JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EVALUATION OF SURFACE GRINDING RESPONSE PARAMETERS OF EN31 ALLOY STEEL ON SURFACE GRINDING MACHINE BY USING TAGUCHI METHODOLOGY

Vishal Sharma[1], Omer Abdulaziz Farhan Alqadhi[2] Ganesh Kantak[3]

Department of Mechanical Engineering

Vivekananda Global University, Jaipur

Abstract

Surface grinding is one of the important material removal processes which is applied at the last stage of high dimensional accuracy and desirable surface finish product can be obtain in manufacturing process. Grinding process is applied for the finishing dissimilar parts of automotive engine like splined shaft, crankshaft, gears and guide ways etc. there are different types of grinding process used in manufacturing industries in present time i.e. cylindrical grinding, surface grinding, creep- feed grinding and central less grinding. In this research work surface grinding machine is used for obtain high metal removal rate and lower surface roughness on the flat surface of material. EN 31 alloy steel is taken as experimental material which is commonly used in automotive industries and the production of molding dies, shear blades, cutting tools, bolts etc. in this present work three input parameters depth of cut (D), Feed rate(F), number of passes are used at various range and surface roughness, metal removal rate are the performance parameter and taguchi design in MINITAB software is used to obtain optimum performance parameters. Data accomplished by taguchi method, results shows that the maximum MRR is 0.14385gm/sec and minimum surface roughness is 0.23µm and wheel speed and number of passes are the most significant parameters of surface grinding process.

Keywords: surface grinding machine, surface roughness, material removal rate, taguchi method, depth of cut, No. of passes, wheel speed.

I INTRODUCTION

Grinding, or abrasive machining, once performed on conventional milling machines, lathes and shapers, are now performed on various types of grinding machines. Grinding machines have advanced in design, construction, rigidity and application far more in the last decade than any other standard machine tool in the manufacturing industry. Grinding machines fall into five categories: surface grinders, cylindrical grinders, centerless grinders, internal grinders and specials.

1.1 Surface Grinding

Surface grinders are used to produce flat, angular and irregular surfaces. In the surface grinding process, the grinding wheel revolves on a spindle; and the workpiece, mounted on either a reciprocating or a rotary table, is brought into contact with the grinding wheel. [1]

Surface grinding is the most common of the grinding operations. It is a finishing process that uses a rotating abrasive wheel to smooth the flat surface of metallic or nonmetallic materials to give them a more refined look by removing the oxide layer and impurities on work piece surfaces. This will also attain a desired surface for a functional purpose. [1]

The surface grinder is composed of an abrasive wheel, a work-holding device known as a chuck, and a reciprocating or rotary table. The chuck holds the material in place while it is being worked on. It can do these one of two ways: ferromagnetic pieces are held in place by a magnetic chuck, while non-ferromagnetic and nonmetallic pieces are held in place by vacuum or mechanical means. A machine vise (made from ferromagnetic steel or cast iron) placed on the magnetic chuck can be used to hold non-ferromagnetic work-pieces if only a magnetic chuck is available.

1.2 Factors Related to Surface Grinding

Factors to consider in surface grinding are the material of the grinding wheel and the material of the piece being worked on. Typical work-piece materials include cast iron and mild steel. These two materials don’t tend to clog the grinding wheel while being processed. Other materials are aluminum, stainless steel, brass and some plastics. When grinding at high temperatures, the material tends to become weakened and is more inclined to corrode. This can also result in a loss of magnetism in materials where this is applicable. [1]

- The grinding wheel is not limited to a cylindrical shape and can have a myriad of options that are useful in transferring different geometries to the object being worked on. Straight wheels can be dressed by the operator to produce custom geometries. When surface grinding an object, one must keep in mind that the shape of the wheel will be transferred to the material of the object like a reverse image. [2]
- Spark out is a term used when precision values are sought and literally means “until the sparks are out (no more)”. It involves passing the work-piece under the wheel, without resetting the depth of cut, more than once and generally multiple times. This ensures that any inconsistencies in the machine or work-piece are eliminated. [2]

1.3 Surface Grinding Machine

A surface Grinding Machine is a machine in which a grinding wheel is used as a cutting tool for removing the material from the surface of the workpiece. It is also called an abrasive machining process where abrasives are placed on the surface and corners of the grinding wheel so as to do the finishing process with much more accuracy. [3]

II. LITERATURE REVIEW

S. S. Patil and Y. J. Bhalerao, (2017) Objective of grinding process is to generate high quality surface finish on work piece. There are many parameters which influence on the work piece roughness. Work piece material and characteristics, grinding wheel specification, grinding conditions and dressing conditions influence on the surface quality of the work piece. Selection of grinding wheel is important aspect for producing good quality of surface finish on the work piece. The main components of grinding wheel are the abrasive grains, bond material and porosity. Selection of correct grinding wheel is necessary for generating better surface finish on the work piece. Analytical Hierarchical Process (AHP) is used for ranking of vitrified bond grinding wheel parameters on surface roughness on the work piece in sub sequent grinding operation. The grit, grade, (Hardness of wheel) structure and type of abrasive are critically assisted in terms of the surface finish produced on work piece in the subsequent grinding operation. *Y. Liu et al. (2018)* In this study, a finite-difference time-domain computational model using a uniaxial perfectly matched layer boundary for ground penetrating radar (GPR) demining of ground rough surface is constructed. On the basis of this model, the numerical results of B-scan echoes from ground rough surface with different degrees of roughness are obtained and compared with the profile of corresponding rough surface. These results and comparisons highlight the effect of roughness on the profiles of the rough surfaces. The relationship between the B-scan wave outline and the profile of the rough interface is also analyzed. *B. Burns, (2018)* When using non-ground coupled Ground Penetrating Radar (GPR) to detect buried objects, one major source of clutter is the surface of the ground. This is especially true if the surface of the ground is not very flat. Responses from the surface will show up below the main response from the ground and mix with the responses of buried objects. To better understand this response and potentially remove it I investigated measuring the soil surface profile with a LIDAR and then modeling the GPR response using the FDTD code gprMax. The modeled response was then subtracted from the measured GPR data. *M. Inac et al., (2018)* In this paper, a yield increase on post-grinding of 200 mm wafer level packaging applications is presented. 200 mm wafer level plasma enhanced oxide-oxide direct bonding and wafer grinding are used in the packaging of the wafers. Since the surface conditions of the wafers that are used in the packaging is the most critical point of the wafer bonding and grinding processes, it is focussed to optimizing wafer surfaces to increase the yield. After the optimizations on the surface conditions of the BiCMOS wafer used in the packaging, the 200 mm plasma enhanced wafer to wafer direct bonding yield increases from 0% to 99% and at the same time the post-grinding yield of these wafers increases from 0% to over 90%. *L. Zhang, et al. (2019)* The grinding wheel dressing experiments and the slider grinding experiments were carried out in this paper. The surface topography of the alumina wheel before and after grinding, and the morphology of the slider raceway were obtained by a 3D surface morphology instrument. An image processing method was employed to measure the surface roughness of slider raceway and wheel surface morphology. Under the same grinding parameters, the influence of alumina grinding wheels obtained under different dressing parameters on the surface quality was analysed. *Y. Wan, et al. (2019)* The super hydrophobicity of solid surfaces is primarily dependent on low surface energy and surface microstructure. In order to prepare a low-wetting surface, a micro-column array was constructed on the surface of aluminium by micro-milling and grinding, and the influence of the square-column structure on the surface wettability of the material was analysed. Milling will cause burrs on the surface of the square column. Under the joint action of the square columns and the burrs on the surface, the contact angle of the material surface increased from 50.3° to 98.4°. After grinding, the burr on the surface of the square column disappears, but the irregular secondary groove structure is formed at the top of the groove, which further improves the contact angle of the surface of the test piece (127.8°).

III METHODOLOGY

Material Used

The material chosen for this investigation is an EN 31 alloy steel. This steel can be tempered and hardened to provide greater wear resistance than high-carbon steel blocks 100mm long and 16 mm thick. In all the grinding experiments performed, stub coolant was supplied. It's especially popular for automotive type applications for axles, bearings, spinning discs, and moulding dies. This steel has a high resistance to wear and can be used as components with high levels of surface loading or abrasive wear.

CHEMICAL COMPOSITION OF EN31STEEL

Chemical Composition	Percentage (%)
Fe%	88.42
O%	0.01
Si%	0.32
Al%	0.14
Na%	0.45
Cr%	1.86
C%	0.95-1.00

Design of Experiments (DOE)

Design of experiments is a technique that allows you to explore all the possible factors in an experiment, with multiple variables. Be sure to use this technique if you need something thorough and reliable for your research. Successful with experiments for optimum treatments of land for agriculture to get maximum yield by Ronald A. fisher. Manufacturing process is consisting the controls factors, response factors and several noise factors. An orthogonal array is necessary for this type of experiment design, according to the total number of parameters involved.

CONTROL FACTOR LEVELS

Control factor	Units	Levels			
		i	ii	iii	iv
No. of Passes	Nil	1	2	3	4
Feed rate	mm/min.	20	40	60	80
Depth of cut	mm	0.02	0.04	0.06	0.08

There are four levels of control factors that we manipulate in this experiment: Within-subjects and Between-subjects. We design the experiment with algebraic methods which are known as the statistical approaches to produce unbiased results. In order to make it easier for industrial experiments, the following aspects for application need consideration.

Taguchi Approach

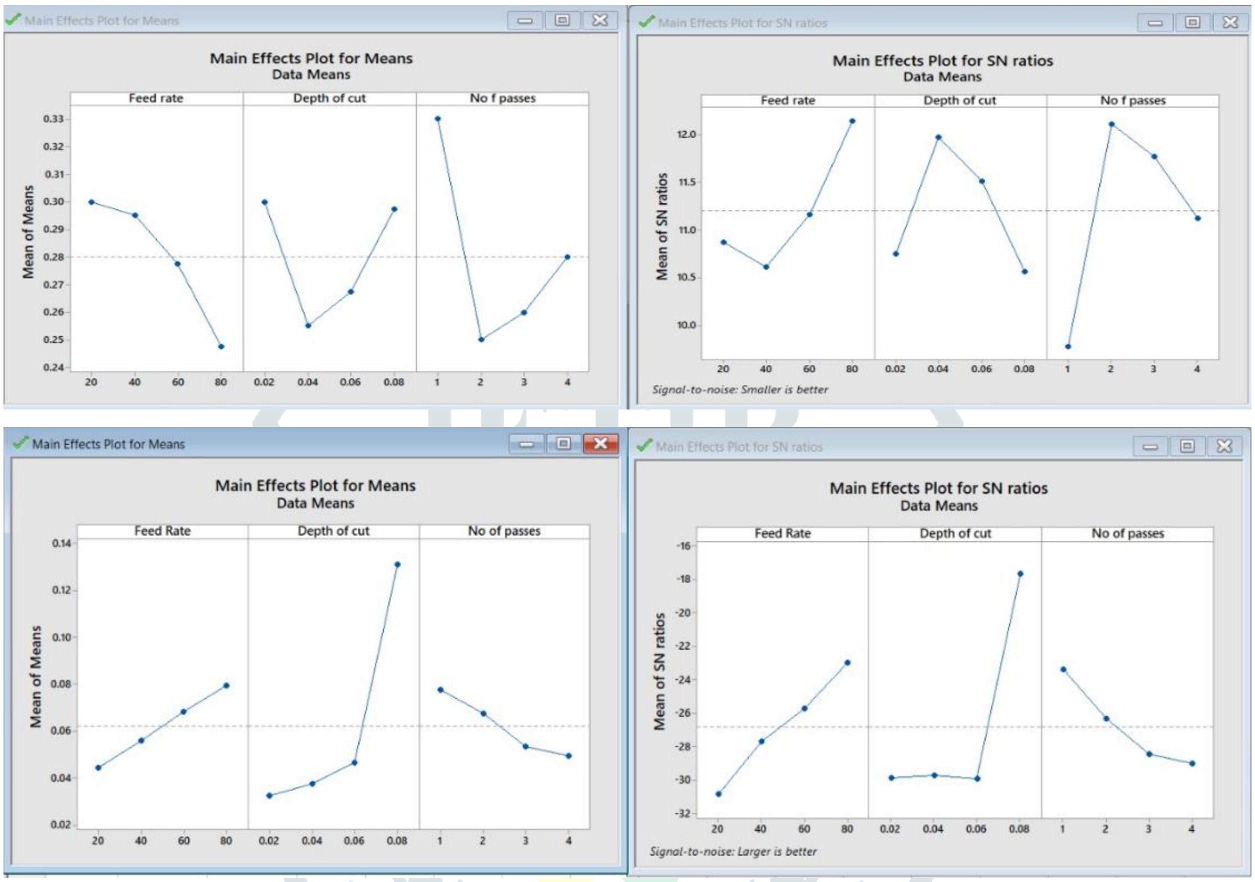
Dr. Genich Taguchi was a Japanese scientist who helped to shape the quality engineering field. The philosophy is "Quality should be designed into the product, not inspected. Quality is not achieved by random luck. There are two views on quality. The first is that quality can be maintained post-mortem through inspection and correction, while the second tells us that quality must be assured as much as possible during production. Designing in a way that produces insensitivity from external noises will allow for better quality standards.

SPECIFICATIONOF SURFACE GRINDING MACHINE

Machine model	E_6030_NC
Automation Grade	Automatic
Max Allowable length of workpiece	250×500mm
Brand	COSMOS IMPEX
Longitudinal travel	650 mm
Control Axis	X, Y, Z
Cross Travel	320 mm
Vertical Down feed on Hand Wheel	0.001 mm
Maximum Distance Center of Spindle to Table	400 mm
Spindle Motor	2.2 KW
Grinding Area	650×500 mm
Grinding Wheel Dimension (OD$\times W \times ID$)	$203 \times 20 \times 50.8$ mm

IV RESULT AND DISCUSSION

Fig. 6.1 and fig. 6.2 show the influence of signal to noise ratio on surface roughness and MRR for different input variable levels. The graph shows that the optimum value levels for best surface roughness (minimum) and MRR maximum are obtained when there is a higher signal to noise ratio. Predicted experiment results can be seen in figs 6.1 and 2 as well as predicted values using Taguchi method in figs 6.1 and 6.2.



Results for Ra and MRR

The Taguchi methods were successfully applied for the surface grinding process in this experimental work.

- The minimum Ra is 0.23µm, and the process parameters are 3 passes, a depth of cut of 0.06 mm and 20mm/min.
- The maximum material removal rate that was obtained is 0.14385gm/sec. and the optimum machining parameters are no of pass 2 and depth of cut of 0.08 mm and 60mm/min feed rate.

V Conclusion and Future Scope of Work

- **Conclusion**

The proposed work discusses the experimental results of a surface grinding process applied to an EN31 alloy steel profile. Using the Taguchi method, we investigated the influence that three important parameters have on two responses: surface roughness and material removal rate. We completed our analysis of experimental work with Minitab.

- For EN31 steel, the following results are found:
  a) Maximum material removal rates (measured in cubic centimetre per minute) increase as the depth of cut increases.
  b) The minimum surface roughness is found at 0.06 mm maximum depth of cut, at 3 passes with20mm/min feed rate.

➢ **Future Scope**

- In this study, only three parameters were considered, in accordance to their effect on surface roughness and MRR. For future work, there are other important parameters such as feed rate, work material, tool wear, tool life and power consumption that should also be considered.
- Some of the benefits of surface grinding is that it can be extended for longer by selecting other materials or steel alloys.
- The surface roughness in a surface grinding process can be increased to workpieces of any dimension like changing the diameter and length on a conventional cylindrical grinding process without any modification in the machining setup.

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