

The Impact of Ball Burnishing Process on the Surface Integrity of Al 2024 T3 Alloy

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Abstract: Ball burnishing is a process which used in the present experimental work of on specially fabricated Aluminium 2024 T3. The surface integrity places a vital role in determining the strength and fatigue properties of the material. In the process, a ball of suitable strength is made to impinge on the cylinder which is fixed to the lathe. The movement of the tool is coaxial with rotating work piece. Burnishing is a cold forming process, in which the protrusions arising due to machining is displaced to fill the dumps to improve the surface finish. Here, a tool is fabricated which has the ability to vary the pressure accordingly and tests are conducted to evaluate the variation of hardness and roughness parameter with speed and pressure on the given specimen. The outcomes reveal that there is a significant improvement in surface roughness and hardness were achieved by the application of newly developed ball burnishing tool produces better finishing on Al 2024 T3. Ball burnishing is an optimum procedure which requires minimum time and no skilled labour.

KEYWORDS: Burnishing; Aluminium 2024 T3, Hardness, Surface Integrity

I. INTRODUCTION

Surface integrity of manufactured component plays a vital role to avoid friction losses, improve corrosion resistance property and increased fatigue life. Burnishing is a of finishing metal surfaces where the material is plastically deformed under cold working condition with the use of pressurised hard steel ball or ball. The micro hardness, wear resistance and fatigue strength of the surface layer is increased by inducing compressive stress and strain hardening. The work piece chosen is relatively softer in order to prevent damage of balls, then hardened and highly polished steel ball are impinged on the work piece. During the process, the work piece is stressed upto a certain value and after it exceeds yield point the plastic deformation of the material occurs. When metal-to-metal contact occurs, the wear resistance of burnished surface will be more than abraded surface. The burnishing process is classified as follows.

- Roller burnishing
- Ball burnishing

II. EXPERIMENTAL PROCEDURE

A. MATERIAL SELECTION

In this investigation Aluminium Alloy 2024 T3 is used which is widely used in general purpose application. It's a precipitation- hardened aluminium alloy. The major constituents are magnesium and silicon. The major advantage of Aluminium 2024 T3 being the good weld ability. The specimen selected is 25mm in diameter, 159mm in length, 3mm groove length and length of each surface 50 mm. It is used in aircraft structures, Yacht construction, and automotive parts. Properties of Aluminium alloy 2024 T3

- Density: 2780 kg/m³
- Young's modulus: 73 GPa
- Tensile strength: 420 Mpa
- Melting point: 600⁰c
- Thermal Conductivity: 121 W/m K (at 100⁰C)
- Poisson's ratio: 0.33

B.MODELLING

The burnishing tools till date do not have the convenience for variation in pressure, because of which a new tool was introduced in this investigation which enable the burnishing of entire stretch with a fixed pressure at a stretch. The main objective of this investigation was to examine the effect of newly developed tool to improve surface characteristic. The effect of burnishing parameters such as feed rate, speed of burnishing, and force exerted on the work piece is comprehensively studied through this work. The Ball Burnishing tool has been developed to control the pressure applied by ball on work piece. Tool consists of cylinder connected to hand pump. At the nose end of cylinder, L-shaped frame is attached. Ball is supported by the frame. When oil pressure is supplied through cylinder, ball exerts burnishing force on aluminium alloy 2024 T3 rod during burnishing.

Composition	Al	Cu	Cr	Mg	Mn	Si	Zn	Fe	Ti
Percentage	94.7	4.9	0.1	1.8	0.9	0.5	0.25	0.5	0.15

C.SPECIMEN PREPARATION

Initially, the specimen is chosen as per the desired requirements. The work piece is then machined by fixing it on lathe. Next single point cutting tool is fixed in the tool post of the lathe and work piece is turned to have a 4 steps sand groove in between them. It was divided into number of parts of length 50mm with a gap of 3mm. These are tested for various parameters. Specimen one is without burnishing, the rest is burnished with variation in pressure and speed.



Aluminium specimen after turning and grooving

D.EXPERIMENT CONDUCTION

The specimen is prepared and burnishing tool is fixed to the tool post. The fixture is fabricated in such a way that the tool can be fixed to any lathe for operation. Burnishing force can be controlled by rotating knob connected with pressure gauge. At first the tool comes in contact with work piece at a point which is a condition of sliding friction, later once the work piece is rotated the rolling friction comes into picture. The ball comes into initially contact with the metal surface in the ball, further when the contact the pressure of contact increases and exceeds the yielding the metal in the plastic deformation zone. At this point local plastic strain is developed. After the ball is passed through the entire specimen it is removed and the material will recover elastically which results in residual compressive stresses occur in the surface layer.



Burnishing process carried out on the specimen

Once the tool is fixed to the fixture; the ball is brought into contact with the specimen and pressure is applied from the hand pump assembly through ball to the specimen. The trials are conducted for change in pressure keeping speed and number of pass constant. The hardness test is conducted using Micro Vickers hardness testing equipment. Later roughness test is conducted using Tally surf meter. The specimens are studied under Electron microscope before and after burnishing.

III. RESULTS AND DISCUSSION

EFFECT OF BALL BURNISHING ON SURFACE HARDNESS

Burnishing is carried out for a fixed number of passes. The pressure is varied from 10kg/cm² to 40kg/cm². The MVHN value is noted down at each stage and tabulated. Table 2 shows the hardness of material before and after burnishing with varied pressures. Fig 2 shows the variation of surface hardness with pressure. It is found there is a significant change in plastic deformation of higher picks after burnishing. The hardness is also found vary with the speed which is shown

LOCATION	HARDNESS HRB
1	85
2	88
3	89
4	93
5	95
6	96
7	98

EFFECT OF BURNISHING ON SURFACE ROUGHNESS

From the trials it is found that there is a significant change in surface roughness due to the variation in spindle speed, and pressure exerted. Surfaceroughness value before and after burnishing is tabulated in Table 3



LOCATION	MEASURED VALUES (R _a) in μ	
	INDIVIDUAL VALUES	AVERAGE
1	3.270,2.234,2.790,2.334,2.273	2.5802
2	1.121,1.152,1.586,1.520,1.880	1.4518
3	1.379,1.352,1.468,1.587,1.799	1.517
4	1.691,1.808,1.662,1.321,2.818	1.86
5	1.936,2.226,1.982,2.778,2.284	2.2412
6	1.914,2.182,2.375,2.027,2.388	2.1772
7	2.253,1.982,2.325,2.022,1.910	2.0984

IV. CONCLUSIONS

The results obtained from experimental methods are summarized as follows: -

1. Ball burnishing process employed for surface modification of aluminium alloy allows the high spots to be flattened and the valleys filled in.
2. From the comparative study it is found that the Micro hardness is also improved from 95.8 to 112.8, however speed at 200 rpm yields the highest improvement in hardness.
3. Ball burnishing improves Surface roughness significantly by 65% with the increase in the pressure. Hence the hydraulic system by means of which pressure can be varied plays a vital role.
4. As the Burnishing force is increased the wear resistance of Aluminium 2024 T3 will be reduced.

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