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Effect of burnishing process parameters on surface Quality- A Review

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***Abstract* – In present era of globalization for every industry, surface quality of machined components is of utmost importance. The product functionality and reliability depends on the surface quality. Whatever may be the manufacturing process used, it is impossible to produce perfectly smooth surface. The imperfections and irregularities are bond to occur in some form of peaks and valleys on the machined components. In burnishing, a hard and highly polished ball or roller is used to flatten this rough peaks into the valleys by plastic deformation. Burnishing is a very simple, effective and chip less manufacturing method. Quality of the burnished components greatly depends upon the various burnishing parameters which includes speed, feed, depth of cut, No. of tool passes, burnishing force etc. This paper presents the reviews of different works in the area of burnishing and effect of various burnishing parameters on the surface characteristics like surface roughness, hardness, microstructure properties, fatigue strength, corrosion resistance, wear resistance, etc.**

***Index Terms* -** Burnishing process, burnishing parameters, Surface characteristics

I. INTRODUCTION

In today's competitive market, surface quality is one of the most specified customer requirements. Major indication of surface quality on machined components is surface finish. Surface finish not only gives good appearance to the material, but also increases the properties of the material such as increase in the surface hardness, decrease in surface roughness and increase in the load carrying capacity of the material. Now, in recent years, a process namely burnishing is commonly used to increase the surface finish of the material. Also surface characteristics are improved by plastic deformation in burnishing.

Burnishing offers an attractive post-machining alternative due to its chip less and relatively simple operation. Schematic working principle of burnishing process is shown in Fig. 1[1]. In burnishing, the force or pressure is applied through a hard ball or roller and when this pressure exceeds the yield strength of the material plastic deformation takes place that lead to the plastic flow of metal from the rough peaks to fill the valleys and thereby surface roughness decreases. Besides producing a good surface finish, the burnishing process has additional advantages over conventional finishing processes such as securing increased hardness, fatigue life, corrosion resistance, wear resistance etc.

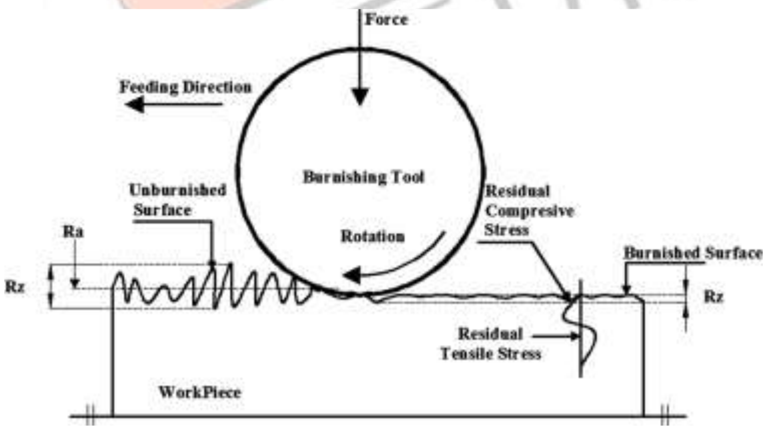


Figure 1. Schematic working principle of burnishing process [1]

II. Literature Review

Review of many researchers to evaluate the effect of different process parameters of burnishing process is discussed in this section. **Khalid. S. Rababa et al [2]** studied the diamond pressing burnishing process. The improvements in the mechanical properties and micro hardness of the surface of O1 steel was studied. In this, the burnishing force were 105, 140, 175 and 210 N. The major conclusions from this study were: (1) RB process has a large effect on the micro hardness of O1 alloy steel (2) The stress of material has been increased of about 150 MPa (3) RB has a positive effect on the surface roughness of O1 alloy steel. The improvement percentage on the surface quality was 12.5%. (4) RB has an effect on the ultimate tensile strength, the UTS has been increased by 166 MPa. **Aysun Sagbas et al. [3]** studied the improvements in surface hardness of ball burnishing on 7178 aluminum alloy. The effect of the main burnishing parameters such that burnishing force, number of passes, feed rate on the surface hardness was determined by using 2^4 full factorial design. ANOVA was employed to find the significance of the factor effects based on a 95 % confidence level. Experiments were designed on Taguchi’s L9 orthogonal array. They found that the burnishing force is the dominant factor, while, the number of passes is a major factor. The optimal parameter combination for the maximum surface hardness was obtained at burnishing force of 200 N, number of passes of 4, feed rate of 0.25 mm/r. **Aysun Sagbas et al. [4]** done the optimization of ball burnishing process on Al 7178. Desirability function approach (DFA) together with response surface methodology (RSM) was used to optimize the process. The empirical model using RSM with CCD was developed to investigate the influences of four burnishing parameters including burnishing force, number of passes, feed rate and burnishing speed on the performance characteristics of surface roughness. The results indicated that burnishing force and number of passes were the significant factors on the surface roughness. Based on the experimental work, the absolute average error between the experimental and predicted values at the optimal combination of parameter settings for surface roughness was calculated as 2.82%. **N.S.M. El-Tayeb et al. [5]** designed and fabricated simple and inexpensive burnishing tools, with interchangeable adapter for ball and roller burnishing. The test material used was aluminium 6061 under different parameters and different burnishing orientations to investigate the effect of burnishing speed, burnishing force and burnishing tool dimension on the surface qualities and tribological properties. The results showed that burnishing speed of 330 rpm and burnishing force of 160N produce optimum results and a decrease in the burnishing ball diameter leads to a considerable improvement in the surface roughness up to 75%. The friction coefficient of burnished surfaces is dependent on the surface roughness. Low friction coefficient corresponds to low surface roughness. **Malleswara Rao J. N. et al. [6]** studied the effect of roller burnishing on surface hardness and surface roughness on mild steel specimens. The considered burnishing parameters were burnishing force and No. of tool passes. The results show 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. And Maximum reduction in surface roughness is observed in first five passes on mild steel by Roller Burnishing operation. The effect of burnishing speed, feed, number of passes and depth of penetration on the surface micro hardness of Al 6061 was measured by **Ashish Deshmukh et al. [7]**. In this, DOE using Taguchi’s L9 array was planned to find out the effect of burnishing parameters on response variable. The outcome revealed that the single roller burnished samples of Aluminum 6061 lead to the enhancement in surface micro hardness.

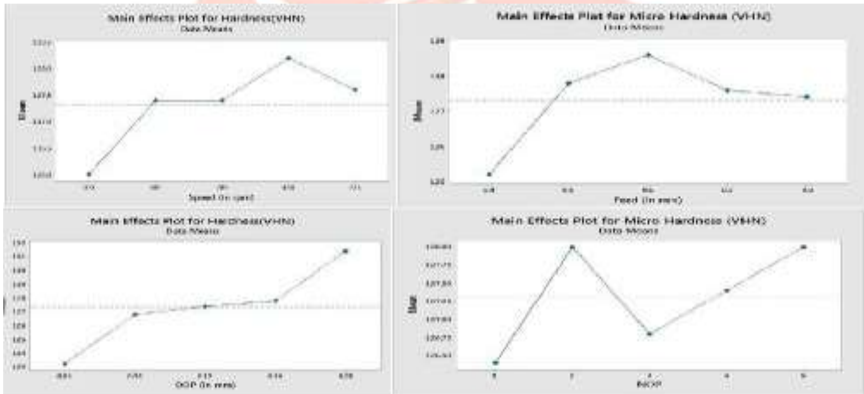


Figure 2. Main effects plot of micro hardness Vs. various burnishing process parameter

From Main effects plot of micro hardness against various burnishing process parameter, they found that the depth of penetration is the more important parameter which has significant effect on surface micro hardness (VHN value). **N. M. Qureshi et al. [8]** done the experimental study on the effect of ball and roller burnishing processes on surface roughness of EN8 steel. Taguchi methodology was used to find optimum machining parameters. The parameters selected for this study were: Speed, feed, Depth of penetration, No. of passes. The experiments were designed and run as per Taguchi’s L16 orthogonal array.

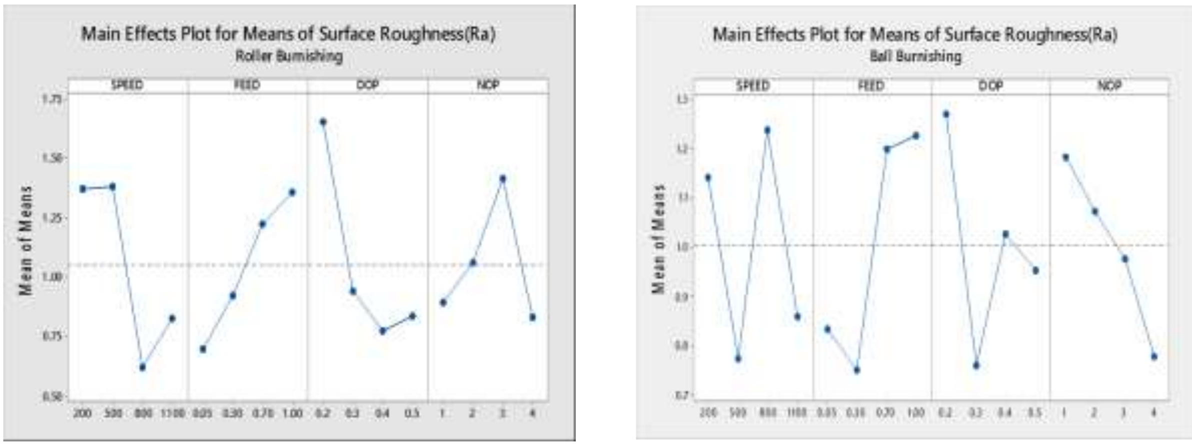


Figure 3. Main Effect Plot for Means for roller and ball burnishing

From fig 3, it was concluded that the optimum level for Roller Burnishing was obtained at speed of 800 rpm, feed of 0.05 mm/rev, DOP of 0.40 mm and No. of passes of 4. The optimum level for ball burnishing were: speed=500 rpm, feed=0.30 mm/rev, DOP=0.3 mm and No. of passes=4. The effects of various burnishing parameters on the surface characteristics, surface microstructure, micro hardness are evaluated in the case of EN Series steels (EN 8, EN 24 and EN 31), Aluminium alloy (Al6061) and Alpha-beta brass by **P Ravindra Babu et al. [9]**. Taguchi technique was employed in this investigation to identify the most influencing parameters on surface roughness. The input parameters were burnishing speed, burnishing force, burnishing feed and number of passes. After this experimental work, it was concluded (1) Burnishing results in significant surface finish, depth of burnishing and increase in micro hardness and residual stresses. (2) The optimum speed, force and feed for 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, which is nearly matched with the values obtained by theoretical Taguchi method. (3) With the present data where the numbers of passes are restricted to 3, the aluminium alloy AA6061 shows best surface finish in the second pass (though the third pass does not show much degradation in surface finish). **E. Rafati et al. [10]** investigated the effective factors of Roller burnishing process and optimize them using Taguchi method. The work piece material was Al-2014. The speed, feed and Depth of penetration were considered as input parameters. In this, the standard L9 matrix of Taguchi approach was selected. The experiments results revealed that rotational speed, tool's depth of penetration and feed rate are the most important factors in roller burnishing process. Increasing the rotational speed (RPM) leads to the surface quality improvement, where the best surface quality (less surface roughness) is achieved at 710 RPM. For improving the surface quality, it is recommended to reduce the feed rate of burnishing tool. **D. Srinivasa Rao et al. [11]** studied the effect of ball burnishing parameters i.e. feed rate, speed, force, ball diameter and lubricant on surface hardness and wear resistance of HSLA Dual-Phase Steels. It can be concluded from the experimental results that the highest surface hardness and wear resistance can be achieved with 16.5 mm diameter ball, grease as lubricant, feed of 0.085 mm/rev, speed of 22.62 m/min, and burnishing force of 25 kgf. The outcome revealed that an improvement of about 30–45% in surface hardness of dual-phase steels (when compared to the initial hardness values as shown in Table 11) can be obtained by ball burnishing process. **M.H. El-Axira et al. [12]** was investigated the effect of the stated parameters i.e. speed, feed, depth of penetration and No. of passes of internal ball burnishing process on the work material characteristics. The work piece material was aluminium alloy 2014. RSM with the Box and Hunter method was employed in this study. They found that from an initial roughness of about Ra 4μm, the specimen could be finished to a roughness average of 0.14μm. As a result of this study it was concluded that (1) An increase in internal ball burnishing speed leads to a slight decrease in surface average roughness. (2) The effect of burnishing feed is much more pronounced than the effects of burnishing speed on surface average roughness. An increase in internal burnishing feed leads to a decrease in surface average roughness, reaching a minimum value at burnishing feed of (0.15–0.25mm/rev). A further increase in burnishing feed causes an increase in average roughness. (3) The best results for average roughness is obtained when applying high depth of penetration. The influence of deep ball-burnishing using different parameters for finishing rotating parts was investigated by **A. Rodríguez et al. [13]**. In this work, the influence of each process parameter such as speed, feed and burnishing pressure on cylindrical specimens of AISI 1045 steel was determined. Also Surface topographies, sub-surface micro-hardness and residual stresses were measured and a finite element model of ball-burnishing was used to understand and predict residual stress values and their variety with the process parameters. Based on the experimental results achieved, the conclusions were: (1) Burnishing speed variation hardly affects the surface finish and hardness of the workpiece. Thus, it is possible to burnish using the maximum speed supported by the machine, reducing processing times. (2) Burnishing pressure is a critical parameter in the process. (3) Residual stresses measurements using X-ray diffraction techniques show that compressive stresses are introduced in the component. The effect of burnishing process parameter with roller burnishing tool on CNC Machine using Response Surface Methodology and developing the Mathematical Model was studied by **Vipul Patel et al. [14]**. The Work piece material was Aluminium Alloy 6351 T6. The process parameters used were cutting speed, interference, tool feed, number of tool passes and response Parameters were Surface Roughness and Hardness. In this, total L31 experiment has been carried out with four factors and five levels. From the experiment it was identified that (1) the minimum Surface Roughness obtained is 0.080 μm at 450 rpm, 0.064 mm/rev, 2 mm, 4 for Cutting Speed, Feed Rate, Interference and Number of Tool Passes respectively. (2) the maximum Hardness obtained is 107 BHN at 450 rpm, 0.064 mm/rev, 5 mm, 3 for Cutting Speed, Feed Rate, Interference and Number of Tool Passes respectively. **P. S. Kamble et al. [15]** used the internal roller burnishing tool to burnish the drilled hole. In this experimental study, Speed, feed, and number of passes have been varied using taguchi method to examine the surface finish and micro hardness. The test material was “En-8” material, which is used as plain carrier in planetary type gear box to carry the planetary gears. The results were found that the Surface finish from 2.44 micron to 0.13micron is achieved. Before burnishing micro hardness found 377Hv and after burnishing it increases up to 528Hv.

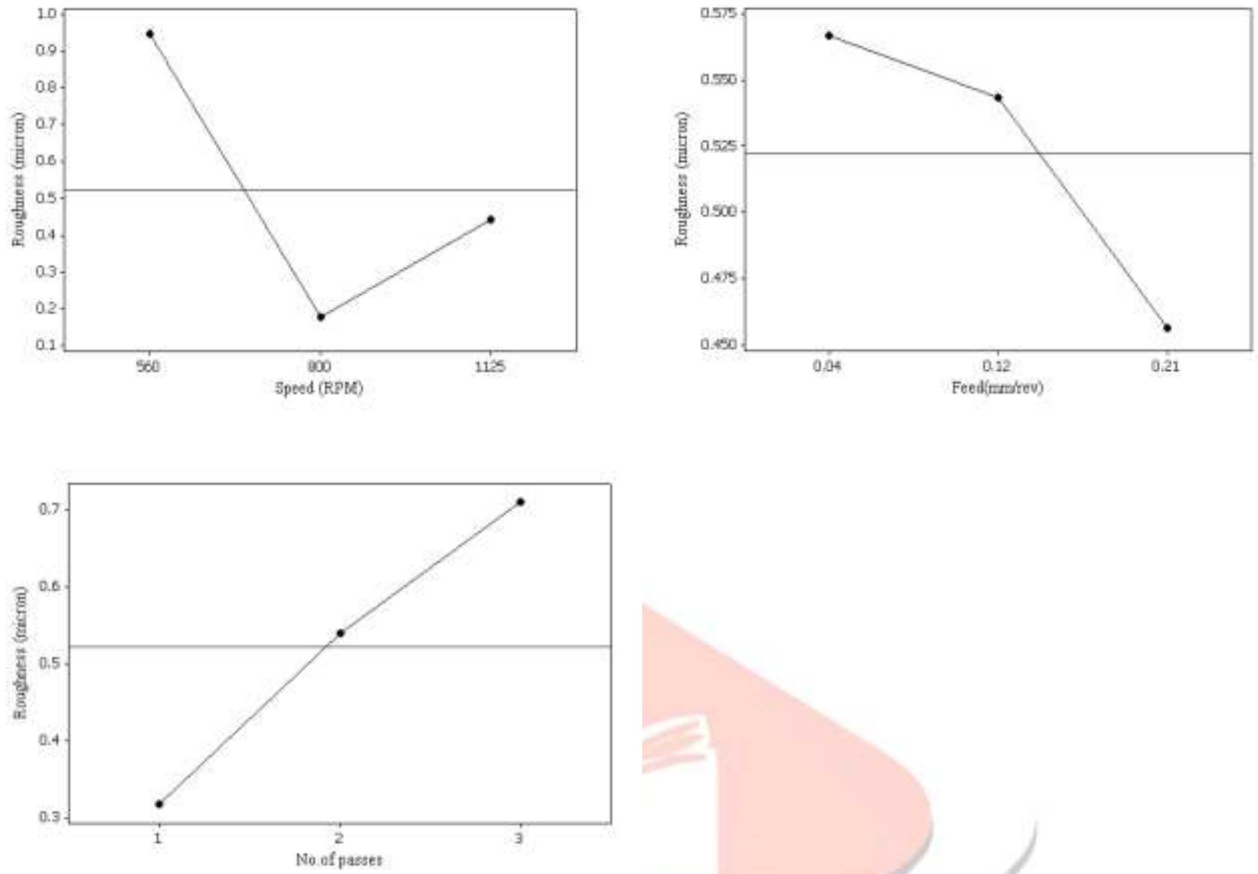
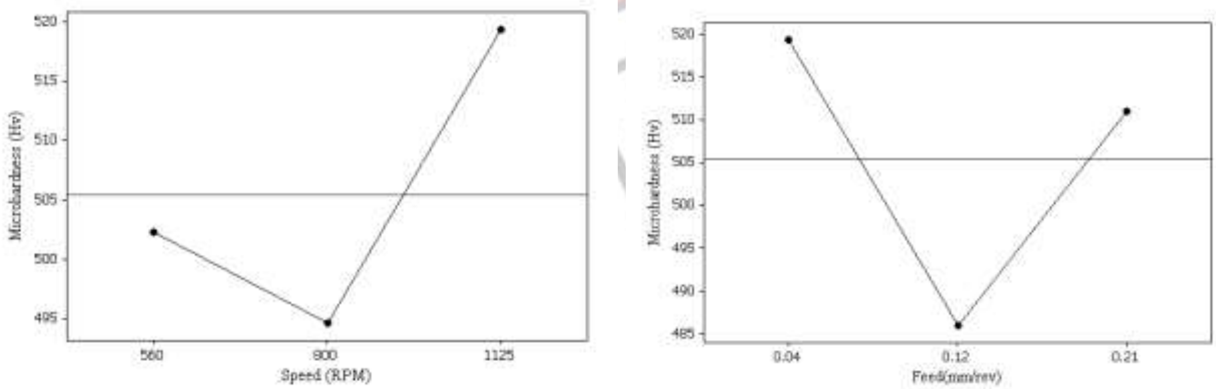


Figure 4. Speed, feed, No. of passes vs. surface roughness



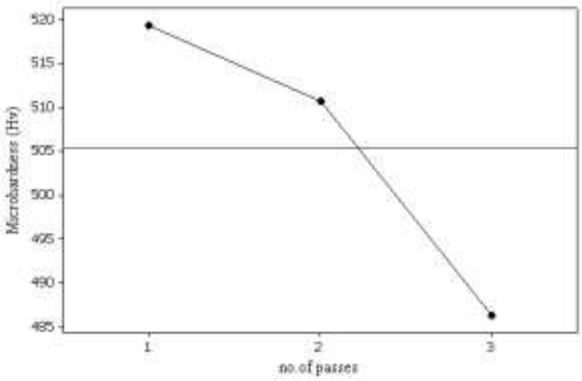


Figure 5. Speed, feed, No. of passes vs. Micro hardness

The effect of various parameters i.e. tool diameter, burnishing speed and burnishing feed on the surface characteristics such as surface roughness and micro hardness are evaluated by **Hussein Mesmari et al. [16]**. Taguchi method is used to formulate the experimental layout and analyzing the effect of each parameter on the burnishing characteristics, and predicting the optimal choice of each parameter. The result showed that tool diameter mainly affects the surface roughness, while the tool diameter and burnishing speed significantly affects the surface micro hardness. **C. S. Jawalkar et al. [17]** has conducted the experiments to find optimize value for enhancing the surface quality and hardness economically in roller burnishing process. They have considered the input parameters of roller burnishing process were spindle speed, tool feed, number of passes and lubricants. The surface roughness and micro hardness were main response variables. The commonly used industrial material EN 8 is selected as a work piece for experimental purpose. Taguchi's standard L9 orthogonal array was used. ANOVA analysis was applied to find out most significant roller burnishing process parameters. After the experimental work they concluded that the number of passes, feed and spindle speed contribute maximum for surface roughness in burnishing for EN 8 material. Number of passes and speed contribute maximum percentage in surface hardness for burnishing of EN 8 due to hard hardening effect. **Ghodake A. P. et al. [18]** reviewed the effect of burnishing process on the behavior of engineering materials. Their conclusions include – force and number of tool passes are the important parameters to improve ductility of materials. Burnishing greatly affects frictional co-efficient and improves wear resistance of materials.

III. CONCLUDING REMARKS

From the literature review it was found that there is wide applicability of process parameter in the field of burnishing process. The present review has led to the following conclusions.

– Reduction in the surface roughness and the increase in hardness with increase in the initial hardness of the burnished work pieces were identified by the application of burnishing process.
– When the burnishing process continuously takes place for longer period of time, hardness and surface finish increased significantly. burnishing parameters have significant effect on the surface hardness and wear resistance.
– Burnishing is an economical and feasible mechanical treatment for the quality improvement of rotating components, not only in surface roughness but in compressive residual stresses as well.
– Ball-burnishing improves both physical and mechanical properties of turned parts. Particularly, this technique improves the surface quality (even reaching 0.3 µm Ra), increases the hardness of the workpiece surface (up to 60% Brinell) and introduces compressive residual stresses, which are favourable for increasing the fatigue life of the piece and improve the wear resistance of the component.
– Roller burnishing also gives better result in drilled hole.

IV. REFERENCES

[1] I. Ovali and A. Akkurt, Comparison of Burnishing Process with Other Methods of Hole Surface Finishing Processes Applied on Brass Materials, Materials and Manufacturing Processes, 26(8) 2011,1064-1072.
[2] K Rababa and M Mohammad Al-mahasne, Effect of Roller Burnishing on the Mechanical Behavior and Surface Quality of O1 Alloy Steel, Research Journal of Applied Sciences, Engineering and Technology, 3(3), 2011, 227-233.
[3] A Sagbas, F Kahraman, DETERMINATION OF OPTIMAL BALL BURNISHING PARAMETERS FOR SURFACE HARDNESS, Materiali in tehnologije / Materials and technology, 43(5), 2009, 271–274.
[4] A Sagbas, Analysis and optimization of surface roughness in the ball burnishing process using response surface methodology and desirabilty function, Advances in Engineering Software, 42(11), 2011, 992–998.
[5] N.S.M. El-Tayeb, K. Low, P. Brevern, On the surface and tribological characteristics of burnished cylindrical Al-6061, Tribology International, 42(2), 2009, 320–326.

[6] J. N M Rao., C Reddy, P. Rama Rao, The effect of roller burnishing on surface hardness and surface roughness on mild steel specimens, International journal of applied engineering research, 1(4), 2010, 777.
[7] A Deshmukh, R. Patil, Analyasis and Optimization of Roller Burnishing Process on Cylindrical Surface micro Hardness of Aluminium Alloy, International Journal of Innovative Research in Science, Engineering and Technology, 4(7), 2015.
[8] N. M. Qureshi, Analysis of Effect of Ball and Roller Burnishing Processes on Surface Roughness on EN8 Steel, International Journal of Engineering Research & Technology,4(6), 2015.
[9] P Ravindra babu, K Ankamma, T Siva Prasad, A V S Raju and N Eswara prasad, Optimization of burnishing parameters and determination of select surface characteristics in engineering materials, Sadhana,37(4), 2012, 503-520.
[10] E. Rafati, M. S. Mahdieh, Investigation of Variance of Roller Burnishing Parameters on Surface Quality by Taguchi Approach, International Journal of Advanced Design and Manufacturing Technology, 6(3), 2013, 77.
[11] D. Srinivasa Rao, H. Suresh Hebbar, M. Komaraiah, and U. N. Kempaiah, Investigations on the Effect of Ball Burnishing Parameters on Surface Hardness and Wear Resistance of HSLA Dual-Phase Steels, Materials and Manufacturing Processes, 23(3), 2008, 295–302.
[12] M.H. El-Axira, O.M. Othmanb, Study on the inner surface finishing of aluminium alloy 2014 by ball burnishing process, journal of materials processing technology, 202(1), 2008, 435–442.
[13] A. Rodríguez, L.N. López de Lacalle, A. Celaya, A. Lamikiz, J. Albizuri, Surface improvement of shafts by the deep ball-burnishing technique, Surface & Coatings Technology, 206911), 2012, 2817–2824.
[14] V Patel, T.S Bisoniya, Experimental investigation of effect of machining parameters on surface roughness in roller burnishing process, International Journal for Technological Research in Engineering,2(9), 2015.
[15] P. S. Kamble, V. S. Jadhav, Experimental study of Roller burnishing process on plain carrier of planetary type gear box, International Journal of Modern Engineering Research, 5(2), 2012, 3.
[16] H Mesmari, I EL Bukhari, Investigation on internal roller burnishing process of al- 2024-t361 surface roughness and micro hardness characteristics, International Journal of Advanced Technology & Engineering Research, 6(4), 2014.
[17] C. S. Jawalkar and R. S. Walia, Study of Roller Burnishing Process On EN8 Specimens Using Design of Experiments, Journal of Mechanical Engineering Research, 1(1), 2009, 038-045.
[18] A P Ghodake, Effect of Burnishing Process on Behaviors of Engineering Materials- A Review, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 5(5), 2013, 09-20.