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BALL BURNISHING PROCESS TO IMPROVE SURFACE ROUGHNESS

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ABSTRACT
The ball burnishing process is made with the intention of improving the surface finish of some pieces that have been previously mechanized. The following paper presents the results of the tests carried out this process applied to aluminium pieces.
An experimental design (DOE) to investigate which is the process parameter control was developed. Surface roughness parameters, Ra and Rt, in the direction of step (perpendicular to the tool feed) were measured. We present the Pareto charts and a response surface for the Ra and Rt in the direction of the step.
Keywords: Ball Burnishing, Surface Roughness.

1. INTRODUCTION
Through a ball burnishing operation (YC Yen et al., 2005), surfaces with complex configuration can be produced, leaving them a good surface finish. As shown in Figure 1, this process is developed using a tool that is mounted on a hydraulic head, which applies pressure to a ball. This ball is which when it is going beyond the surface to mechanized, produce a plastic deformation in the material, eliminating the peaks and the surface irregularities, flattening the profile and improving the surface finish.

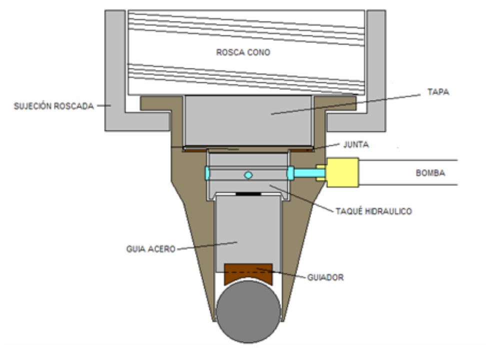

Figure 1. Ball burnishing process schema

This process is easy to apply because it is made in the machine itself where the piece has been mechanized, through the use of a tool and without having to dismantle the piece, is the operation of burnishing.
To carry out this study we proposes to develop an experiment to measure the surface roughness remaining on the work-pieces after being burnish with different technological parameters.

2. EXPERIMENTAL STUDY

The study consists of planning the surface of the work-piece using a plate of ø80mm and 5 inserts, with the following parameters: rotation speed = 1000 rpm, Feed = 200mm/min, Depth of cut = 0.5 mm. After mechanizing the work-piece, in a part of this area the ball burnishing operation is made. At the final surface roughness from the planned operation and the burnishing operation, are measured.
To carry out these tests an experiment is designed in order to perform the fewest possible tests. To do this it is decided that the variables that will interact on the system are 3 and it takes to them a higher and a lower value, which are combined through a factorial design 2^3. The parameters used as variables are: the tool feed, the pressure of the ball (given by the depth given to it) and the side step of the operation. The values that take these variables are shown in Table 1.

Table 1. Experiment variables values

Parameter	Lower value	Higher value
Feed (f)	100 mm/min	200 mm/min
Depth (t)	0.5 mm	1 mm
Side step (b)	0.08 mm	0.15 mm

The work-pieces (Figure 2), are made in Aluminium A96351, according to UNS with 80 HRH hardness, which characteristics are in Table 2. Twenty specimens were produced for the same number of tests, because the experiments were made with a replicate and using 4 central points, exactly where the parameters take the value between lower and higher values.

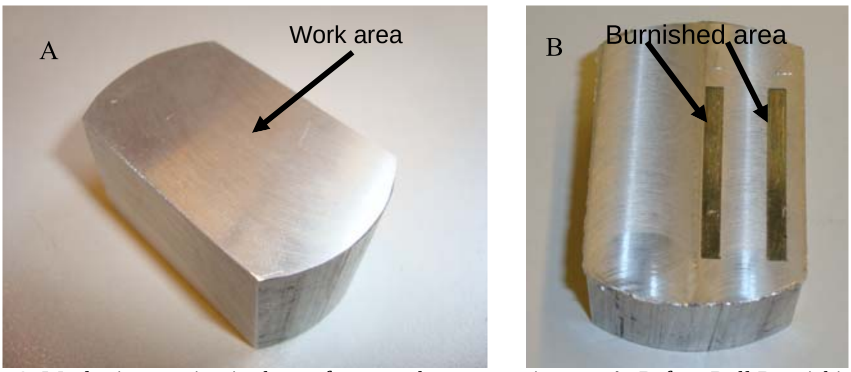

Figure 2. Work-pieces using in the surface roughness experiments. A- Before Ball Burnishing, B- After Ball Burnishing

Table 2. Material properties of the work-pieces using in the experiments

% Al	%Si	%Fe	%Mn	% Mg
≈ 97.7	0.96	0.25	0.55	0.53

3. EXPERIMENTS RESULTS

The results were positive because of the values of surface roughness were improved respect to them. A statistical analysis of the measurements results of Ra and Rt (in the step direction) were performed, to determine the influencing of the parameters considered as variables in the experiment. The results of this analysis can be displayed below.

3.1. Results for Ra

The step is of all, the more important factor that exerts a certain influence on the parameter Ra (figure 4). The smaller the value of it, is the smallest value of Ra. The step is virtually the only statistically significant factor (figure 3).

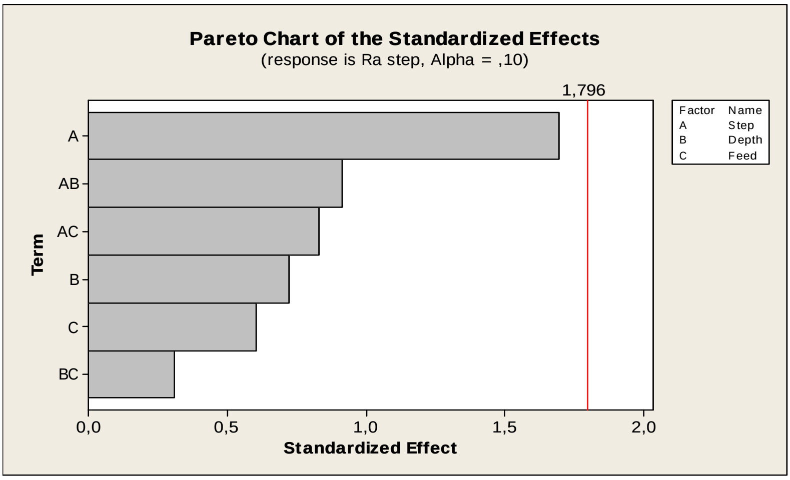

Figure 3. Pareto diagram to the Ra results.

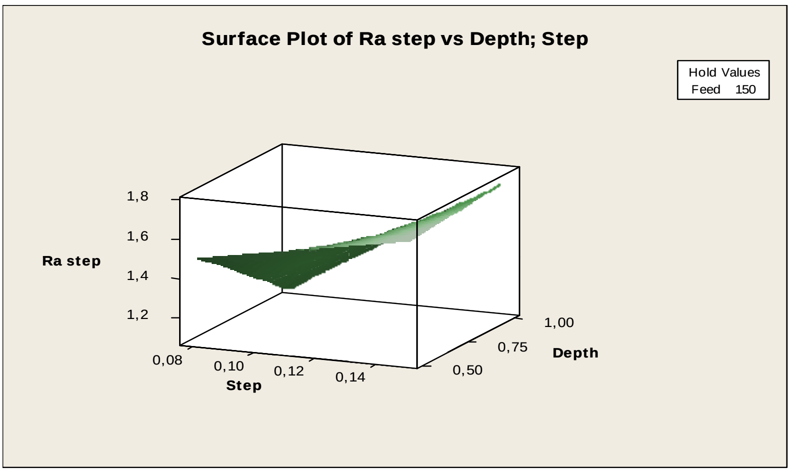

Figure 4. Surface response for Ra

3.2. Results for Rt

The factor that weighs more is the crossover effect of the feed and the step (figure 5). As you increase or decrease both of these parameters at the same time, the values obtained for Rt are lowers (figure 6). For example, if the step and the feed are small, Rt values are in the order of 11 microns.

It appears that the curvature of the model is not important because the average values of Ra and Rt, are within the graph of surfaces response. However it would be necessary to do experiments in more points in order to accurately determine if this is really true. Also it could be doing more experiments to find a model that is more in line with experimental results.

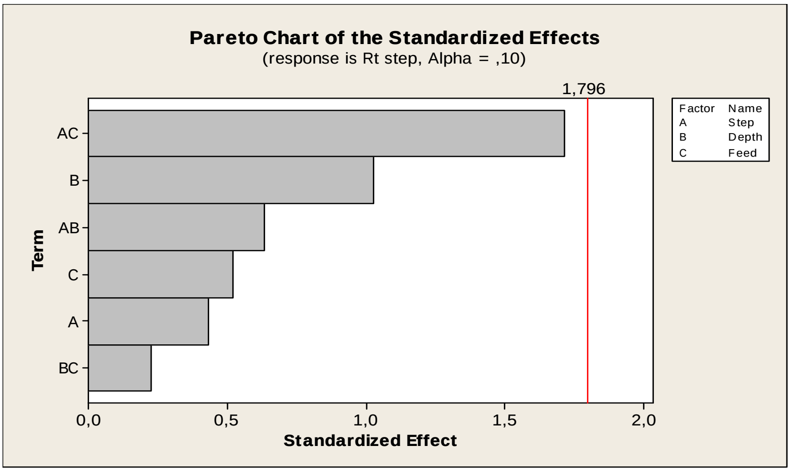

Figure 5. Pareto diagram to the Rt results.

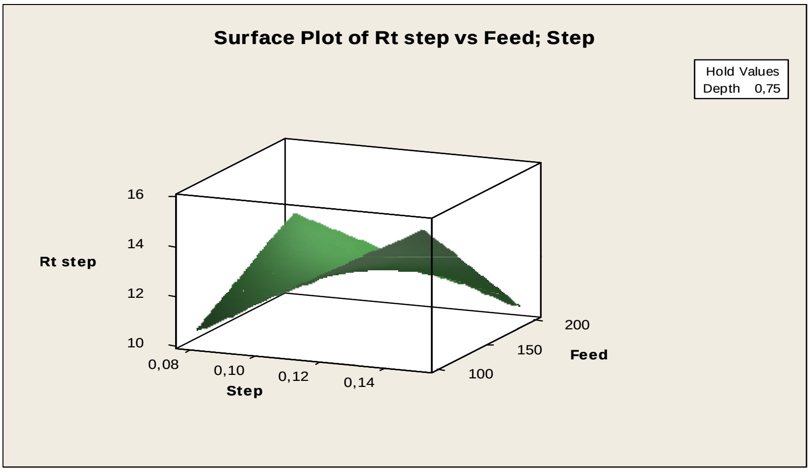

Figure 6. Surface response for Rt

4. CONCLUSIONS

The ball burnishing process provides obvious significant advantages, which gives it a good chance to establish itself relatively easily in the market.

This paper has been able to demonstrate that:

- The values of the average superficial roughness (Ra), decrease in the pieces tested, after burnishing.
- The surface roughness values are different depending on the technical parameters with which the operation is conducted. Is very interesting to determine which is the control parameter in each case.

5. REFERENCES

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