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TO STUDY AND OPTIMIZE THE PROCESS PARAMETER THROW ROLLER BURNISHING PROCESS ON EN19 MATERIAL

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ABSTRACT

Roller burnishing has been investigated to improve surface finish which directly affects component's quality and performance. Examination of many serious accidents involving automobile, has revealed that failure of the first stage crank shaft impacted by high revolving speed and other issues was the main reason caused. Automobile parts material EN19 with its high mechanical properties is used for the first of crank shaft to reduce failure; however, the effects of burnishing on surface properties in terms of surface roughenss and surface hardness EN19 have not been well documented.

In this research, it is demonstrated that improvement is material properties can be achieved by roller burnishing applied to EN19, such as smoother surfaces and enhanced surface hardness with a greater depth of layer. For surface roughness, burnishing pressure, speed and no of passes are significant factors whereas turned surface roughness is negligible. The pressure is the most important factor for both surface hardness, as well as for surface roughness at the surface and maximum magnitude with its depth. The results indicated the potential benefits of the roller burnishing application for the automobile parts material.

KEYWORDS: Optimize the Process Parameter Throw Roller Burnishing Process on En19 Material

INTRODUCTION

Technological revolution in the recent years increased in the expectation from the manufacturing industry. The expected service life of the components has taken a long-leap, without increasing the production cost. So the engineers had to come up with improvised and versatile manufacturing processes that address these expectations. The service behaviour and life of the components depend mostly on the surface properties. For this reason, significant attention has been paid to the post-machining operations, because the conventional machining processes like turning, milling etc produce surfaces with inherent irregularities and imperfections. So there is need for a surface finishing operation that nullifies these irregularities and also improves other surface properties like hardness, corrosion resistance, wear resistance and fatigue life. These properties can be increased by utilizing surface plastic deformation (SPD) process, which does not involve material removal, but improves the surface properties by deforming the surface plastically, under compressive loads. Under this external load, the surface of the component is subjected to cold working. One such SPD process that has gained increasing acceptability in the manufacturing industry is burnishing.

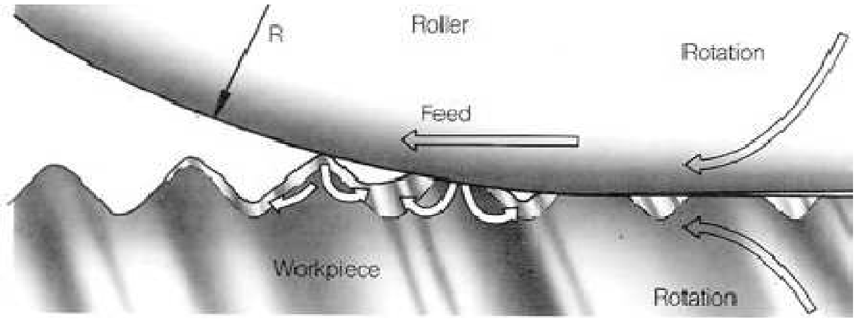

Figure 1: Basic Operation of Burnishing

Principle of Burnishing Operation

Burnishing is a versatile process that improves the surface finish and dimensions of the turned parts, without usage of extensive tooling. A conventional lathe, on which the work pieces were turned, can be used for burnishing, thereby eliminating the time and effort for remounting the work piece. The tool used for burnishing consists of one or more ball or roller, held in a casing. This tool can be mounted on the tool post of the lathe. When the tool is made to come in contact with the rotating work piece, the friction force rotates the balls or rollers of the tool, in a planetary motion. Burnishing process is considered as a cold working process, because the surface of the work piece is subjected to severe stress due to the planetary motion between the tool & work piece and the pressure applied by the tool. When this stress exceeds the yield strength of the material, it results in the plastic flow of the material from the peaks of the surface irregularities into the valleys, there by reducing the surface roughness. This also induces thermally stable and long lasting compressive residual stresses.

Review of Research Paper

A.A. IbrahiM, et al,work deals with the control of ball burnishing parameters of steel components via fuzzy logic. This burnishing tool using three balls is designed and constructed in such a way as to replace the three original adjustable jaws of the center rest. The centre rest and the lathe saddle were clamped together to operate as one piece. They had conducted experiment on a lathe to study the effect of burnishing parameters like feed, speed, force, and number of balls used in single pass on surface characteristics of surface roundness error. They control burnishing parameters by use of Experimental results used as a knowledge base to prepare a fuzzy logic model.

M.M. El-Khabeery, et al, investigated of the effect of roller-burnishing upon surface roughness, surface microhardness and residual stress of 6061-T6 aluminum alloy. They determined residual stress distribution in the surface region that was burnished using a deflection-etching technique. They influence three process parameters like burnishing speed, burnishing depth of penetration and number of passes. They has been shown that low burnishing speeds and high depths of penetration produce much smoother surfaces, whereas a combination of high speed with high depth leads to rougher surfaces because of chatter. The optimum number of passes that produces a good surface finish was found to be 3 or 4. The maximum value of compressive residual stress decreases with an increase in burnishing speed. The maximum compressive residual stress increases with an increase in burnishing depth of penetration and/or number of passes.

Malleswara Rao J. N., et al, investigated to effect of roller burnishing on surface hardness and surface roughness on mild steel specimens. They found that the surface hardness of mild steel specimens increases with increase in the burnishing force up to 42 kgf. Further increase of burnishing force results in the decrease of surface hardness on mild steel specimens. The maximum surface hardness obtained is 70 HRB. Maximum reduction in surface roughness is observed in first five passes on mild steel by Roller Burnishing operation.

Dinesh Kumar, et al,presented on improving Surface Finish and hardness for mild steel cylinder using roller burnishing. They observed that the load required passing the tool increases with increase in interference and Surface hardness also increases with interference increases. They observed that the average improvement in surface finish with interference 120 um was 93.4 % and average increase in hardness with interference 80um has been observed 22 %.

P Ravindra babu, et al, investigated on the surface Characteristics, surface microstructure and micro hardness through various process parameter such as burnishing speed, burnishing force, burnishing feed and number of passes on EN Series steels (EN 8, EN 24 and EN 31), Aluminum alloy (AA6061) and Alpha-beta brass material. They found that the minimum roughness are 535 rpm, 200 N, 0.063 mm/rev for EN 8 and 355 rpm, 200 N, 0.095 mm/rev for EN 24 and EN 31 alloy steels for optimum speed, force and feed respectively.

K Saraswathamma, et al,reported optimization of surface roughness in the roller burnishing process on 6063 aluminium alloy using response surface methodology and desirability function. They found that the surface roughness obtained at a speed of 190 rpm, feed of 0.22 mm/rev and interference of 6 μm and also at 135 rpm, 0.32 mm/rev and 6 μm.

From the literature review of previous works on burnishing reveals that only, a few researchers concentrated on the analysis of roller burnishing process dealing mostly with the surface finish and hardness, but with little focus on the optimization of burnishing parameters. Furthermore, it has been not much study carried out on burnishing of EN19. Thus, there is very less work carried out on EN19 so it has been decided to work on EN19 material with consideration of their importance in industrial and automobile field. The current study will aimed at optimizing and analyzing the burnishing parameters, namely, burnishing speed, feed and number of passes using Full factorial method. The influence of burnishing parameters on output responses microstructure, surface roughness and surface hardness in this study.

RESEARCH WORK-OUT

Figure 2: Burnishing Machine Setup

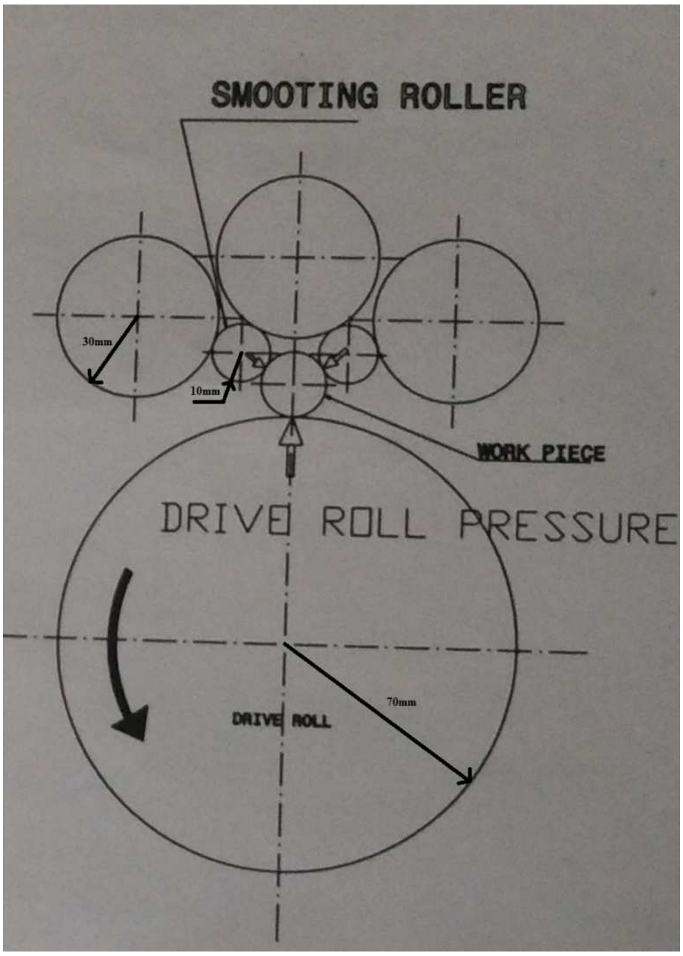

Figure 3: View of Multi Roller Burnishing Tool

EXPERIMENTAL RESULTS

Table 1: Experimental Readings

Sr. No.	Speed	Pressure (Bar)	No. of Passes	Ra	Hardness RC
1	20	15	2	0.78	35
2	20	10	3	0.83	35
3	20	15	1	0.79	34
4	20	20	3	0.74	38
5	16	10	3	0.81	37
6	10	15	1	0.77	36
7	20	10	1	0.90	32
8	10	20	3	0.66	39
9	20	15	3	0.73	35
10	10	20	1	0.74	38
11	20	20	2	0.76	37
12	10	10	1	0.79	35
13	16	10	1	0.88	34
14	10	15	2	0.69	37
15	16	15	3	0.71	36
16	20	20	1	0.77	37
17	10	20	2	0.68	39
18	16	20	1	0.76	38
19	16	10	2	0.82	35
20	10	15	3	0.67	38

21	10	10	3	0.68	37
22	16	20	3	0.69	40
23	20	10	2	0.86	33
24	16	15	2	0.76	36
25	10	10	2	0.71	36
26	16	15	1	0.78	35
27	16	20	2	0.71	39

Main Effects Plot for Means of Surface Roughness

The main effects plot for surface roughness versus Speed, Feed rate and No. of passes are shown in figure.4,

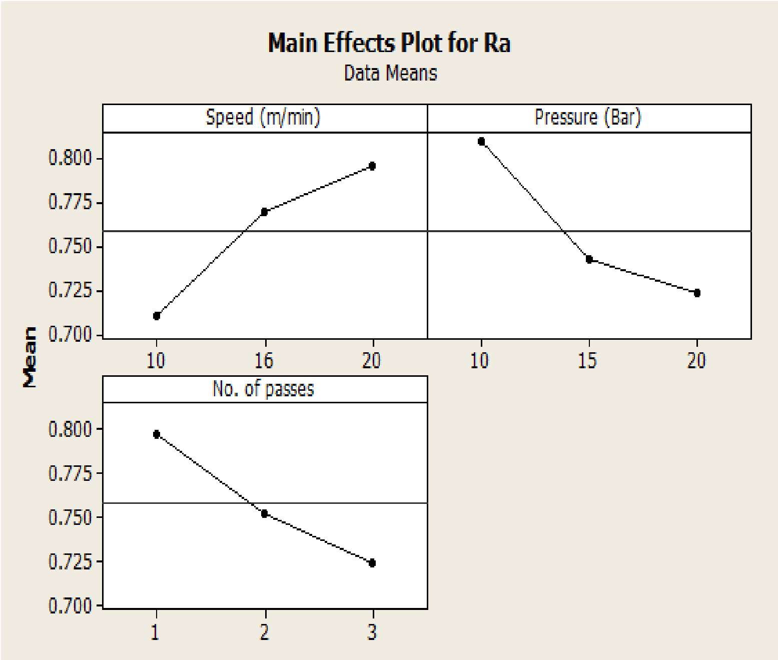

Figure 4: Effect of Control Factor on Surface Roughness

which is generate from the value experiment of surface roughness as per table in minitab-16 statistical software is useful to find out optimum parameter value for response variable.

Figure.4 shows that lower surface roughness will meet at Speed 10 m/min, pressure and No. of passes3. The graph generate by use of minitab-16 statistical software for surface roughness is shown in figure.4.

From the figure.4, it has been conclude that the optimum combination of each process parameter for lower surface roughness is meeting lower Speed[A1], higher Pressure[B3] and higher No. of passes**.**

The effect of burnishing speed on average roughness can be assessed form figure 4.2, the figure clearly show the average surface roughness is reduced slightly with an increase in burnishing speed. This reduction is expected to be due the stability of the RB tool which is much better at high speeds within the selected range. However, an increase in burnishing speed deteriorates the surface roughness as a result to the over hardening and consequent flaking of the surface layers.

Burnishing pressure is one of many important burnishing parameters that can greatly affect On burnishing process characteristics. Figure 4 shows, the average surface roughness also reduced as the burnishing pressure is raised, reaching to a minimum value of 64.1 RC at burnishing pressure lower level among three (medium burnishing). Further increase in burnishing pressure can lead to an increase in average roughness. So it is recognized to be better to select processing in this higher burnishing pressure, which is believed to be related to high deforming action of the tool, and more regular metal flow produced a smoother internal surface.

Main Effects Plot for Means of Surface Hardness

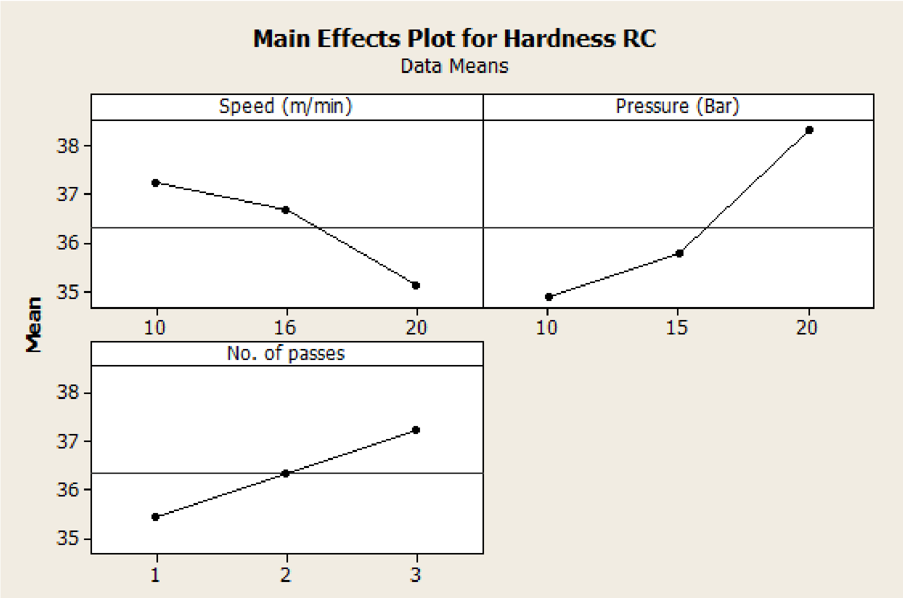

Figure 5: Effect of Control Factor on Surface Hardness

Figure.5 shows that higher surface hardness will meet at Speed 10 m/min , Pressure 20 bar and No. of passes3. From the figure.4.3, it has been conclude that the optimum combination of each process parameter for lower surface hardness is meeting at lower Speed[A1], higher Pressure[B3] and higher No. of passes**[C3].**

Burnishing Speed; The effect of burnishing speed doesn't appear to be significant. Figure 5 shows the effect of burnishing speed on hardness, when the hardness reaches the maximum value at level one(10 m/min) of burnishing speed. At medium and high burnishing speed the hardness gradually reduced, in this condition the reduction is expected to be related to less amount of cold working imposed to the deformed metal surface, due to rapped deformation rate (high strain rate). **Burnishing pressure;** The effect of burnishing pressure on the hardness are shown in figure 5hardness reaches the maximum value at burnishing Pressure between level two and three.

ANALYSIS OF VARIANCE (ANOVA)

Analysis of Variance for Ra

From ANOVA result it is observed that all responses are influencing parameter for surface roughness, while the value of p for all process parameter is 0.000, 0.000 and 0.000 which is less than 0.05 p values. So, it is influencing parameter for surface hardness.

ANOVA: Ra Versus Speed (m/min), Pressure (Bar), No. of Passes

Factor	Type	Levels	Values
Speed (m/min)	fixed	3	10, 16, 20
Pressure (Bar)	fixed	3	10, 15, 20
No. of passes	fixed	3	1, 2, 3

Table 2: Analysis of Variance for Ra

Source	DF	SS	MS	F	P
Speed (m/min)	2	0.034496	0.017248	28.57	0.000
Pressure (Bar)	2	0.036363	0.018181	30.12	0.000
No. of passes	2	0.024674	0.012337	20.44	0.000
Error	20	0.012074	0.000604		
Total	**26**	**0.107607**			

R-Sq = 88.78%   R-Sq(adj) = 85.41%

Analysis of Variance for Surface Hardness

From ANOVA result it is observed that all responses are influencing parameter for surface hardness, while the value of p for all process parameter is 0.000, 0.000 and 0.000 which is less than 0.05 p values. So, it is influencing parameter for surface hardness.

ANOVA: Hardness (RC) Versus Speed (m/min), Pressure (Bar), No. of Passes

Factor	Type	Levels	Values
Speed (m/min)	fixed	3	10, 16, 20
Pressure (Bar)	fixed	3	10, 15, 20
No. of passes	fixed	3	1, 2, 3

Table 3: Analysis of Variance for Hardness RC

Source	DF	SS	MS	F	P
Speed(m/min)	2	21.556	10778	32.33	0.000
No. of passes	2	14.222	7.111	21.33	0.000
Pressure(Bar)	2	57.556	28.778	86.33	0.000
Error	20	6.667	0.1511		
Total	**26**	**100**			

R-Sq = 93.33%   R-Sq(adj) = 91.33%

CONCLUSIONS

Experimental investigation on roller burnishing machining of EN19 has been done using Design of experiment. The following conclusions are made.

- From the mean effect plot the optimum parameter settings for surface roughness at, ie. Speed 10 m/min, pressure 20 bar and no of passes is 3.
- It can also observed that all process parameters are more contribute for surface roughness but pressure is the most prominent factor affecting the surface roughness.
- Same thing occurred on hardness for all process parameters.
- The Analysis of Variance resulted that the pressure has major influence on the surface roughness (µm) and hardness (RC). Whereas the speed and no of passes has less effect on surface roughness and surface hardness.
- The objectives such as surface roughness and hardness are optimized using a single objective Full factorial method.

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