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A review Paper on Burnishing Process

Mr. V. G. Sanap[1], Prof. Dr. A. N. Chapgaon[2], Prof. M. A. Sutar[3]

[1]P.G. Student, Mechanical Engineering Department, A.M.G.O.I., Vathar, Maharashtra, India
[2]Professor, Mechanical Engineering Department, A.M.G.O.I., Vathar, Maharashtra, India
[3]P.G. Coordinator, Mechanical Engineering Department, A.M.G.O.I., Vathar, Maharashtra, India

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Abstract – *It is widely accepted that chipless finishing process can be used efficiently to produce smooth and good fatigue behavior surface at low cost. The review of literature reveals that there is wide applicability of process parameters which improve the quality of surface roughness and surface hardness. In industrial manufacturing applications to improve the surface quality of cylindrical parts such as valves, pistons of hydraulic or pneumatic cylinders, pump shafts and bearing bores, some surface-finishing processes such as grinding, super finishing and honing are applied. Burnishing can increase the surface hardness by generating compressive stresses on the surface and as a result, it improves fatigue and corrosion resistance in addition to providing better surface quality. Roller burnishing is a very simple and very low power consumption process and can be applied on a conventional or computer numerical control lathe.*

Key Words: *Burnishing process, fatigue behavior, surface roughness surface hardness, etc.*

1. INTRODUCTION

Burnishing is a chipless machining method which cold works the metal without cutting or abrading the surface. It removes no metal rather compresses or irons-out the peaks of metal surface in the valley of generating a dense and uniform surface. Roller burnishing improve surface finish and results in dimensional accuracy. The cold working condenses the grain surface of metal, producing increase in surface hardness 50% to 100% within a penetration of 250 to 300 micron. In roller burnishing the material is elastically deformed to a given depth below the surface. The result is compressive stresses at the surface. In turn, this increases the resistance of the material to fatigue failure due to the presence of residual stresses in the surface. Roller burnishing improves surface irregularities, 4-8 Ra surface finish, accurate sizing.

Most of the high quality manufacturing process like (eg. Fine turning, grinding, honing, lap grinding and polishing) can be replaced by burnishing process. This process entails considerable technological and economical advantage for surfaces in the roughness area Rz < 10 micron. Main applications of burnishing process are automotive components, compressor and turbine blades etc.

The dimensional and geometrical accuracies obtained by normal method of machining like turning, milling etc. are limited. The geometrical errors include circularity, cylindricity, flatness and parallelism of functional surface. Also the surface finish has a vital influence and power losses due to friction. Poor surface finish will lead to rupture of oil films on the peak of micro-irregularities, which lead to a state approaching dry friction and results in excessive wear of the rubbing surfaces. Therefore, fine finishing process are employed in machining the surface of many critical components to obtain a very high surface finish of high dimensional and geometrical accuracies such process include grinding, honing, lapping, Superfinishing and burnishing.

The surface integrity of an engineered surface is generally characterized in terms of surface finish, state of residual stress, microstructure and micro hardness. Generally, good surface finish, high compressive residual stress, and high hardness of the surface layer prolong the fatigue life of the components.

LITERATURE REVIEW:

Brief but thorough review of literature is made, which gives an idea about the present research status in this area and various parameters involving in it.

Adel Mahmood Hassan. et, al. [2] made following conclusions under the burnishing conditions considered in his experimental work: The surface roughness decreases with increase in feed rate, burnishing speed, force, and number of tool passes, to a certain limit, then it starts to increase with each of the above-mentioned parameters. The surface hardness decreases with an increase in feed rate and burnishing speed, while the hardness increases with the burnishing force and number of tool passes. An increase in burnishing force causes an increase in hardness and depth of the hardened subsurface layer. Large diameter Roller seem to be more effective in improving surface roughness, while small diameter Roller seems to be more effective in increasing surface hardness. A surface roughness~ Ra of 0.1 p~m and an increase in surface hardness of 60% could be obtained by The size of the burnishing Roller has a significant effect on surface roughness and hardness burnishing turned cylindrical commercial aluminum and brass surfaces by using the simple burnishing tool designed in this study. The microstructure examination shows that there is an elongation in the grain near the surface of the burnished workpiece.

Sagbas,et, al.[9] in his experimental study, the evaluations of the four variables burnishing force, number of passes, feed rate and burnishing speed were investigated by combining RSM and DFA. RSM with CCD was employed to evaluate the effects of burnishing parameters on the surface roughness of the 7178 aluminium alloy. The significant factors on the surface roughness were determined as burnishing force and number of passes. The predictive power of this model was tested with supplementary experimental surface roughness data and a good fit was observed. The average absolute error between experimental and predicted values was calculated as about 3.5% sufficiently low to confirm the high predictive power of model. After building the regression model, a numerical optimization technique using desirability function was employed to optimize the burnishing process. The experimental results at the optimum process parameter combination confirm the effectiveness of the response surface models for optimum burnishing parameters. RSM approach can help manufacturers to determine the appropriate burnishing conditions, in order to achieve specific surface roughness. RSM was found to be a useful approach and it should be recommended that this methodology be adopted to all optimization studies.

The main aim of Khalid S.Rababs,et, al. [13] study is to enhance the mechanical properties and micro hardness of the surface of O1 steel using the roller burnishing process. In manufacturing processes, surfaces and their properties are as important as the bulk properties of the materials. Surface treatment is an important aspect of all manufacturing processes. It has been used to impart certain physical and mechanical properties, such as appearance, corrosion, friction, wear and fatigue resistance. Widely used methods of finishing treatment that create necessary parts with the given roughness usually do not provide optimum quality of the surface. Therefore, methods of Surface Plastic Deformation (SPD) are used. One of the most effective representatives is the roller burnishing. This can simply achieved by pressing a hard and highly polished ball or roller against the surface of metallic work pieces. In this paper the effect of diamond pressing process with a different pressing force (105, 140, 175, 210) N was studied and the results of the experiments are presented. The major findings of this study are; the true stress of material has been increased of about 150 MPa, the surface quality has been enhanced by 12.5%, finally the U.T.S. has been increased by 166 MPa.

Liviu Lucaet, al. [3] demonstrated effects of burnishing parameters upon final roughness. The tool employed used the hydrostatic principle, contact force being generated by fluid pressure at the ball-indenter. A hardened steel was used. Work parameters chosen were related to the hydraulic pressure, burnishing feed and speed, and prior hard turning feed and nose radius. Results showed significant influence of pressure in the process, as well as important influence of the original roughness after hard turning. Conditions for obtaining roughness in the range of grinding (0.5 μm) were provided.

MaximovJ. T.et. asl., [8] in his paper presents a new method of mechanical surface treatment of external cylindrical surfaces and it is called “Spherical motion burnishing ” (SMB). The axes of the workpiece and ring-shaped tool having toroidal acting surface intersect at angle θ = 20. The tool motion is superposition from a spherical motion and rectilinear translation with respect to the workpiece. The contact between the surface treated and its enveloped-tool acting surface is one of sliding friction in the presence of a lubricant. The method can be implemented on conventional machine tools, in particular on lathes by means of a relatively simple device and tool. To evaluate the manufacturing potentials of the SMB method a designed experiment has been carried out. The quality of the treated surfaces of workpieces made of low-and medium-carbon steel has been investigated experimentally. Mathematical models of the roughness and the residual axial normal stresses have been obtained on the basis of a planned experiment. The authenticity of the models has been proved on the basis of four extra tests. The method can be classified as mixed burnishing because it combines the advantages of hardening, dimensional burnishing and smoothing burnishing.

Burnishing has been widely used to produce excellent surface finish, work hardening and compressive residual stress by plastically deforming the workpiece surface layer. However, conventional burnishing is difficult on hard materials, because an excessive burnishing force might be required.

YinggangTian.et. Al.[12] proposed and researched tentatively another cross breed polishing process, laser-helped shining (LAB), in his examination. Amid LAB, the workpiece surface layer is briefly and privately mellowed by a controllable laser shaft, and after that promptly prepared by a customary shining device. LAB and customary shining trials were directed on MP35N, toughened and solidified AISI 4140, individually, to assess the impact of laser control on the polishing comes about. Since more plastic misshaping happens in LAB than in traditional polishing, on account of the transitory softening of workpiece material before shining, it is appeared by these trials that LAB can create much better surface complete, higher surface hardness and comparative compressive lingering pressure contrasted with its customary partner.

Tooth Jung Shiou.et. al.[6] in his examination is presents the conceivable Roller burnishing surface complete procedure of a freestyle surface plastic infusion form on a machining focus. The outline and fabricate of a polishing instrument was first proficient in this investigation. The ideal plane ball-polishing parameters were dictated by using the Taguchi's orthogonal cluster strategy for plastic infusion forming steel PDS5 on a machining focus. Four polishing parameters, specifically the ball material, shining rate, polishing power, and nourish, were chosen as the exploratory elements of Taguchi's outline of investigation to decide the ideal polishing parameters, which have the overwhelming impact on surface unpleasantness. The ideal polishing parameters were discovered in the wake of directing the examinations of the Taguchi's L18 orthogonal table, investigation of variety

(ANOVA), and the full factorial analysis. The ideal plane shining parameters for the plastic infusion form steel PDS5 were the mix of the tungsten carbide Roller, the polishing pace of 200 mm/min, the polishing power of 300 N, and the bolster of 40μm. The surface harshness Ra of the example could be enhanced from around 1 to 0.07μm by utilizing the ideal shining parameters for plane polishing. Applying the ideal polishing parameters for plane shining to freestyle surface plastic infusion shape, the surface unpleasantness Ra of freestyle surface district on the tried plastic infusion part could be enhanced from around 0.842 to 0.187μm, through a correlation between utilizing the fine processed and utilizing the ball-polished form hole.

Klockeet..F,et ,al [16] in his article demonstrates the model improvement utilizing the FEA for roller polishing connected on various geometries. The point of this work is the improvement of legitimate and compelling FE-models, which can give a quantitative expectation of the rime zone condition of roller shined workpieces. These FE-models are unquestionable through the correlation of the figured lingering pressure state with the trial consequences of roller shining tests.

The high pressure slopes in the rime zone after roller polishing require fine lattice of this region, which confines the model size and renders a large scale displaying of the roller shining procedure as time-wasteful or even unthinkable. The model improvements and the suspicions made in the demonstrating stage make extra scramble the numerical blunders and must be picked precisely. A quantitative expectation of the lingering pressure condition of the rime zone requires an advanced and delegate approval methodology in light of measurably firm assessment of the model outcomes, which is the thing that these FE-models accomplish. All created FE models were approved and can anticipate the leftover pressure state after roller polishing with adequate precision.

Swirad S. S.et..al. [4] exhibited impacts of shining parameters upon definite unpleasantness. The trials were directed with the tube shaped surfaced PCD device. The PCD instrument can be utilized effortlessly and profoundly productively in the polishing procedure. The surface unpleasantness of workpieces can be lessened essentially by the shining procedure with the PCD device. Utilization of the new jewel composites with Ti3SiC2 as a holding stage as the new instrument material for sliding polishing will permit to kill existing imperfection of the connected composites.

Sliding polishing with tube shaped instrument can be utilized as a completing procedure. With no specialized troubles we can accomplish surface unpleasantness Sa in the vicinity of 0.1μm and 0.2μm. Amid the trial procedure, a completed shined surface harshness of Sa = 0.0497μm was accomplished at polishing power 200 [N], encourage 0.085 [mm/r] and instrument sweep 3 [mm], from an underlying surface unpleasantness of Sa = 0.63μm.

Tooth Jung Shiou.et. al.[5] plans to enhance surface harshness of the solidified and tempered STAVAX plastic shape stainless steel utilizing the ball granulating, ball shining and ball cleaning surface complete procedures on a machining focus. The level surface ideal ball shining and circular cleaning parameters have been resolved subsequent to leading the Taguchi's L9 and L18 lattice tests, examination of variety (ANOVA), and the full factorial test, individually. The surface harshness of the ground test examples could be enhanced from about Ra = 0.5167 to 0.123_m overall by utilizing the ideal level surface ball polishing parameters. The surface unpleasantness of the shined examples can be additionally enhanced to Ra = 20 nanometers (nm) by utilizing the circular cleaning process with decided ideal parameters. By utilizing the finest accessible business grain size of the grating material aluminum oxide (Al2O3, WA) as 1_m in distance across (framework no. 10,000), the mean surface harshness estimation of Ra = 16.7nm by and large was conceivable. The decided level surface ideal shining and cleaning parameters were then connected consecutively to the freestyle surface test question of a F-theta examine focal point, to enhance the surface unpleasantness. The surface harshness esteem Ra of freestyle surface locale on the STAVAX tried part, which was solidified and tempered (HRC = 50), can be enhanced successively from around 1.83 to 0.035_m by and large.

2. a) Characteristics of Burnish surfaces

1. Low roughness(Ra < 0.1 micron)
2. Rounded surface profile
3. High surface bearing ratio.
4. Less friction and wear.
5. Increased hardness through cold working.

b) Benefits of burnished surfaces:

1. Short cycle time
2. Use of conventional or CNC controlled machine.
3. Complete processing in one setting.
4. No metal removal and no waste.
5. Lubricant requirement is low
6. Long tool life
7. Low noise emission.

3. Some requirement for optimum burnishing results

a) Material: - Though any metal can successfully roller burnished but ductile or malleable are best (for eg. Steel stainless steel, steel alloy, cast-iron, aluminium, copper, brass and bronze.)

b) . Hardness: - Hardness should be less than 45HRC, ideally (however Martials as hard as 65 HRC can be effectively burnished) c). Uniformity: -The finish depends upon uniform and tear free surface in order for the peaks and valley to cold flow correctly.

d) Roughness: - An initial 2-3 micron surface finish is ideal for roller burnishing. The rougher starting finish gives better final finish.

4. Conclusion

The conclusion of this review process is as below:

1. Surface roughness decreases with increase in feed rate burnishing speed, force and number of tool passes up to certain limit. Afterwards it starts to increase with each of above mentioned parameters.

2. Surface hardness decreases with an increase in feed rate and burnishing speed, while hardness increases with the burnishing force and number of tool passes.

3. The size of burnishing ball has significant effect on surface roughness and hardness.

4. Increasing the burnishing force results in increase in hardness and depth of hardened subsurface layer.

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