A Review Paper for Effects of Cutting Fluids and Tool on Surface Roughness and Material Removal Rate on Different Tool Material for Bearing Steel (EN31) Turning Operation on CNC Machine

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Abstract— The main purpose of this review paper is to check whether quality lies within desired tolerance level which can be accepted by the customers. Surface roughness relative using various CNC machining parameters including spindle speed (N), feed rate (f) and depth of cut (d) and cutting fluid. In experimental study to investigate the surface roughness relatives using various CNC machining parameters like spindle speed, feed and depth of cut and cutting fluids on surface finish on EN-31.The experimental study to investigate of cutting conditions in facing operation of EN-31 in this paper. Machining was done using cemented carbide insert.

Key words: CNC turning operation, EN-31, Surface roughness

I. INTRODUCTION

The challenge of modern machining industries is mainly focused on the achievement of high quality in term of work piece dimensional accuracy, surface finish, high production rate, less wear on the cutting tools, economy of machining in terms of cost saving and increase of the performance of the product with reduced environmental .The mechanism behind the formation of surface roughness in CNC Lathe turning process is very dynamic, complicated, and process dependent. Several factors will influence the final surface roughness in CNC Lathe operations such as controllable factors (spindle speed, feed rate and depth of cut) and uncontrollable factors (tool geometry and material properties of both tool and work piece). Surface finish is one of the most important requirements in machining process, as it is considered an index of product quality. It measures the finer irregularities of the surface texture. Achieving the desired surface quality is critical for the functional behavior of a part. The factors that influence surface finish are machining parameters, tool and work piece material properties and cutting conditions shown in below Figure (1).The surface finish depends on cutting speed, feed rate, depth of cut, cutting fluid, tool nose radius lubrication of the cutting tool, machine vibrations, tool wear and on the Mechanical and other properties of the material being machined. CNC turning process parameters are classified according to Tool, Machining parameters, Work piece, machine tool and cutting process parameters.

A CNC is a machine tool used principally for shaping pieces of metal, wood, or other materials by causing the work piece to be held and rotated by the CNC while a tool insert is advanced into the work causing the cutting action. Field and to many operations and that is not too large to be moved from one work site to another.

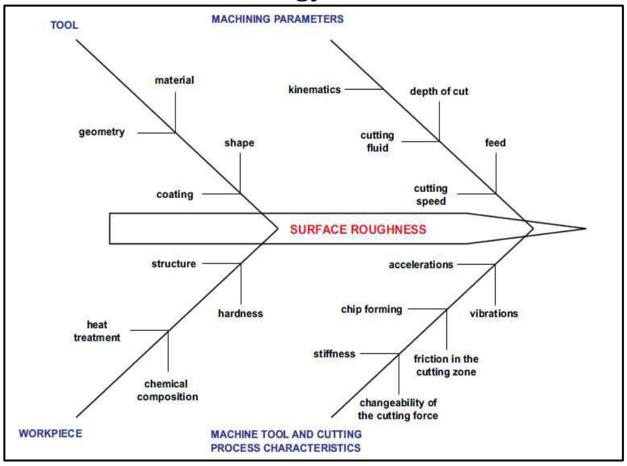

Fig. 1: Parameters affects the surface roughness

A. *Turning operation:*

Turning is a machining process in which a cutting tool, typically a non-rotary tool insert, describes a helical tool path by moving more or less linearly while the work piece rotates. The tool's axes of movement may maintenance shops generally use a CNC that can be adapted be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the nonmathematical sense). Usually the term "turning" is reserved for the generation of *external* surfaces by this cutting action, whereas this same essential cutting action when applied to *internal* surfaces (that is, holes, of one kind or another) is called "boring". Fig.2 shows the turning operation.

Cutting speed in turning V in m/s is related to the rotational speed of the workpiece by the equation; $V = \pi DN$ Where D is the diameter of the workpiece; N is the rotational speed of the workpiece. The three primary factors in any basic turning operation are speed, feed, and depth of cut.

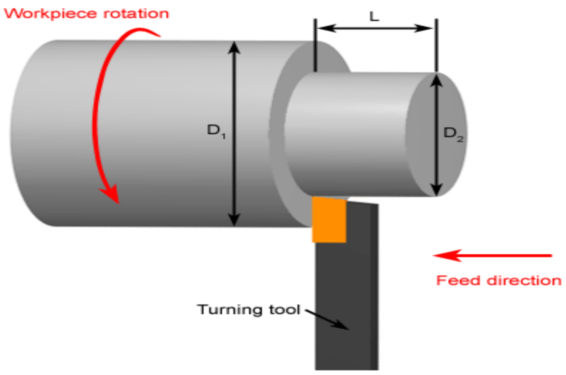

Fig. 2: turning operation

B. Test specimen:

The experiment was conducted using one work piece material EN-31.The basic used of EN-31material as Ball and Roller Bearings, Spinning tools, Beading Rolls, Punches and Dies. By its character this type of steel has high resisting nature against wear and can be used for components which are subjected to severe abrasion, wear or high surface loading.__The chemical composition and mechanical properties of the selected work piece is shown as in table 1 and table 2 respectively.

C%	Si%	Mn%	S%	P%
0.90 - 1.20	0.30 - 0.75	0.10 - 0.35	0.040	0.040

Table1. Chemical composition of EN 31 Alloy Steel

Bulk modulus	Shear modulus	Elastic Modulus	Poisson's Ratio	Hardness Rockwell C
140 GPa	80 Gpa	190 GPa	0.30	0.20

Table2. Mechanical Properties of EN 31 Alloy Steel

C. Machine tool:

CNC is one in which the functions and motions of a machine tool are controlled by means of a Prepared program containing coded alphanumeric data. CNC can control the motions of the work piece or tool, the input parameters such as feed, depth of cut, speed, and the Functions such as turning spindle on/off, turning coolant on/off. CNC is widely used for lathe, drill press, Milling machine, grinding unit, laser, sheet-metal press working machine, tube bending machine etc. Highly automated machine tools such as turning center and machining center which change the cutting tools automatically under CNC control have been developed .In the non-machine tool category, CNC applications include welding machines (arc and resistance), coordinate measuring machine, electronic assembly, and tape laying and filament winding machines for composites etc.

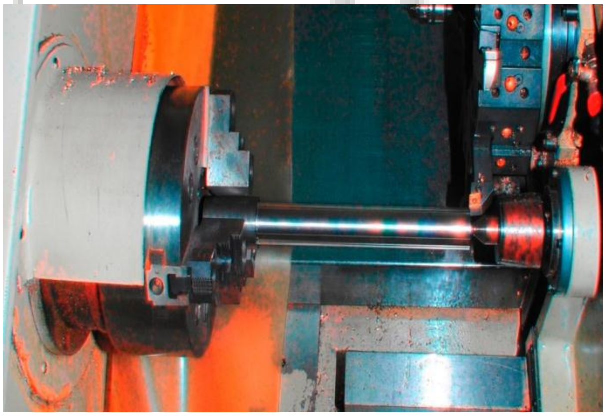

Fig. 3: Photograph of CNC Lathe

D. Cutting inserts:

Carbides are the most common tool material for machining of castings and alloy steels. These tools have high toughness, but poor wear characteristics. To improve the hardness and surface conditions carbide tools are coated carbide with hard materials such as TiN, TiC, TiAlN, and TiCN by chemical vapor deposition (CVD).Currently, the most popular CVD coatings are titanium carbide (TiC), titanium nitride (TiN), titanium carbon nitride (TiCN), and alumina (Al2O3). The first successful CVD coating, TiC offers high hardness and excellent wear resistance.

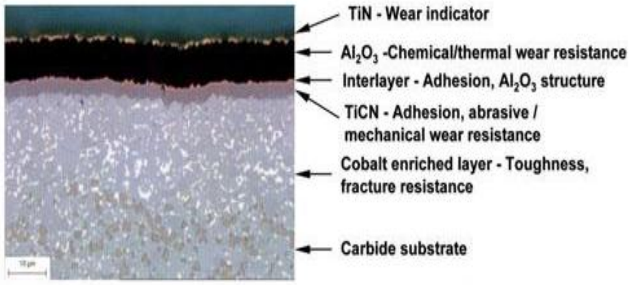

Fig. 4: Carbide Tool Structure

A later development, Al2O3 coatings, offers superior thermal stability, oxidation wear resistance, and high-temperature hardness. High- temperature characteristics of Al2O3, when it's deposited as a single layer or alternating multilayer, provide increased productivity in high- speed machining of steels and cast irons. DNMG 150608 (with an ISO designation) carbide inserts, clamped on tool holders CSBNR2525 M12. As cutting tools, CVD coated carbide TiC+AI2O3+TiN insert (ISO P25) were used in the experiments. Inserts possesses, a coating consisting of a TiCN under layer, an intermediate layer of Al2O3 and a TiN out layer, all deposited by CVD (Fig.4).

E. Cutting fluids:

Cutting fluid is a type of coolant and lubricant designed specifically for metalworking and machining processes. There are various kinds of cutting fluids, which include oils, oil-water emulsions, pastes, gels, aerosols (mists), and air or other gases. They may be made from petroleum distillates, animal fats, plant oils, water and air, or other raw ingredients. Depending on context and on which type of cutting fluid is being considered, it may be referred to as cutting fluid, cutting oil, cutting compound, coolant, or lubricant. Most metalworking and machining processes can benefit from the use of cutting fluid, depending on workpiece material. Common exceptions to this are machining cast iron and brass, which are machined dry. For many machining operations including sawing, drilling, turning, milling and grinding cutting fluids can be used to allow higher cutting speeds to be used, to prolong the cutting tool life, and, to some extent reduce the tool- work surface friction during machining..

The fluid is used as a coolant and also lubricates the cutting surfaces. The advantages of using cutting fluids are listed below: Cools the work surface and tool, Lubricates the interface between the work surface and tool, Flushes away some dust, chippings, and sward, Reduces tendency for chip adhesion/pressure welding to tool tip, May improve resulting surface finish, May increase tool life (see below), Allows higher cutting speeds. Cutting Fluids Classification: There are several ways of classifying cutting fluids and there is no standardization to establish one of them within the industries. May be the most popular classification gathers the products like the following classification.

1) *Air*
2) *Water base cutting fluid:*
   - Water;
   - Emulsions (soluble oil);
   - Chemical solutions (or synthetic fluids);

3) *Neat Oils:*
   - Mineral oils;
   - Fatty oils;
   - Composed oils;
   - Extreme pressure oils(EP);
   - Multiple use oils.

F. *Vegetable Oil:*

Vegetable oil-based coolants in machining applications have made it possible to achieve quantum increases in overall performance. As a proven and tested technology, vegetable oils have been recognized as having superior lubricating properties since the 1960s. During this time, the process of stabilizing coolant emulsions that are based on water-miscible vegetable oils proved to be challenging, which meant that machining lubricant options were limited to mineral oil-based coolants containing various additives. Vegetable oil was used for the most part in straight oil applications. Oils can be heated and used to cook other foods. Oils suitable for this objective must have a high flash point. Such oils include the major cooking oils – soybean, canola, sunflower, safflower, peanut, cottonseed.

G. *Surface roughness measurements:*

The arithmetic average surface roughness (Ra) of the workpiece is measured by Taylor Hobson (Surtronic 25, UK) surface roughness tester (shown in Fig.5), where the cutoff length and assessment length was fixed as 0.8 mm and 4 mm respectively. The instrument was calibrated using a standard calibration block prior to the measurements. The measurement was taken at four locations (90_ apart) around the circumference of the work pieces and repeated twice at each point on the face of the machined surface and the average values reported for the response.

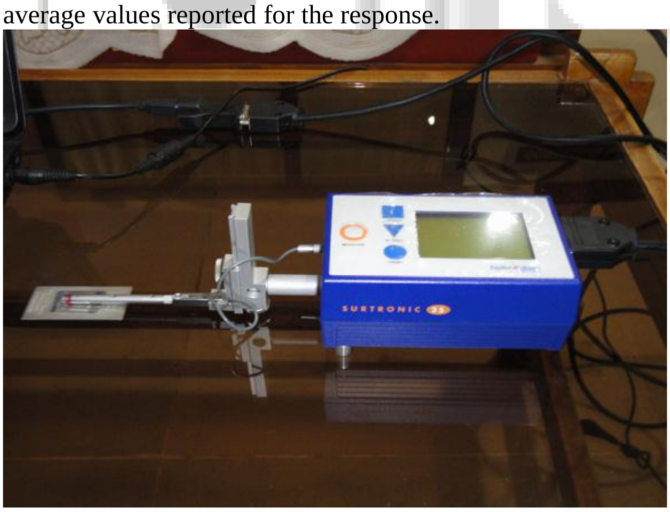

Fig. 5: Surface roughness tester, Taylor Hobson (Surtronic 25)

II. LITERATURE REVIEW

Rajendra Singh, Rahul kr.Gupta.(2014) model for surface roughness has been discussed. Examples of studies are given with their relative abilities and limitations in the relation to modeling of machining process focusing on the prediction of a surface roughness measured by using ANN approaches. ANN can produce an accurate relationship between cutting parameters and surface roughness. It can be used for modeling surface roughness, so that it can be predicted close to real value before machining stage. ANN model shows higher accuracy than the traditional statically approaches. In this research study, The experiments were conducted on CNC Lathe using the carbide tool insert (CCGT 09T30FL), machining variables such as surface finish measured value and vibration in CNC Lathe machining processes.

Jayesh M. Patel, Rakesh H. Patel. (2014) obtain optimal turning parameters (Constant cutting speed, feed rate, depth of cut and side rake angle) for minimum surface roughness and cutting force in dry turning and wet turning process, while turning EN9(AISI1055) medium carbon steel material and tungsten carbide P20 grade tool. A full factorial design of experiments procedure was used to develop the surface roughness and cutting force regression models, within the range of parameters selected. The regression models developed show that the dependence of the surface roughness and cutting force on machining parameters is significant, hence they could be used for making prediction and analyses of variance (ANOVA) are employed to investigate the cutting characteristics.

Hitesh Patel, Jigar Patel. (2014) find that there are many researches done on optimization techniques for process parameter for surface roughness and material removal rate. But I found that there are very few research done on AISI D2 tool steel so we want to do research on this material. We like to use gray relational analysis for optimization

PapiyaBhowmik, GauravArora.(2014) The chip thickness formed using groundnut oil as cutting fluid was highest, probably due to its better lubricating ability, especially at elevated temperature. this allows easier and deeper penetration of cutting tool into work piece and better metal removal rate. Viscosity of groundnut oil-based sample was lowest and the range was closest even at very high temperature. low viscosity means high viscosity index and the tendency to be fluidic at high value of working temperature.

K.Adarsh Kumar,Ch.Ratnam.(2012) machining parameters speed, feed, depth of cut, are studied on surface roughness for face turning operation using EN-8. Regression Analyses (RA) technique is used to study the effect of these parameters and their interaction on surface roughness. An empirical equation is formed by using Regression Analyses (RA) in Mini-Tab software to predict the surface roughness. The surface roughness model produced during this research work may be used in enhancing the surface quality of a product as cutting parameters are optimized and can give better surface finish.

Hardik B. Patel, Satyam P. Patel. (2013) face milling was selected by varying adjustable cutting parameters. With the L9 orthogonal array, experimental runs and determining suitable optimal cutting parameters for surface finish. The surface finish achievement of the confirmation runs under the optimal cutting parameters indicated that of the parameter settings used. In this study, response surface methodology will apply to produce the best surface roughness in this milling operation. Also, RSM is an efficient and effective method for optimizing surface roughness in a milling.

Govindan P, and Vipindas M. (2014) Reducing quality loss by designing the products and processes to be insensitive to variations in noise variables is a novel concept to statisticians and quality engineers. Taguchi method for experimental design is straightforward and easy to apply to many engineering situations, making it a powerful yet simple tool. It can be used to identify problems in a manufacturing process from data already in existence. It helps in the identification of key parameters that have the most effect on the performance characteristic value so that further experimentation on these parameters can be performed and the parameters that have little effect can be ignored. Orthogonal Array in Taguchi technique will help to finalize the number of levels, thus finalize the number of experiments and Signal to Noise ratio will help us to observe the behavior of quality characteristics of work piece. Taguchi approach has a potential for savings in experimental time and cost on product or process, development and quality improvement as it requires minimum number of experiments.

V. García Navasa, D. Fernándeza.(2014) Compared to dry turning and turning with lubricant (oil based emulsion), cryogenic machining using LN2 is the best solution to machinability problems of components manufact0ured using AISI 4150 steel (such as transmission spindles) because of reduced heating problems, leading to tool life improvement and better surface integrity (higher surface hardness, lower residual stresses and no white layers, although surface roughness is a bit worse than with lubricant) of turned components.

Manpreet Singh, Sanjeevverma. (2014) of the researchers had taken input parameters (speed, feed, depth of cut) and in some cases other parameters such as nose radius, environment etc. and facing output parameters SR, MRR. From the literature review it is found that for surface roughness the most significant parameters are speed, feed and nose radius and least significant parameter is DOC and for MRR the most significant parameters are DOC, feed and speed and least significant parameter is nose radius .

Jitendra Thakkar, Mitesh I Patel. (2014) found that most effected parameters to cutting condition are cutting speed, feed rate and depth of cut and they are easily controlled by operator at the machine at same time. All turning operation will be performed on CNC turning machine. In which input parameters are cutting speed, feed rate and depth of cut and the response parameters are surface roughness and material removal rate. We will use surface roughness tester to measure surface roughness and MRR will measured by mathematical equation. We will use AISI 410 work piece material for turning operation. For Experimental design we will use full factorial method ($L=m^n$) to find out number of readings. To find out percentage contribution of each input parameter for obtaining optimal conditions, we will use ANOVA method.

III. CONCLUSION

The objective of this study is to obtain optimal surface roughness produces, so basic parameters (Constant cutting speed, feed rate, depth of cut and cutting fluid) effecting for wet turning process, while turning EN31 carbon steel material and carbide tool. Surface roughness within the range of parameters selecting. The regression models developed show that the dependence of the surface roughness "In feature performing experimental work throw finding which machining parameters and relative cutting fluid best result providing EN-31 turning on CNC machine."

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