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Research Paper

FABRICATION OF CYLINDRICAL GRINDING ATTACHMENT ON LATHE MACHINE AND OPTIMIZATION OF GRINDING PARAMETERS BY REGRESSION ANALYSIS

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In modern manufacturing and assembling, high dimensional accuracy and fine surface finish play an important role. The grinding process is commonly used as finishing operation which makes the process distinguished from other machining processes. One of the best low cost methods of producing such parts is by a cylindrical grinding attachment on a lathe machine. In the present study heavy duty lathe was retrofitted with a grinding attachment. A mounting plate was loaded on a cross slide after removing the tool post. AC motor is employed for driving the grinding wheel. The grinding wheel was mounted on ball bearings with an overhang. The grinding wheel chosen is with aluminum oxide abrasives. The required speed can be attained by arranging pulley drives. The prepared work mounted between the centers of the lathe machine chosen. Cylindrical grinding with traverse feed is used for finishing components turned on a lathe. The surface finish obtained on the heavy duty lathe was modeled against various parameters, such as work speed; traverse feed rate and depth of cut. The improvement in surface finish on the work pieces leads to higher corrosion resistance, fatigue strength and reduced power loss due to friction. The optimization of the parameters is done by Regression Analysis. The outputs are subjected to Regression Analysis and the optimal values are attained.

Keywords: Cylindrical grinding Attachment, Surface finish, Work speed, Feed, Depth of the cut, Optimization

INTRODUCTION

Grinding is the process of removing metal by the application of abrasives which are bonded to form a rotating wheel when the moving abrasive particles contact the work piece, they act as tiny cutting tools, each particle cutting a tiny chip from the workpiece. In cylindrical grinding, the workpiece rotates about a fixed axis and the surfaces machined are concentric to that axis of rotation

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The cylindrical grinder development took place during industrial revolution (Lewis *et al.*,1959). In 1830, modern day cylindrical grinder was first built by Jonathan bridges and James Wheaton (Robert *et al.*,1964). Joseph brown made first attempt was a small lathe with a grinding wheel mounted on air displayed at 1876 centennial exposition and subsequent patent (Lewis *et al.*,1959; and Robert *et al.*, 1964). Norton improved the cylindrical grinder to use faster rpm values and more precise grinding tolerances on April 18, 1925 (Day *et al.*,1996). Integrating CNC and the PC into one dynamic system allowed for even further control of the manufacturing process that required little to no human supervision (Arnold *et al.*, 2001). Two surfaces will be moving opposite directions when contact is made which allows for a smoother operation (Kocherovsky *et al.*). Krabacher (1959) investigated machining parameters on material removal rate and surface roughness, noticed that surface quality was found to improve with decreased material removal rate. Heaker and Liang (Hecker *et al.*, 2003) predicated surface roughness due to mainly chip thickness in grinding. The work piece surface roughness dependence on wheel wear and feed is investigated in early 70's by Vickers taff (Vickerstaff, 1973). The influence of feed and depth of out on wheel wear and surface finish have been investigated using regression analysis and mathematics models and development by Rama Chandran (Ramachandran, 1976). Prediction of surface finish along with normal force are modelled against various process parameters by buttery (Hamed, 1979). However, the study of roughness on the work pieces carried out by a cylindrical grinding attachment on a lathe machine is scarce and nor reported neither to. Hence the present investigation makes the prominence.

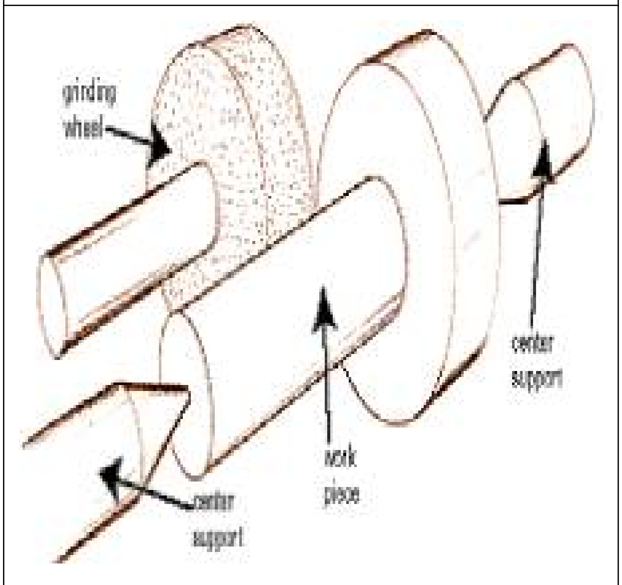
In the following, the basic concept of cylindrical grinding is introduced the fabrication of cylindrical grinding attachment and regression analysis are described next. The succeeding section illustrates the effects of the grinding parameters on the surface roughness of wet and dry condition.

BASIC CONCEPT OF CYLINDRICAL

Grinding

The basic components of a cylindrical grinder include a wheel head, which incorporate the spindle and drive motor, a cross slide, that moves the wheel head to end from the workpiece, a head stock, which locates, holds, and drives the work piece, and a tailstock, which holds the other end of the work as shown in (Figure 1).

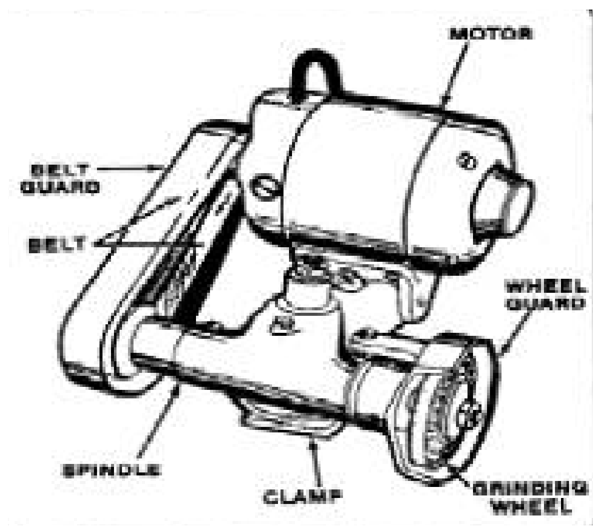
Figure 1: Cylindrical Grinding



The present study relates to a grinder attachment for a lathe. Attachment is motor driven for isolating the grinding wheel from vibrations. For best results in many cases, the grinding operation should immediately follow the turning operation without removing the rotor from the lathe spindle.

In order to provide a smooth surface on rotors, such as brake drums, brake discs, clutch plates and fly wheels, it is desirable to finish grinding the brake surface to level off any hard spots in the rotor. Cylindrical grinding attachment is defined as having four essential actions. The work must be constantly rotating. The grinding wheel must be constantly rotating. The grinding wheel is fed towards and away from the work, Either the work or the grinding wheel is traversed with the respect to the other. The attachment can be fixed on a lathe with or without tailstock. The abrasive material is on a grinding wheel that rotates in a direction such that rolling or sliding contact occurs where the in wheel and workpiece touch as shown in (Figure 2).

Figure 2: Tool Post Grinding Machine



FABRICATION OF CYLINDRICAL GRANDING ATTACHMENT

The components used in the attachment are listed below.

- Motor
- Grinding Wheel
- Mounting plate
- Shafts
- Bearings
- Pulleys and Belt

Motor

Motor is a device that creates motion, not an engine; it usually refers to either an electrical motor or an internal combustion engine. It may also refer to:

- Electric motor, a machine that converts electricity into a mechanical motion.
- AC motor, an electric motor that is driven by alternating current.
- In this present attachment we use and AC motor for rotating the Grinding Wheel. The

Figure 3: Motor Used in Attachment

motor is shown below (Figure 3), with specification.

- AC Motor, 0.5 H.P, 2800 RPM,3-Phase, 0.37 KW, 0.75 AMPS. 440 Volts.

Grinding Wheel

In this present attachment we use Aluminium Oxide Abrasive Grinding Wheel, the grinding wheel is shown below with specifications (Figure 4).

Figure 4: Grinding Wheel Used in Attachement

- Abrasive Grinding Wheel
- Carborundum Universal Company
- Aluminum Oxide Abrasive
- 200 mm Diameter
- 20 mm Thickness
- 31.75 Bore
- Max.Speed 3150 Rpm

Mounting Plate

A MS plate of 12" × 6" is employed for this attachment. The plate is placed on the lathe after removing Tool post from it.

The plate bears the whole weight of the attachment. It is used for moving the grinding wheel and motor constantly with the movement of the carriage.

Shafts

There are two types of Shafts are used in this attachment,

- Fixed shaft 76 mm Diameter, 40 mm Inside Bore
- Rotating shaft 17 mm Diameter

Figure 5: Two Types of Shft Used in Attachment

The Rotating shaft is used for the rotation of the Grinding wheel; the power from the motor is transmitted to the rotating shaft through Pulleys and Belt, the rotating shaft is inserted into the fixed shaft through Ball Bearings.

The fixed shaft is attached to the mounting plate by Welding and makes it immovable. The Ball Bearings are used for the rotation of the Rotating shaft inside of the fixed shaft. The grinding wheel is mounted on to the Rotating shaft and tightened with nuts so that the grinding wheel rotates with the shaft. The two types of shafts are shown below (Figure 5).

BEARINGS

There are two types of bearings used in this Attachment,

- Ball Bearings
- Thrust Bearings

Ball Bearing: A ball bearing is a type of rolling-element bearing which uses balls to maintain the separation between the moving parts of the bearing The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. Usually one of the races is held fixed. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were rotating on each other. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races. Compared to other rolling-element bearings, the ball bearing is the least expensive, primarily because of the low cost of producing the balls used in the bearing.

Thrust Bearing: A thrust bearing is a particular type of rotary bearing. Like other rotary bearings they permit rotation between parts, but they are designed to support a high axial load while doing this. The two bearing are with Outside diameter 40 mm and inside diameter 17 mm. those two bearings are shown below (Figures 6 and 7) .

Figure 6: Ball Bearing

Figure 7: Thrust Bearing

Belt and Pulley Systems

A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axes and, if the pulleys are of differing diameters, a mechanical advantage to be realized. A belt drive is analogous to that of a chain drive, however a belt sheave may be smooth (devoid of discrete interlocking members as would be found on a chain sprocket, spur gear, or timing belt) so that the mechanical advantage is approximately given by the ratio of the pitch diameter of the sheaves only, not fixed exactly by the ratio of teeth as with gears and sprockets.

In the case of a drum-style pulley, without a groove or flanges, the pulley often is slightly convex to keep the flat belt centered. Though once widely used in factory line shafts, this type of pulley is still found driving the rotating brush in upright vacuum cleaners.

The below (Figure 8) shows the pulley and belt attachment used in our attachment. These are the components we use in our Cylindrical Attachment on Lathe. The components are made useful with so many other operations Turning, Boring, Drilling, etc. The assembling of the above components to make our attachment is given below.

Figure 8: Pulley and Belt Arrangement

Assembling of Components to Make Cylindrical Grinding Attachment

1. At first the motor is fixed to the mounting plate by drilling holes on it through Nuts and Bolts.
2. The fixed shaft is placed at the Lathe's centre height by certain alignments. The height is maintained by using some of the square rods with certain height.
3. The square rods are welded to the fixed shaft so that the shaft is fixed at that height only. The square rods are welded to the mounting plate for maintaining height and for support.
4. The rotating shaft is inserted into the fixed shaft through the ball bearings (Figure 9).
5. The Grinding wheel is clamped onto the rotating shaft, with the help of plastic bushes available to us.
6. Flanges are placed on either sides of Grinding Wheel so as to support the wheel from slipping from the shaft.

Figure 9: Motor and Shafts Attached on to Mounting Plate

7. The Thrust Bearing is used for the free movement of the Grinding Wheel is placed before the wheel is clamped onto rotating shaft.
8. A step is made on the rotating shaft so that the wheel may not come on to the Fixed shaft.
9. The sequence of clamping things onto the rotating shaft, Thrust, Bearing, Flange, Grinding Wheel, Flange, Nuts.
10. The pulleys are arranged so that the power is transmitted from Motor to Rotating Shaft.
11. The pulleys are arranged so that they are in same line; A V-Belt is used for transmission of power from Motor to Rotating Shaft. The (Figure 10) is shown below.
12. This Attachment is placed on the lathe's carriage by removing the Tool post from it. (The Figures 11, 12 and 13) shows the Lathe before and after the attachment on it.
13. This is our Cylindrical Grinding Attachment on Lathe; we can grind the cylindrical shafts of various diameters on Lathe itself.

Figure 10: Grinding Attachement

Figure 11: Lathe with General Tool Post

Figure 12: Lathe After Removing the Tool Post

Figure 13: Lathe After Attaching the Grinding Set-Up

14. This is how we assemble the components to make a Grinding Attachment on Lathe.

REGRESSION ANALYSIS

In statistics, Regression Analysis includes any techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed.

Grinding Process and Conditions

Traverse grinding operation is employed in the present cylindrical grinding process and the work piece is ground by both dry and wet grinding conditions. In wet grinding process the cutting fluid employed is a water based emulsion consisting of 90% water, 5% cutting oil, 2% sodium nitrate, 2% emulsion and 1% soda ash.

Experimental Design Matrix

Rotational speed of work piece, axial movement of grinding wheel also called transverse feed rate and the plunge distance or the depth of cut are the parameters chosen in the present investigation. The high and low levels of these parameters are identified by reviewing the literature and also by making trial runs are given in (Table 1).

A two level full factorial design matrix is employed for the experimentation and the surface roughness (Ra) of the components is evaluated at the in put parameters for the wet and dry data are listed is shown in (Table 2).

The regression equation for the data considered is in the form

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_1x_2 + b_5x_2x_3 + b_6x_3x_1$$

Table 1: Parameters

S. No.	Parameter	Units	Level (Targets)	
			High	Low
1.	Work Speed (x_1)	m/min	15	6
2.	Feed (x_2)	mm/rev	0.3	0.1
3.	Depth of Cut (x_3)	μm	100	50

Table 2: Experimental Design Matrix with Surface Roughness for Wet and Dry Condition

Run	x_1	x_2	x_3	Wet Ra (μm)	Dry Ra (μm)
1	15	0.3	100	0.2375	0.4375
2	15	0.3	50	0. 075	0.0625
3	15	0.1	100	0.5625	0.7625
4	15	0.1	50	0.3325	0.3375
5	6	0.3	100	0.4625	0.4625
6	6	0.3	50	0.3375	0.5375
7	6	0.1	100	0.7375	0.7375
8	6	0.1	50	0.5625	0.7625

where y is the surface roughness (Ra) and b_0, b_1, …, are constants.

The data have been subjected to regression analysis and Analysis of Variance (ANOVA) is conducted using Yate's algorithm (Alan Jeffer, 2003). The final regression equations are presented in the (Table 3). The response 'y' is the surface roughness expressed in terms of input parameters.

Table 3: Regression Equations

S. No.	Condition	Regression Equation
1.	Dry	$Y = 0.45 - 0.008x_1 - 0.028x_2 - 0.028x_1x_2 - 0.012x_1x_3$
2.	Wet	$Y = 0.39 - 0.09x_1 - 0.03x_2 - 0.02x_1x_2 - 0.02x_1x_3$

CONCLUSION

The cylindrical grinding process on the lathe yields out to be a low cost operation. The regression equations to the surface roughness would be useful in arriving at the domain for the input range. Under dry condition the optimal values are done by changing the input values, Work Speed = 15 m/min Feed Rate = 0.3 mm/rev Depth of Cut = 50 μm. Under dry condition the optimal values are obtained by changing the input values, Work Speed = 15 m/min Feed Rate = 0.1 mm/rev Depth of Cut = 50 μ. Cylindrical grinding attachment is very useful for finishing the cylindrical shafts on lathe, upto 0.1 μm. By applying Regression Analysis under Dry and Wet conditions we have found the optimal input values to get good surface finish.

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REFERENCES

1. Alan Jeffer (2003), "Advanced Engineering Mathematics", pp. 105-177, Academic Press.
2. Arnold Heinrich Martin (2001), "The Recent History of the Machine Tool Industry and the Effects of Technological Change", Institute for Innovation Research and Technology Management, University of Munich.
3. Day Lance and McNeil Ian (1996), *Biographical Dictionary of the History of Technology*, pp. 525-527, Routledge, London and New York.
4. Hamed M S and Buttery T C (1979), "Grinding Forces and Surface Finish Control Using a Theoretical Model of the Process", *Precision Engineering*, Vol. 1, No. 1, pp. 29-30.
5. Hecker R L and Liang S Y (2003), *Int. J. Mach. Tool. Manufact.*, Vol. 43, pp. 755-757.
6. Kempthorne (1996), *Design and Analysis of Experiments*, 1st Edition, pp. 234-251, John Wiley & Sons, New York.
8. Krabacher E J (1959), *J. Engineering for Industry*, Vol. 81, pp. 187-200, ASME.
9. Lewis Kenneth (1959), *The Grinding Wheel*. 2nd Edition, pp. 104-141, Judson Company, Cleveland.
10. Ramachandran P and Vaidyanath S (1976), "Statistical Evalution of Parameters in Grinding", *Wear*, Vol. 36, No. 1, pp. 119-125.

11. Robert Woodbury (1964), *History of the Grinding Machine*, 2nd Edition, pp. 31-71, MIT Press, Cambridge.

12. Vickerstaff T J (1973), "Wheel Wear and Surface Roughness in Cross Feed Surface Grinding", *International Journal of Machine Tool Design and Research*, Vol. 13, No. 3, pp. 183-198.