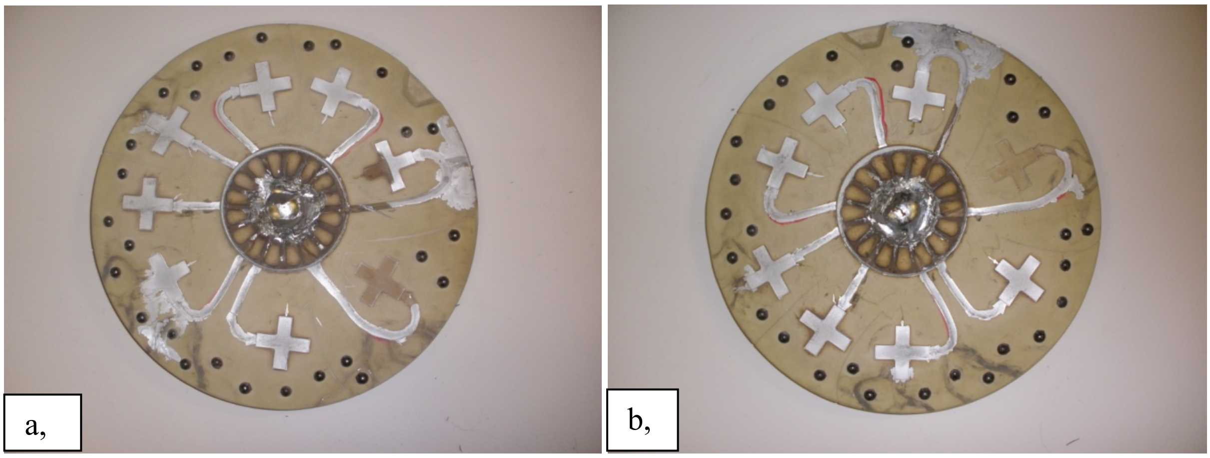

Fig. 8. *Casted at 500 rpm a, clockwise rotation b, counterclockwise rotation*

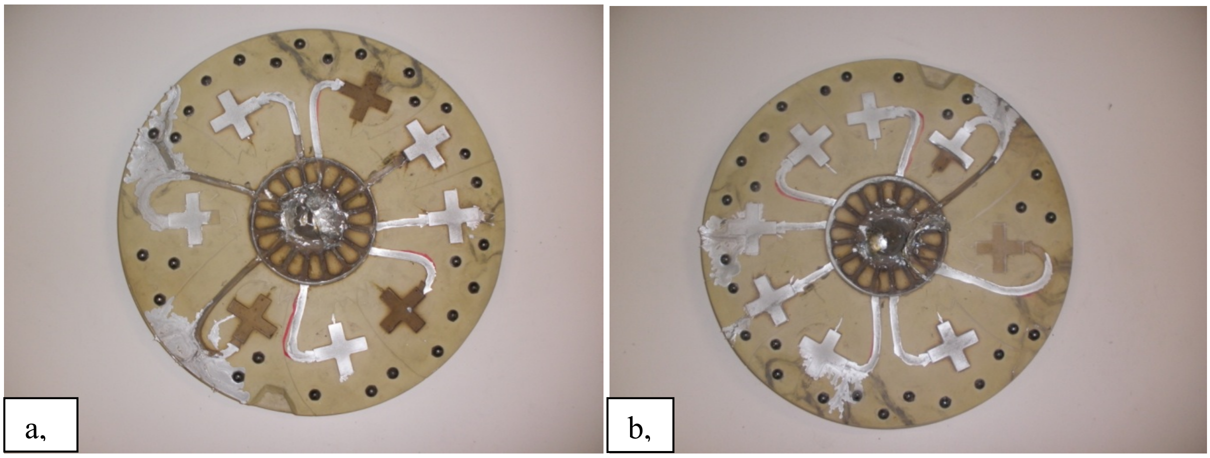

Fig. 9. *Casted at 600 rpm a, clockwise rotation b, counterclockwise rotation*

Discussion

Fig. 4 shows silicon mould casted at 100 rpm with clockwise and counterclockwise direction. It can be seen that this rotational speed was so low that centrifugal force is not enough to force the molten metal to fill the mould`s cavities with all kinds of runners. The rotational speed increased to 200 rpm (Fig. 5) fills the mould`s cavities with straight runners, but it is not big enough to fill the mould`s cavities with side runners or back runners. The results similar as for 200 rpm were obtained at 300 and 400 rpm (Figs. 6 and 7). Increasing the rotational speed to 500 rpm (Fig. 8) succeded in filling all the mould`s cavities with side runners. This increasing also causes big fins in parting line, which increases the costs and time of final processing of castings. The mould`s cavities with back runners are also not filled properly as in previous cases due to low centrifugal force. The centrifugal force at 600 rpm (Fig. 9) was so big that it caused splashing of such amount of molten metal through parting line (Fig. 10) that mould`s cavities can not be properly filled with remaining amount.

Fig. 10. *Close up of mould with fin in parting plane*

Fig. 11. *Mould with all cavities filled*

On Fig. 11 can be seen silicon mould after casting with filling obtained after:

- mould`s temperature increasing to 120 ^{o}C,
- increasing of holding pressure to 310,5 Psi,
- incerasing revollutions to 500 rpm,
- mould` surface treatment with CaO powder.

There was also visible fins of molten metal in parting line or its spraying from mould through parting plane into inner space of casting machine

It can be seen on Figs. 4 - 9 that the direction of rotation has not significant effect on the mould filling.

Conclusions

From experiments was established that the most suitable runners for molten metal filling into mould`s cavity are straight runners with the shortest possible length. The runners from the side of mould`s cavity can be used for complex shape castings spin casted at higher rotational speeds. The runners from the side of mould`s cavity should be used only as additional to straight runners. The runners from back side of mould`s cavity should be avoided because of number of necessary adjustments. This is in contrary with informations from manual, which states that increasing of rotational speed is enough [2]. The necessary adjustments are increasing the mould`s temperature, clamping force, rotational speed and surface treatment of mould before casting. The runners from back side of mould`s cavity could be used only as dditional runners for filling of some parts of mould`s cavity.

Using straight runners the revolutions from 200 rpm are sufficient for simple shape castings casted in moulds with diameter 230 mm. The side position of runners requires up to 500 rpm and there is risk of fin in parting line. This risk can be eliminated by holding pressure increasing by minimum 25 %. It is also determined that direction of rotation has not significant effect on mould`s cavities filling.

Acknowledgement

The financial support of grants from the Ministry of Education of the Slovak Republic VEGA 1/0383/10 is gratefully acknowledged.

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