Swaging Process for Productivity improvement in the manufacture of Spindles

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Improvement in productivity will be achieved through utilization of resources in a better way. Economy and efficiency are two routes to achieve improvements in productivity. In this journal paper, designing the Spindle Blade and Aluminium Plug in the spindle assembly used in textile Frames have been deliberated by analyzing the trials conducted on different processes and machine tools for reducing cost and improving productivity. Conventionally, a copying lathe is utilized for the manufacture of the spindle blades and the aluminium plugs. In this journal paper, the design analysis and optimization of spindles have been attempted through a swaging process. In addition to increasing the productivity, swaging process also saves considerable amount of material and labour with increase in tensile strength of Spindles.

Keywords: Productivity, Spindle Blade, Aluminum Plug, Swaging, Optimization.

Introduction

Productivity is the balance between all factors of production that will give the greatest output for the smallest effort1. In technical terms, productivity is the ratio of output (of product) to the input (of factors required for producing the product). The output is measured in terms of the units of goods produced or the value of the goods and services and the input is the combination of the raw materials, machinery, worker’s time, power and efforts. Productivity of a labour is measured and expressed in two ways as 1) labour cost per unit of output and 2) output per man-hour. There are two broad ways of improving productivity. The first method is to increase output with the same amount of input and the second method is to reduce the input for the existing level of output2.

Trial Analysis

A copying lathe is used conventionally for the manufacture of the spindle blades and the aluminium plugs in the spindle assembly used in textile frames. Alternately, a single spindle automate has been analyzed initially3. Then, using a swaging process in a swaging machine, several trials have been taken for analysis. During the course of these trails, it was found that through swaging process in addition to increase in production there is also a saving in the material and labour along with an increase in the tensile strength4.

Design Analysis

A Textile Spinning frame is having 440 Spindle Assemblies. Each Spindle Assembly consists of a Spindle Blade made up of En31 steel, Aluminium Plug made up of LM4 aluminium and Wharve made up of Cast iron Fe 200 material and assembled together as shown in Figure 1. In this journal paper, only the following machining processes of Spindle Blade and Aluminium plug are considered for Analysis and Optimization.

A) Spindle Blade B) Aluminium Plug
a) Facing a) Facing
b) Taper turning 1 & 2 b) Taper turning
c) Pointing 1 & 2

Analysis of Spindle Blade

Spindle Blade machined through Copying Lathe

Individual cut pieces are fixed to the chuck and machined in regular machining of Spindle Blade on copying Lathe. Raw material utilized is 0.157 Kg and Machining time is 20 Minutes
Spindle Blade machined through single Spindle Automate

A single Spindle Automate with change of vertical slant tooling for facing and gear box with 1:48 reduction for driving drum cam for movement of horizontal tooling for taper turning and pointing have been designed and adopted in the machining trial of Spindle Blade. A long bar is fed, clamped and machined resulting in less machining allowance. Raw material utilized is 0.145 kg and Machining Time is 18 Minutes.

Spindle Blade through taper forming by Swaging process

Swaging process is similar to a cold forging. Swaging setup is designed with Swaging rollers fixed in an eccentric housing and internally synchronized with gears. During rotation of the Housing, Swaging rollers hit against the job and taper is formed with elongation of material. Pointing is also formed by swaging. Raw material utilized is 0.105 kg and Machining Time is 17 Minutes.

Analysis of Aluminium Plug

Very similar to the analysis of Spindle Blade, the analysis is carried out for the manufacture of Aluminium Plug with respect to three different processes.

Aluminium Plug machined through Copying Lathe

For Aluminium Plug machined in a copying lathe. Raw material utilized is 0.200 Kg and Machining Time is 4.5 Minutes

Aluminium Plug machined through single Spindle Automate

With a change of tooling & drum cam, Facing and Taper Turning are carried out by feeding a long Aluminium bar. Raw Material utilized is 0.185 kg and Machining Time is 4.25 Minutes.

Aluminium Plug manufactured by swaging process

Through Swaging process, required taper and length is formed by deformation and elongation of LM4 material. Raw material utilized is 0.150 kg and machining time is 4 Minutes.

Results and Discussions on Productivity Optimization and cost Reduction

In the case of Spindle Blade, the savings reaped on material is 0.012 kg and 0.052 kg for machining on Single Spindle Automate and Swaging process respectively when compared to the normal machining on copying lathe. In the same way, saving on machining time is 2.0 minutes.
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In the case of Aluminium Plug, saving on material is 0.015 kg and 0.050 kg for machining on Single Spindle automates and swaging process respectively when compared to normal machining on copying lathe. Similarly, saving on machining time is 0.25 minute and 0.5 minute respectively for machining on Single Spindle automates and Swaging process compared to machining on copying lathe.

Trial results and findings on Cost Reduction and Productivity Improvement are furnished in Table 1. From content of Table 1, it is clearly evident that Swaging process gives a better saving on material and machining time for both Spindle Blade and Aluminum Plug. By Swaging Process, cost reduction is Rs.36 per Spindle Blade and Rs.18 per Aluminum Plug. Productivity of material is 33% and 25% whereas productivity of machine is 10% and 11% respectively. Overall productivity improvement is 38% and 28% respectively.

Swaging process seems to be more productive and further study can also be made for other machining components. It is noticed as a consequence of Swaging process, tensile strength of Spindles is getting increased from 850N/mm² to 1400N/mm², which increases the life of Spindles.

Conclusion

Swaging process when compared to conventional machining processes, is a sustainable and eco-friendly industrial process. Productivity improvement on cost is noticed to vary from 28.29% & up to 38.14%. It is noticed as a consequence of Swaging process, tensile strength of Spindles is getting increased from 850N/mm² to 1400N/mm², which increases the life of Spindles. Swaging process seems to be more productive and further study can be made for other machining components also. Higher productivity is of vital importance for the swift industrialization and economic development. The available resources have to be used in such a manner that both the total output and the productivity per unit are increased. In this manner, capital will become available for investment in new plants and projects opening the way to economic advancement.

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