The impact of breaks during foundry work of the pressure casting machine on casting quality

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Abstract

The result in the appearance of the technical object damage are its failures, which are considered as the most important causes of productivity loss in the technical objects. The article introduces main types of losses resulting from the downtimes of a casting machine. The time impact analysis of the font mould failure and the remaining time of the machine's failures on the castings quality was conducted. The failure time structure of the font mould and other failures of the machine was presented.

Keywords: Die casting, Time loss, Correlation coefficient – R, Coefficient of determination - $R^2$

1. Introduction

Failures may prevent the technical object's functioning or limit it. Failures which unable the functioning occur very rarely and they can be easily spotted, according to their significant effects on the system. On the other hand, the failures limiting functioning enable the work of the technical objects, however, with lowest efficiency [1].

The time period of failure and the repair covers the total period up to the moment when the machine will manufacture proper products all over again. Depending on the nature and cause of the failure in the die casting, the time of process stabilization, so it means the time of receiving first good product, differs. Due to the identification, documentation and systematic elimination of losses, caused by inefficient maintenance of the technical objects movement, in general, the overall efficiency of already existing manufacturing systems can be increased at about 80-90%.

The purpose of the article is to indicate which of the period loss resulting from shutdowns during the work of a casting machine have the greatest impact on the decreasing of the casting quality.

2. Main types losses characteristic

The cold -chamber, horizontal casting machine of IDRA type of the production year 2007 was subjected to the research. On the basis of the machine's work time during 27 weeks in the year 2008 taking into consideration the duration period and type of downtimes and the level of the incompatibilities, their impact on the casting quality was examined.

Downtimes of the analysed machines were divided into planned downtimes and unplanned downtimes. The research concerned the unplanned downtimes which were further divided on the font mould failures ($T_{Af}$) and other machine's failures ($T_{Am}$).

Subsequently the correlation coefficient $r$ [2] was implemented for presenting the relation between the time of the font mould failure ($T_{Af}$) and the time of other machine's failures ($T_{Am}$), and the incompatibilities level (PN).

The loss of accessibility, efficiency and quality decrease all together the volume of the proper manufacturing which could produce the machine during the shift-time. The general division of losses that decrease machine's productivity is shown in the Fig. 1.
Main types of losses decreasing machines productivity

For the time loss are also included losses that are connected with the production implementation. The main cause of the machine working speed drop is unstable product quality manufactured at full speed. The machine working speed is related with the so-called efficiency loss. These losses are very often caused by the micro downtimes. This phenomenon in less applicable to fully automated casting machines.

3. Downtimes structure of the shift fund working time of the casting machine

Participation of various types of downtimes during the shift fund working hours is presented on the Fig. 2. An analysis of the figure shows that machines downtimes were mainly caused by font mould failures (13.89%) and machinery failures (9.68%).

Font mould and machine's failures sum up to more than 20% of the shift fund working hours and the planned retooling takes only 2.46%.

4. Analysis of the time impact of font mould failure and the time of other machine’s failures on the castings quality

Using the correlation coefficient – r, and then the coefficient of determination - $R^2$ there was indicated the impact of the font mould failures time ($T_{Af}$) and the machine's failures time ($T_{Am}$) on the level of non-compliant products in each of the 27 weeks.

The coefficient of determination ($R^2$) was used to present which part of the variable's inequality $P_N$ (the incompatibilities level-defined as the percentage of inconsistent products to the total production) is explained by the occurrence of the font mould failure time ($T_{Af}$) and the machine's failure time ($T_{Am}$). Evolution of the coefficient of determination during 27 weeks for the font mould failure time ($T_{Af}$) and the machine's failure time ($T_{Am}$) are shown in the Fig. 3.
From the analysis of the fig. 3 can be concluded that the font mould failure time in 25th of the 27 analysed weeks have impact on the inconsistent products' occurrence.

Between the time of font mould failure (TA_f), the time of remaining machine's failure (TA_m) and the incompatibilities level (PN) exist positive correlation what means that increase in the font mould failure time's duration and the machine's failure causes increase in the inconsistent products' occurrence. The purpose was also to ascertain: what determines the casting's quality more: the font mould failure time (TA_f) or the machine's failure time (TA_m)?

Font mould downtime (TA_f) at smaller extent influenced the occurrence of inconsistent products also in the 7th and 25th week of the research.

From the analysis of the Fig. 3b it can be concluded that the remaining machine's failure time (TA_m) only during 7 week out of 27 analyzed significantly affected the occurrence of inconsistent products.

5. The font mould failure and other machine’s failures structure

The analysis of the conducted researches shows that the font mould failure time rather than the machine's failure has more impact on the inconsistent products' occurrence. The font mould failure time (TA_f) mostly determines the quality level in the 20th week of the research (73.3%). The machine's failure time (TA_m) only during the 6 weeks had impact on the inconsistent products' occurrence out of which the most in the 8th week of the research (over 80%).

The times of font mould failure and the machine's failure times were further analyzed in order to examine the most common causes of its occurrence. The failure causes' structure is presented in the Fig. 4.

The analysis shows that the ejector's failures and slider's failures sum up to 50% of all of the font mould failures. (Fig. 4a). The Fig. 4b analysis indicates that two most common machine's failures occur which are the failure of the sprinkler for applying the separator and the piston's failure, which represent 37.64% of total machine failures.

The ejector failures (e.g. blurred ejector) cause the necessity of mechanical removal of the casting from font mould. Due to this actions the breakage and other damages of the casting occur. The failure of the sprinkler for applying the separator also causes the casting to remain in the font mould and its breakage. Lack of appropriate dimensions of the castings is very often connected with the slider or actuator failure. A common reason of the wrong dimension is also placing the alloy on the core or overused core. The slider's failure is caused by decrement and flash.

The piston's failure is connected with its seizure, rupture what results in the need for polishing or exchange.
4. Conclusions

From the conducted research can be derived that downtimes of the analysed casting machine were caused mostly by the font mould failure time (13.89%) and other machine's failures (9.68%).

The research carried out using the correlation coefficient indicates that inconsistencies in pressure casting more often were caused by accidents than other forms of machine failures.

Among the font mould failure, the most important were failures of extractor and slider ejector. The failures of washer and the piston failures are the most frequent unplanned downtimes of the analyzed casting machine.

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References