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Taguchi Experiment to establish the Process Parameters for Die Cast Aluminum Parts

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Abstract

In the paper presented we did an experimental method for optimizing the die casting process. The method applied was developed by Taguchi and experimented in one Romanian Automotive Company in order to improve the design of the engine in automotive. I decided to propose the above method in the discovery aspect of a very serious problem facing the production department in one company that produce automotive aluminum parts using die cast process. Because we want to discover a solution to remove the porosity which is the biggest problem in die cast design and process. We have plans to start implementing the experiment for all the parts produced.

The experiment conducted for the implementation of the method has been desired to be applied to eliminate this porosity problem and was based on six trials in which it found the ideal combination of factors and the level at which they must be in order to reduce percentage of parts which are outside the tolerance of porosity characteristics.

1. Introduction

Efficiency method presented in this paper is a high practical applicability, and also should be emphasized that newness brings by this method in the development of the company, as a measure to improve the quality assurance and all the advanced plan of the quality process. An important aspect relating to the method proposed for implementation, a method that aims to solve one of the major problems of the company have said to increase confidence in the effectiveness of the method: the prevention of defects is performed at an earlier stage of product development, namely the stage of casting, which was reduced by the costs of removal of defects in the manufacturing steps and use the product.

The results of our experiment will be the starting point for the product and process design for all the parts that was introduces in the experiment and for all the similar process.

Usually when there is a dispersion or instability of the characteristics of a product during manufacture or use, is looking to reduce their causes, or even eliminate. These reasons are multiple: the variability of environmental (temperature, humidity, dust ...), the variability characteristics of raw materials and components used, different operating modes of working. The means generally used to combat them are often very expensive to cost: reducing the range of tolerance for the materials used, devices more or less sophisticated, cooling manufacturing workshops, too rigid rules for the use or operation of products.

The G. Taguchi's strategy is diametrically opposite: instead of seeking to eliminate these factors parasites (called noise factors), he sought to minimize their impact.

Specifically, it is to identify combinations of parameters that reduce the effects of causes, not that they are directly attacked.

The parameters for the product or its manufacturing process, on which we can operate easily, are called control factors (such as pressure in a process of injection, type lubricant used, the temperature of a metal casting, cutting depth of tools, stirring speed of a liquid solution, the amount of resistance in an electrical circuit, ...).

Searching for good values to be assigned for the experimentally control factors, in order to optimize the product or process to meet the desired functional

Keywords: *experimental method, casting process, quality management*

performance and to be robust, insensitive to noise factors and low as cost.

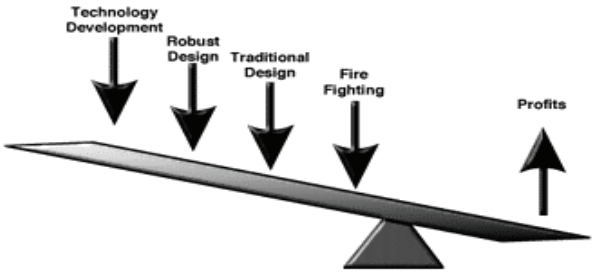
2. Quality management approach in the conception of G. Taguchi

Taguchi approaches the quality problem more in terms of its social impact. Taguchi defines quality in terms of "social loss" includes not only purely technical aspects of the product leading to non-fulfillment of its mission, but also negative effects in terms of economical and environment aspects.

Taguchi focus mainly on design stage, considering that it is more economical to make one insensitive to process variations, than to carry corrective actions. He disagrees with the goal of "zero defects" as support (and rightly so) that there will always be uncontrollable random factors that can cause problems – even be minor. (Taguchi's philosophy has been widely analyzed in the paper "Off-line QC Parameter: Design and the Taguchi Method" by RN Kackar, in the Journal of Quality Technology, vol 17 1985.)

In conclusion these comments: Deming, Ishikawa and Taguchi are with the predilection the promoters of quantitative analysis quality method, while others put more emphasis on "extra mathematic" the complex issues of quality.

Taguchi has intuited the role of design and technological development in order to increase the rate of profit:

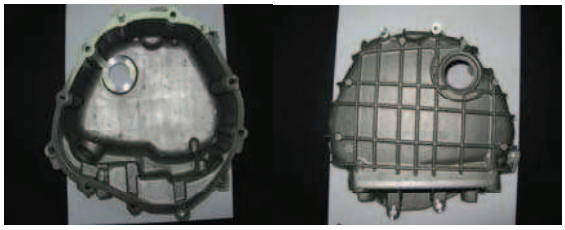


3. Case study: Taguchi method implemented in one automotive company

Taguchi experience plan, contributed to the Japanese success in quality field, which allowed them to become, more than 20 years, world leaders in terms of quality, with competitive prices return.

The company is part of the producing car components sector. The production area is divided in 2 main sectors one of them being die casting process. In this process of casting one of the biggest problems facing the company is porosity. With this in mind I began to study various quality assurance methods to try to solve the problem mentioned above. After several articles and books studied we decided that the most appropriate solution in this case would be trying to implement Taguchi method in the process of casting. Taguchi method is a method easy to implement, the costs are minimal and if the method would prove to be a successful company would greatly benefit with very little effort.

The purpose of this work: method development and its implementation experimentally to improve the casting of the landmark Carter.



The effectiveness of the method: high practical applicability, quality method not used till now in the factory.

An important aspect: to prevent defects is mandatory to react in an earlier stage of product development.

3.1. Steps taken to implement the Taguchi experiment

3.1.1. Establish the objective to be achieved. To set the objective to be achieved from this experiment is sometimes necessary to make investigations in advance, which require different techniques to define and locate the exact problem to be solved.

Besides a logical deductive reasoning question - the effect that specialized uses spontaneously or with the fish bone diagram Ishikawa's in a brainstorming session, he can call separately or successively, the instruments listed below:

- Diagram the major causes;
- Search incriminated components;
- Compare the pairs.

They are all designed to isolate, from a number of possible causes, a small group containing the "culprits". From these we deduce that the objective of this experiment is to obtain a number of items discarded as small and the major cause of scrapped parts is porosity.

3.1.2. Mobilization of stakeholders in preparing and carrying out the experiment.

The success of an experiment depends essentially on his preparation. This pragmatic approach, in successive stages, calls for common sense, to the knowledge of phenomen and the experience gained during the years by engineers and technicians concerned. Having confidence in people in the sector, it is possible to determine the most relevant factors to be checked.

Thus, to determine the reflection group discussions took place with staff of the company and decided that those most able to contribute to the experiment are quality engineers, people in the technical department but primarily set-uppers in casting machine, engineer process and operator participating in the verification porosity. Reflection of the group is part of the person who came up with the proposed implementation method that is undersigned.

3.1.3. Principles to be followed for the selection and measurement criteria of quality.

Choosing the right characteristics to be optimized is the critical stage of the design phase of an experiment to prove the reliable and effectiveness. For this experiment the quality characteristics to be optimized is porosity within the tolerance.

Increased reliability for measuring the results: Obviously, one of the key points of success of an experiment is the precision with which measurements are made so that this step aims to regulate and ensure that the device Roentgen (X-ray) operating at full capacity.

Determining the number of measurements to be made on the test: It is clear that in assessing media objects and variability of results, must be made more measurements, the minimum number is two measurements. We decided that the number of measurements to be 25, which is practically, measured sample pieces from a combination of factors tested.

3.1.4. Principles to be followed for choosing the factors to be checked.

When we speak of election control factors, we refer to nature, their number, their independence and the levels to be tested.

Choosing qualitative factors to be tested: As a very general, factors that are tested must be directly related to energy - in all possible forms used in the system studied.

So the same condition is found to be followed for selection criteria for quality. It is indeed clear that the factors leading to increases, this energy consumption or processing can influence the results.

Number of factors to be checked: In an experiment, to test how many factors the greater the chance of identifying influential factors, the more it ensures the reproducibility of results. Have always thought it looked optimize various parameters resulting from the equilibrium values of the system studied.

Otherwise the number of factors chosen for this experiment to be sure is five, each having assigned two levels.

Choosing factors indeed independent from each other: In determining these factors has been meeting with a group of reflection to determine the recipe for success for this experiment. So after discussions and following tracking sheet casting defects and causes, they were established by Annex following factors are to be checked: distance to phase two; speed to phase two; temperature alloy; the amount of aluminum introduced into the casting frame and pressure multiplier.

3.1.5. The strategy to be adopted in the study of interactions.

There are often interactions between different factors during an experiment. The purpose of this phase is to identify how the influential factors are and should be noted once again the values of the two levels of factors. These values were determined with the team and it was the inclusion of these values in technical standards. Presented experiment concluded that all five influential factors are equivalent, so the experiment can proceed with existing data.

3.1.6. Thoroughness and accuracy in preparing and carrying out the experiments.

Without thoroughness and accuracy in carrying out procedures for testing and measuring the characteristics to be optimized, the interpretation of results will be random and reproducibility will be a chance. To avoid this, must be carefully prepared three types of documents: Protocol implementation experiment; Test files and Report files.

3.1.7. Validation test is mandatory to confirm the experiment.

At the end of the experiment work, we defined for each of the factors attempt, the favorable level. This combination has led to the reduction of problems in the company by obtaining parts with a porosity that is much lower. Implementation of this experiment involved determining the minimum and maximum costs.

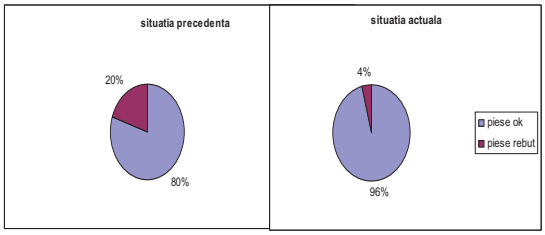
3.2. Experiences plan in table form

In the next table are passed all the tests, all factors, the levels at which these factors were checked, the result of the test (percentage of porosity achieved from the combined sample) and highlighting the most favorable test.

Table 1. Results datbase

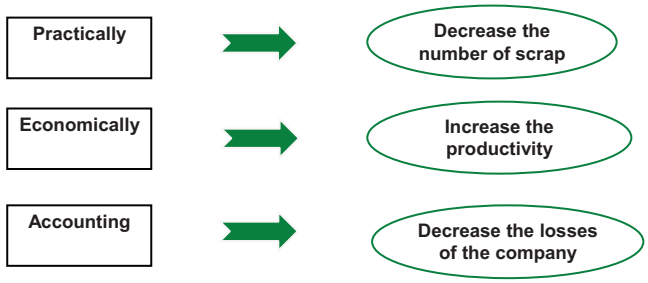
No.	Tested indicators					Results
	A	B	C	D	E	
1	1	1	1	1	1	20%
2	1	2	1	1	2	32%
3	2	1	2	2	2	40%
4	2	1	2	1	2	4%
5	1	1	2	1	2	28%
6	1	2	2	2	2	44%

Fig. 1 Taguchi method Efficacy



The methods implemented optimize the casting parameters as following:

Fig. 2 Results after the Taguchi method implementation



4. Design / redesign of the product

Given the complexity of this activity, it is recommended that it be conducted in an interdisciplinary team and be based on methods of stimulating the imagination and creativity.

Using different methods of creativity, the research has the task of producing as many ideas, from which to select the best.

Proposals to improve the study part:

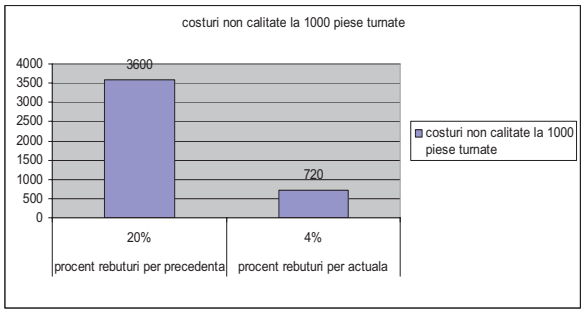
An idea that could serve as a future project is making a hole of Ø8 with a length of 215 mm with a special milling, over the piece, hole in which to introduce a sensor for permanent display oil temperature. Aces display using electronic equipment could be installed in the car with display for pressure.

The improvement serves to prevent a possible overheating of the oil resulting in more poor lubrication of the engine block.

Although it is recommended oil change every 15,000 kilometers a preventive measure in addition is always welcome.

The cost of implementing such a sensor including as regards all the electronic and can be easily raised. This improvement may not have a positive impact on all customers because it believes that changing the oil every 15,000 kilometers is sufficiently prevention. Instead there were excited about the idea and potential customers especially those who can afford to spend larger sums of money, because this type of buyers are willing to pay more for a way to further safety car.

Fig. 3 Economic and financial advantages



5. Conclusions

The written work presented an experimental method to optimize the casting process. This method was applied in Japan, was develop by Taguchi and proposed by me. We made the decision to propose the above method after discovering the issue of a very serious problem facing the company, namely the high percentage of components which have porosity. The possibility of finding a solution to remove porosity was the start of plans for implementing the experiment.

The experiment conducted for the implementation of the method that we wanted to be applied to eliminate this problem of the company, named porosity was based on six tests from we discover the ideal combination of factors and levels that they must be to reduce percentage of parts which have porosity beyond tolerance.

Efficient methods presented in this paper is that it has a high practical application and also should be emphasized that novelty brings Taguchi method in the development of the company, is a way of providing quality not used so far. An important issue on the method proposed for implementation, the method aims to solve one of the major problems that the company should increase confidence in the effectiveness of the method: the prevention of defects shall be made at an earlier stage of product development, thus being reduced costs by eliminating the defects of the stages of construction and use of the product.

After an evaluation of the experiment and declare that it provides considerable efficiency by reducing porosity, the company's decide to apply Taguchi method to other products to ensure their quality .

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