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OPTIMIZATION OF TURNING OF CENTER LATH MACHINE USING 304 STAINLESS STEEL AS A SPECIMEN

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Abstract
In metal cutting industries, in order to determine the quality of the product the surface roughness is used as the crucial factor. Good surface roughness not only achieving the quality but also it reduces the manufacturing cost. AISI 304 is a high quality; high tensile stainless steel usually gives good ductility and shock resisting properties combined with resistance to wear. This type of material is generally regarded as being difficult to machine. Here the Taguchi method, gray relational analysis and response surface methodology was utilized to design and optimize the machining parameters in turning of AISI 304 stainless steel. The turning parameters selected for optimizations are cutting speed of 450,550 and 650 rpm, the depth of cut of 0.2, 0.3, and 0.4 mm and feed rate of 0.2,0.25 and 0.3mm/rev. the experiment was designed and carried out based on the standard L9 Taguchi orthogonal array.

Key words: Machining Parameters, Gray Relational Analysis, Surface Roughness (SR), Material Removal Rate (MRR).

Introduction

Surface roughness is one of the most important requirements in machining process. It measures the finer irregularities of the surface texture. Achieving the desired surface finish is a difficult task for the functional behavior of a part. Surface roughness influences the performance of mechanical parts and their production costs because it affects factors, such as, friction, ease of holding lubricant, electrical and thermal conductivity, geometric tolerances and more. The quality of surface finish is a factor of importance in the evaluations of machine tools productivity. In a turning operation, it is important task to select cutting parameters for achieving high cutting performance. Cutting parameters affect surface roughness, surface texture and dimensional deviations of the product. Surface roughness is a factor that greatly influences manufacturing cost. The quality of components produced is of main concern to the manufacturing industry, which normally refers to dimensional accuracy, form, and surface finish. Surface roughness of work parts plays an important role on mechanical properties. The proper functioning of machine part is in many instances, largely dependent on the quality of its surface. Engineering properties such as fatigue, hardness, and heat transfer are affected by surface finish.

1. Literature Review Turning is one of the significant and commonly used machining processes in engineering industries. In turning the conditions such as cutting speed, feed rate, depth of cut, features of tools and work piece materials affects the process efficiency and performance characteristics. Performance evolution of CNC turning is based on the performance characteristics like surface roughness; material removal rate. The automation of the CNC turning process allows reaching tight dimensional tolerances in every piece

2. Experimental Details and Methodology 3.1 AISI 304 stainless steel The AISI 304 is the most versatile and widely used of all the stainless steels. The chemical composition, mechanical properties, welds ability and corrosion oxidation resistance provides the best around performance at relatively low cost. These steels exhibit excellent resistance to a wide range of atmospheric, chemical, textile, and petroleum and food industry exposures. AISI 304 has very good draw ability. Their combination of low yield strength and high elongation permits successful forming of complex shapes. However, these grades work harden rapidly. To relieve stresses produced in severe forming or spinning, parts should be full annealed or stress relief annealed as soon as possible after forming. The austenitic class of stainless steels is generally considered to be weld able by the common fusion.

Literature Review

Turning is one of the significant and commonly used machining processes in engineering industries. In turning the conditions such as cutting speed, feed rate, depth of cut, features of tools and work piece materials affects the process efficiency and performance characteristics. Performance evolution of CNC turning is based on the performance characteristics like surface roughness; material removal rate. The automation of the CNC turning process allows reaching tight dimensional tolerances in every piece. For evaluating the quality of the product surface roughness (Ra) is a significant factor. It is an index to determine the quality of surface finish in any machining process. Modeling techniques available for prediction of surface roughness can be classified as experimental methods, analytical methods, and artificial intelligence based model. Since 1970s precision hard turning has one of the great interests among various machining operations because of it potentially provides an alternative solution for conventional grinding of high hardness and high precision components. Also it greatly reduces the production time, tooling cost, manufacturing cost and increase the overall productivity and product quality of components such as gears, shafts, dies, and bearings. Noordin et al uses response surface methodology to describe the coated carbide tools performance while turning AISI 1045 steel. they found that the most significant factor that influence the surface roughness is feed rate. Choudhury et al. predicted that tool wear is greatly influenced by cutting speed, the second significant factor is feed rate followed by depth of cut. Lalwani et al. studied the application of response surface methodology to predict the influence of cutting parameters on surface finish and cutting force in hard turning of MDN250 steel and found that higher cutting speed, depth of cut and lower feed rate will lead to the good surface finish. Thiele and Melkote have reported on the effect of cutting edge geometry and work piece hardness on surface finish in hard turning of AISI 52100 steel. They were used various geometry of CBN inserts as cutting tool inserts. They found that large edge hones produce poor surface finish than smaller edge hones. They concluded that the surface roughness is significantly affected by tool edge geometry and work piece hardness. M.M.A. Khan et al. has investigated the variation of surface roughness, chip formation mode, tool wear, and chip tool interface temperature based on the role of dry, minimum quantity lubrication and wet lubrication. They found that compared to dry and wet machining minimum quantity lubrication was performed well because of substantial reduction in cutting zone temperature, favorable chip tool interaction and chip formation, also good surface finish and reduced tool wears resulted in increased tool life.

Experimental procedure

Experimental setup the experiment was performed by using the lathe "TOS TRENCIN; model SN40C". This lathe is characterized by 6.6 kW spindle power and a maximum spindle speed of 2000 rpm. The cutting insert used is SANDVIK "Ti(C N)/ Al2O3/TiN" CVD multilayer coated carbide referenced as GC2015 (SNMG 12-0408-MF). The cutting inserts were clamped on a right- hand tool holder with designation PSBNR25x25M12. The work piece adopted in the current study was AISI 304 Austenitic stainless steel with chemical composition (0.02% C 16.91 % Cr, 7.69 % Ni, 0.33 % Si, 1.44 % Mn, 0.41 % Mo, 72.10 % Fe and 1.1 % other components). The dimensions are 100 mm for diameter and 350 mm for length. The mechanical and physical properties of the work piece are summarized in the Table 1. Three different components of forces, commonly called, cutting force (Fc), feed force (Fa) and thrust force (Fr) were measured through the Kistler piezoelectric dynamometer

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Conclusion

1. To establish an approximate relationship Between cutting speed, depth of cut, feed rate in turning operation so that it can be used to Predict response values for given settings of the Control variables.
2. For the higher material removal rate higher values of speed, depth of cut, feed rates are required.
3. For better surface roughness feed rate is the main influencing factor followed by the cutting speed. Depth of cut has no effect on the surface roughness.
4. 3D surface contour plots were plotted it will be useful for optimum cutting condition to obtain particular values of material removal rate and surface roughness.
5. RSM shows that the optimum level of machining parameters are cutting speed of 650rpm, depth of cut of 0.4mm and feed rate of 0.2mm/rev for AISI 304 material.

In order to achieve the above-mentioned objectives, a series of ``n`` experiments are carried out, in each of which the responses is measured (or observed) for specified settings of the control variables. With the optimum utilization of these parameters now these days these parameters play a very vital role for the machining and will be utilized in the industries.

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