A Review on Optimization of Hot Machining Process

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Abstract

One of the main goals of the metal-mechanical industries is the reduction of the production costs through the productivity increase. In the attempt to reach this goals, many researchers have been used the hot machining method. This method consists, basically, in the heating of the work piece hundreds of degrees Celsius above room temperature with aid of an external source of heat. Thus, the reduction of the shear stress of the material of the piece is gotten and, hence, is possible to obtain a smaller wear of cutting tool in relation to the conventional machining. This paper presents a review of hot machining, where the different techniques are presented together their results. This review paper presents a survey on variation in process parameter i.e. temperature, cutting speed, feed etc. and their effect on surface roughness, hardness, material removal rate, tool wear, tool life.
Keywords- Hot machining, Surface roughness, Hardness, Material removal rate, Tool wear, Tool life, Machinability

I. INTRODUCTION

Hot machining is the process which is used for easy machining and to eliminate the problems of low cutting speed, feeds and heavy loads on the machine bearings. These problems arise when machining process is being done on the new and tough materials. The basic principal behind this process is the surface of the work piece which is to be machined is preheated to a temperature below the re-crystallization. By this heating, the shear force gets reduced and machining process becomes easy. During the machining process, instead of increasing the quality of the cutter materials, softening of the work piece is one of an alternate. In hot machining, a part or whole of the work piece is heated. Heating is performed before or during machining. Hot machining prevents cold working hardening by heating the piece below the recrystallization temperature and this reduces the resistance to cutting and consequently favors their composition and properties [4]. From the past experiments it was found the power consumed during turning operations is primarily due to shearing of the material and plastic deformation of the metal removed. Since both the shear strength and hardness values of engineering materials decrease with temperature, it was thus postulated that an increase in work piece temperature would reduce the amount of power consumed for machining and eventually increase tool life [9].

II. DIFFERENT METHODS OF HEATING

Following different methods of heating are used:

A. Furnace Heating
Work piece is machined immediately after being heated in the furnace to required temperature.

B. Resistance Heating
The entire work piece is heated by passing current either through the work piece itself or through resistance heaters embedded in The fixtures.

C. Flame Heating
In this method, work piece material immediately ahead of the cutting tool is heated by welding torch moving with the tool. Multi-flame heads can be used for large heat inputs.

D. Arc Heating
In this method, the work piece material immediately ahead of the cutting tool is heated by an electric arc drawn between the work piece and the electrode moving with the tool. To prevent wandering a magnetic field can be imposed to direct the arc.

E. Plasma Arc Heating
In this method, the work piece is heated using plasma arc just above the tool tip. In this method very high heat is produced. Heating can be limited to a very small surface area.

F. Laser Heating

In laser heating laser beam heats up the materials to be machined by a conventional tool. A laser beam is focused in the surface of the work piece using a group of lens in a point just ahead the edge of the cutting tool [9].

III. LITERATURE REVIEW

Venkatesh Ganta et. al.[1] has investigated to optimize the performance characteristics 15-5PH stainless steel using K313 carbide tool based on Taguchi L27 orthogonal array design. The work-piece material was heated using oxy-acetylene gas flame which is the cost effective method compare to other heating technique used in hot machining process. Analysis of variance is performed to get the contribution of each parameter on the performance characteristics and it was observed that cutting speed is most significantly affect the performance characteristics compare to feed, depth of cut and temperature. The optimal set of process parameters were found to be cutting speed at 31 m/min, feed rate at 0.4mm/rev, depth of cut at 0.4 mm and work piece temperature at 400°C to maximize material removal rate and minimize surface roughness.

K.A.Patel et. al.[2] has investigated to optimize the input parameters during process are speed, feed and depth of cut. The output parameters are surface quality Hot machining process gives good surface finish at high cutting speed, high temperature and low feed rate. And it is also beneficial in terms of surface roughness Optimum results are achieved when Cutting speed is 300 rev/min, Depth of Cut is 0.8 mm, Feed is 0.111 mm/rev and Temperature is 500°C .During hot machining, the change of the work piece surface color was also observed at temperature of 500°C.

Nirav M. Kamdar et. al.[3] were studied under the influence of machining parameter at 200 °C, 300 °C, 400 °C, 500 °C and 600 °C at constant depth of cut 0.8 mm. The optimum result was achieved in the experimental study by employing Design of experiments with Taguchi. . In present Analysis found the varying parameters are affected in different way for different response. Significant parameters and its percentage contribution changes as per the Behavior of the parameter with objective response.

S. Ranganathan et. al.[4] is performed measure, tool wear (VB) are investigated by employing an orthogonal array and the analysis of Variance (ANOVA) at 200^{0}C, 400^{0}C and 600^{0}C hot turning. Optimal cutting parameters for each performance measure were obtained; also the relationship between the parameters and the Performance measure is determined using multiple linear regression equation. The relationship between the factors and the performance measures are expressed by multiple regression equation, which can be used to estimate the expected values of the performance Level for any factor levels.

Maher Bailii et. al.[5] has studied landing gears such as the titanium alloy Ti 5553. The machining of this material leads to high cutting forces and temperatures, and poor machinability which require the use of low cutting conditions. In order to increase the Productivity rate, one solution could be to raise the work piece initial temperature. Assisted hot machining consists in heating the work piece material before the material removal takes place, in order to weaken the material mechanical properties, and thus reducing at least the Cutting Forces. The results analysis shows a low reduction of specific cutting forces for a Temperature area compatible with industrial process. The reduction is more important at Elevated Temperature. However, it has consequences on quality of the work piece surface and Tool wear.

S. Ranganathan et. al.[6] have studied the influence of the cutting parameters namely cutting speed(Vs), feed rate(fs) and depth of cut(ap) at 200 ºC, 400 ºC and 600 ºC hot turning of 316 stainless steel on tool wear are studied. The optimum result scan be achieved in the experimental study by employing Taguchi techniques. Combined effects of three cutting parameters i.e.cutting speed, feed rate and depth of cut on the performance measure, tool wear(VB)are investigated by employing an orthogonal array and the analysis of variance (ANOVA) at 200 ºC, 400 ºC and 600 ºC hot turning. Optimal cutting parameters for each performance measure were obtained; also the relationship between the parameters and the performance measure is determined using multiple linear regression equation.

Dr K. P. Maity et. al.[7] has investigated the hot-machining of high-manganese steel has been carried out using flame heating using an automatic temperature control system. A simple robust system has been designed for automatic movement of the flame-torch while machining to maintain a constant temperature of the work-piece. Design of experiment of using Taguchi Method has been used to optimize the process parameter to maximize the tool life. It is observed that RPM of the work-piece is the most significant under the standard condition considered in the investigation.

M.Davami et. al.[8] have studied AISI 1060 steel (45HRC) and uncoated carbide TNNM 120408 SP10 (SANDVIK Cormorant) respectively. A gas flam heating source was used to preheating of the work piece surface up to 300 ºC, causing reduction of yield stress about 15%. Results obtained experimentally, show that the method used can considerably improve surface Quality of the work piece. Surface roughness in hot machining got better when the work piece Surface temperature is 300 ºC with less variation, Ra≈0.6μm with Vc= 35 (m/min). Hot machining is not only a very useful method for machining of hard-to-cut materials on the rough conditions but also it may used for finishing operation too, when the change of work piece surface color is not very important.- In low cutting speeds, the discontinuous form chips produced in machining may be changed to continuous form.

J. Goudhaman[9] studied that using ATP grade tool for turning operation by hot machining and design of experiments using Taguchi statistical analysis, we find that tool life has increased and power has been decreased. For this experiment the optimum values are found to be Cutting Speed = 150, Feed = 0.05, Depth of Cut = 0.5, Temperature = 600. From the above result we find that by using Taguchi design (MINITAB) and hot machining the power required is decreased and tool life is increased by 14.83 %.

IV. Conclusion

This paper has presented a brief review on effect of hot machining in machining operation. From above study it was found that hot machining is not only a very useful method for machining of hard-to-cut materials on the rough conditions but also it may use for finishing operation too, when the change of work piece surface color is not very important. In low cutting speeds, the discontinuous form chips produced in machining may be changed to continuous form. Cutting speed is most significantly affect the performance characteristics compare to feed, depth of cut and temperature.

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