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ALGORITHM PREDICTION FOR FINISH ROUGHNESS IN THE MILLING PROCESS OF A STEEL AISI P20 WITH THERMAL TREATMENT (HARDEN AND ANNEAL) IN A RANGE HARDNESS OF 60-64 HRC

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ABSTRACT

The research presents an optimization of milling parameters in order to predict the final roughness of the product. The parameters such as cutting speed, feed rate, trajectory and radial depth for AISI P20 steel with thermal treatment hardening and tempering for machining in flat milling using CAD / CAM manufacturing processes were optimized. Taguchi and Anova methods were used to determine the equation that predicts the roughness. The article analyzed the parameter that has the most influence on finished surface. A statistical regression equation was obtained in order to predict the final roughness. The prediction will reduce manufacturing costs and optimize processes. The combinations of the parameters were obtained by using the orthogonal matrix L27 of the Taguchi method. The roughness data measured after machining was analyzed using the variance of the Anova method. Cutting speed parameter has the greater influence on roughness with a percentage of 66.19%. The ideal arrangement of the parameters allowed to find an optimal roughness of 0.11 µm. The arrangement was established by a cutting speed = 25 m / min, feed = 101.461 m / min, trajectory = ZIG-ZAG, radial depth = 1.29 mm. The values of the optimal roughness calculated showed better results in the final product. The results revealed that the Taguchi and Anova methods can calculate optimal values to obtain the best results of the roughness in flat milling.

Keywords: ANOVA, combinations, flat milling, roughness, Taguchi method.

INTRODUCTION

The study was developed with AISI P20 steel in flat specimens. The CAD / CAM manufacturing processes and thermal treatment was applied. The study allows to develop a new research line, which benefits to different manufacturing processes. The results showed an optimization of processes, resources reduction and manufacturing costs optimization. It will create profits for companies involve to the production of plastic articles and manufacturing moulds. The determined parameters obtain optimal surfaces, reducing the polished times. M238 steel is highly used in the blowing industry and plastic extrusion, due to the important features offered. M238 has a high content of nickel that get a uniform mechanical resistance in the core. Steel is used for manufacture parts and accessories for the automotive industry, machine manufacturing and plastic moulds up to 400 mm thick [1]. A hardening thermal treatment was applied to AISI P20 steel. It increases life cycle of the material and reduce the internal stress concentration to increase hardness [2]. The manufacturing process was carried out in a CAD / CAM software that allows to design and model products. Furthermore, it assists the machining phases in order to minimize the manufacturing costs and to improve the production [3]. The programming code is the combination of the parameters obtained by a orthogonal matrix of the

Taguchi method that optimize the product design and manufacturing processes to achieve high quality and low costs [2]. The roughness is analyzed after the machining process. The ANOVA method, or variance analysis, was used to analyze the roughness. This method is a statistical tool used in the industry for control processes. It is a method use to analyze the results of different experimental design factors. The method has two main applications: the comparison of multiple columns of data and estimate the variation of a process [3].

RESULTS AND CONCLUSIONS

The machining factors used in the research explain a great influence on the surface finish. The cutting speed factor has a significant influence of 66.19% on the averages of the roughness in all the levels compared to the advance with 4.31%, trajectory with 0.65%, and radial depth with 2.29% that when adding with the error rate of 26.56% gives 100%.

Figure 1 shows the roughness surface vs. cutting speed and step rate for the ZIG-ZAG path with the best roughness results. Equation (1) presents the statistical regression equation to calculate the average roughness (R_a).

$$R_a = -0{,}15 + 0{,}010 * A + 0{,}003 * B - 0{,}00009 * A * B \tag{1}$$

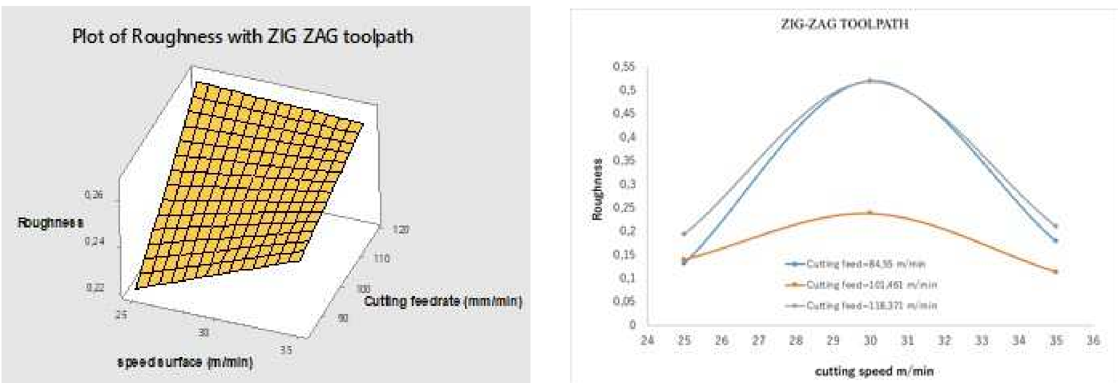

Fig. 1 - Graph of roughness vs. cutting speed vs. Step for a ZIG-ZAG trajectory

The average values of the roughness of the surface and the Anova method were applied for the study of the surface roughness and to optimize the machining factors. The optimal levels for each factor in the experiment are: cutting speed = 25 m / min, feed = 101.461 mm / min, trajectory = ZIG-ZAG and radial depth = 1.29 mm, having a surface roughness result of 0, 11 µm.

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