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Influence of the Home Scrap Content on the Service Life of Equipment Used in High Pressure Die Casting of AZ91 Alloy

Z. Konopka *, M. Łągiewka, A. Zyska
Czestochowa University of Technology,
Armii Krajowej 19, 42-200 Częstochowa, Poland
* Corresponding author. E-mail address: e-mail: konopka@wip.pcz.pl

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Abstract

The results of estimation of home scrap addition in charge influence on durability and wear of casting instrumentation life in the high-pressure casting technology using the hot chamber machine of alloy of AZ91 are presented. The wear of the following elements of the casting instrumentation so-called "casting set" as: syphon, plunger, sliding-rings, nozzle and injection moulding nozzle was estimated. A wear was estimated quantitative by registering the number of mould injections for different charges to the moment of element damage supervision. A damage had to be at such level that liquidated an element from further exploitation and necessary was an exchange on new or regeneration. In a final result allowed it the detailed determination of durability of the applied rigging elements in dependence on the type of the applied type of melt. It is noticed, that together with the increase of home-scrap participation in the charge wear of pressure machine instrumentation elements increases.

Keywords: Innovative materials and casting technologies, Mechanization and automation of casting processes, Guard of environment, Casthouse Rigging, Magnesium alloys

1. Introduction

The pressure castings made from the magnesium alloys find more wide application each time, taking into account the advantageous properties for the use in combination with a low density. The magnesium alloys casting have a very good properties like high corrosion resistance and good mechanical properties in increase temperatures [1-5].

Castings from the magnesium alloys find application in a transport industry, electronic, building and in many other. Replacing is here possible the next examples of such castings as: steering columns, supports, corps of gear-box, skeletons of seats, corps of portable computers, telephone and photographic sets, chambers of video, telescopes, and also building accessories how pens, locks, corps.

The mass production of the pressure castings associates with recyrkulation of plenty of materials among that a metal occupies major position. Distinguishing is possible two categories of home scrap depending on his contamination. Melting loss on the surface of the liquid metal, swarf, nascent sawdusts in the process of tooling and also scrapping of elements of machines and devices then there are materials very muddy, different kind by oils, and cooling liquids. Except that surfaces them in a different degree are oxided. In connection with such presence of contaminations, in the recycling process the specialized in this industry firms must be engaged, which have experience and also corresponding technical requirements and laboratory rear. Often in foundry there is a

circulating home scrap from the casting process, that is far fewer muddy, and also has the identified chemical composition and not oxidable. A home scrap in a casting workshop create: runners and also imperfect castings [6-8].

The best solution of internal magnesium alloys recycling is application of the closed turnover, that consists in refusion of home scrap in a working furnace. That way requires the least changes in relation to a standard productive process. It does not require large investments and can be applied in fondries, where a problem of home scrap warehousing is valid. Benefits that flow from application of this solution are following: small investment (second furnace), shortage of the problems related to the segregation of alloys, not casting of geese, small increase of of electric energy (furnace works in the continuous order), small contribution of work to cleaning of melting loss, economies related to the transport of home scrap, in relation to blessing quality of alloy, because from 40-50% be material from pure goose about very good quality, reduction of place on home scrap [9,10].

The correct functioning of the closed recycling system of magnesium alloys castings consists in melting of home scrap in the furnace, cleaning of metal surface form melting loss, addition and melting of certain participation of warmed-up to the temperature of 573-623 K of pigs of magnesium alloy, transport of liquid alloy by a pipe and batching pump to the casting (working) furnace, from that poured siphon or casting sleeve. A transport between furnaces for help pipes retains the identical level of metal in both furnaces. Above the surface of the melted metal in both furnaces there is a protective gas as $S0_2$ and clean air or SF_6 that provides a metal before a self-ignition [11].

The magnesium alloys can be cast using the hot chamber or cold chamber pressure die casting machines. Details about less sizes, on economic considerations are cast on a hot chamber pressure die casting machines (more short time of cycle), castings by an area large overflow and large sizes are poured off on machines about large forces of short circuit, that are mainly cold chamber machines.

In the presented work rises attempt of estimation of influence of home scrap in charge and metal recycling on wearing out and life of the sleeve, plungers and sliding-rings, and also bar and insets of form.

2. Methodology of researches

The aim of work was presentation of influence of participation of home scrap in charge on the wear of "casting set" during making of castings from the AZ91 alloy executed by the method of the high-pressure casting by using the hot chamber pressure die casting machines. The estimation of wear so-called "casting set" concerns the following elements: syphon, plunger, sliding-rings, nozzle and injection moulding nozzle. A wear was estimated quantitative registering the number of executed injections of form for this melt to the moment of supervision of damage of element that eliminated it from further exploitation and necessary was an exchange on new or regeneration. In a final result allowed it the detailed determination of life of the applied elements of rigging in dependence about the type of charge in melt.

Quality estimation of instrumentation elements wear was done by a supervision of each element after on their dismantling. The state of surface and thickness of walls were estimated and identified a kind and degree of wear with their credible reasons of origin. For every element of instrumentation the type of wear and his reason of origin were certain.

Researches were executed in the three-year period of castings production. A few million arts of castings were produced in that time by using the hot chamber pressure die casting machines.

The five kind of melts with different share of home scrap in charge were executed. From the prepared AZ91 alloy the pen castings were produced by the method of the pressure casting in the conditions of productive casting workshops. Melt of A1, concluded 100% of alloy from a pig, but after previous melted, melt A2 consists of 70% of alloy from a pig and 30% home scrap, melt A3 contains 50% of alloy from a pig and 50% of home scrap, melt A4 contain 30% alloy from a pig and 70% of home scrap and melt A5 was prepared from 100% home scrap in charge.

Castings were fabricated on the hot chamber pressure die casting machines with 6300 kN of squeezing force, using four cavity mould. The temperature of liquid metal (pouring temperature) was 903 K and was identical for all investigated melts. The surface of liquid metal was provided with protective (0,5% of SO_2 + of 99,5% dry air) gas. The parameters of process of casting are set at next level: plunger velocity phases of $v_1 = 0,15$ m/s (first phase), of, II of $v_2 = 2,5$ of m/s (second phase) and time of of pressure intensification $t_{dop} = 1,5$ s.

3. Results of researches

The results of wear of the casting rigging measureable the number of fill-outs (injectias) of executed on a machine during accident-free work of element of set are presented in a Table 1.

Table 1.
Wear of the casting instrumentation

Lp.	Element of casting set	Maximum number of injections to accident free work of casting set element				
		A1	A2	A3	A4	A5
1	Siphon	120	120	100	80	45
2	Plunger	80	80	70	60	35
3	Rings	25	25	20	10	10
4	Nozzle	65	60	55	45	30
5	Injection moulding nozzle	55	50	45	30	20

The results presented in Table 1 show, that the wear of all elements instrumentation increases with the increase of participation of home scrap in charge of melt. The castings production from the re-melted home scrap entailed double reduction of life of all elements of instrumentation on the average.

The reviews of exhaust elements instrumentation allowed presentation of the following description of wear and pulling out of potential reasons of this wear.

A channel in that works plunger and also channel that a liquid metal is transported to the nozzle and injection moulding nozzle (so-called "ancerine neck") in a syphon have a most wear. A channel in that works a plunger finds out often an abrasive wear that takes place from slidding of rings on a wall and also it is wear by washing that takes place from errosion action of liquid metal during his flow in a syphon. As a result of such wear a siphon is more weaked and not tight. In such case a syphon yields regeneration by rolling of sleeve on a greater diameter and the plunger is also founded about a greater diameter.

A nozzle yields to the wear as a result of the abrasive wear caused by the flow of metal. The connection between nozzle and a siphon (opening to that enters nozzle - "ancerine neck") is regenerated. Abrasive wear and cracks were main reason of wear of complete set of rings. The plunger wear is caused by a friction in a high temperature (without lubrication). A injection moulding nozzle alike firmness finds out to the nozzle and also wears out by abrasion influence of liquid metal.

A siphon and plunger find out most life among parts that rapidwear out but at the same time they are most expensive. For example double reduction of firmness of siphon causes in case of the higher described technology of pens castings the increase of cost of implementation of casting about 0.17 PLN. Such elements of instrumentation as: sliding-rings, a nozzle and injection moulding nozzle do not increase substantially the cost of implementation of casting as their prices are in relation to small.

Main reason of megascopic wear of the casting instrumentation is an increase of content of the hard non-metal inclusions in a metal, like aluminium and magnesium oxides. The being in a alloy oxides of magnesium and aluminium have higher from a metal temperatures of melting and come forward thus in him as a constant. High hardness of these inclusions increases substantially the value of friction coefficient of cooperating elements and greater abrasive wear, what finally causes a tunning and cracks of sliding-rings on casting plungers. The increase of participation of home scrap in charge causes the changes of castings structure, increasing participation of hard phase of $Mg_{17}Al_{12}$, that increases machanical properties of alloy. Example of microstructure changing of castings was shown in Figs.1,2 [9].

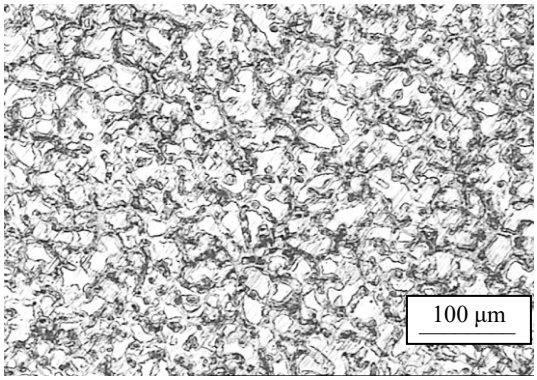

Fig. 1 Microstructure of casting obtained from a pig, but after previous melted (A1)

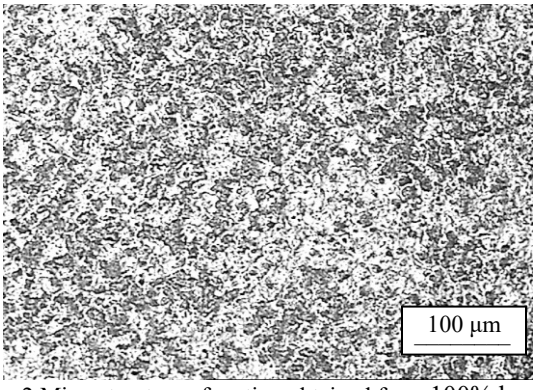

Fig. 2 Microstructure of casting obtained from 100% home scrap in charge (A5)

The tensile strength and elongation of AZ91 alloy as a example of home scrap in charge influence were presented in Figs. 3 and 4 [10].

Such situation takes place especially distinctly, when participating of home scrap in charge crosses 50% of general mass of charge. More early researches specify also on positive influence of home scrap in charge on reduction of castings porosity [11].

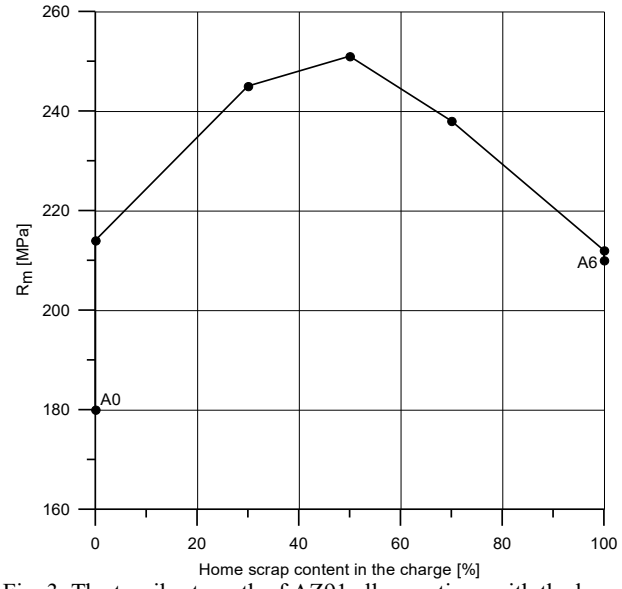

Fig. 3. The tensile strength of AZ91 alloy castings with the home scrap in the charge

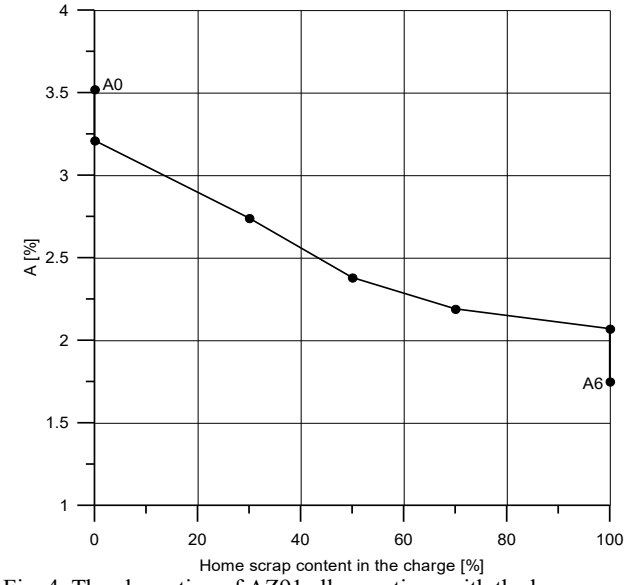

Fig. 4. The elongation of AZ91 alloy castings with the home scrap in the charge.

4. Summarization

In general, increasing of home scrap participation in charge negative effects on the wear of the casting instrumentation. The life of all elements of instrumentation used in castings production in the conditions of application of home scrap to participation about 50 % in charge is comparable with life of this instrumentation applied to casting of metal without participation of home scrap. The higher contents of material recycling cause the expressive wear of "casting set".

The obtained results determine the level of optimal participation of home scrap in charge at the high-pressure casting of AZ91alloy. Researches in this field are a signal indicatory possibility of application of this method of casting also for other alloys of magnesium.

Various contaminations of alloy as oxides cause the wear of elements of casting set quicker, what causes an increase money of products, related to the exchange of these elements. The detailed estimation of economic effects of application of recycling of alloy of AZ91 home scrap in a casting pressure workshop is not an object given to work and comparison of effects of positive influence of home scrap on property of castings with the diminished life of instrumentation elements casting specifies, that maybe there is determination of optimal participation of home scrap in charge of melt.

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