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Surface Quality Evaluation in Electrophoretic Deposition Assisted Polishing of Steel and Other Material: A Review

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Abstract:- This paper review on surface quality evaluation in electrophoretic deposition assisted polishing (EPDAP) of steel and other materials. Surface roughness is an important parameter to determine surface quality and hence is also a critical response parameter in EPDAP. EPDAP is recent development in surface finishing and is capable to generate at the order of nanometres which essentially increasing the life of any part, subjected to repeated reversal stress. Surface quality of electrophoretic deposited polished part depends on few important parameters such as, EPD polishing parameters, work piece parameter, and tool parameter. Due to all these EPD parameter the overall surface roughness is reduced. This review paper gives some background of EPDAP of steel as well as other material for better surface finish.

Keywords: - Surface roughness, polishing, EPDAP, stainless steel, Taguchi, polishing parameter.

I. INTRODUCTION

Nanotechnology targets ultra precession machining because of limit of accuracy in machining such as creating a polishing wheel with highest dimensional accuracy and less porous. Hence ultra polishing process develops and ensure high polishing along with exceptionally smooth surface. Benefits are highly detailed part, improved contact surface quality, longer wear and tear life.

Electrophoretic: the component with very fine surface finish shows greater wear and tear life. These surface with less friction can be accomplished by finishing process out of which polishing by EPDAP is one of them. EPDAP is secondary finishing method on which primary operation is done. In general polishing methods are chemical, mechanical, magneto-rheological fluid assisted, electrophoretic and electrochemical polishing methods. EPDAP is recent development in the field of polishing which was previously widely used for coating surface, also gives fine surface finish in order of nanometres. EPDAP is efficient polishing process produce nano finished surface (10-60nm) and apposite for ductile, hard and brittle material.

In EPDAP consists of abrasive particle slurry mixed in pure water to fill gaps, NaOH is added to maintain the neutral pH 9. OH^- ions present inside the slurry gets attracted to anode and are deposited over it due to electromagnetic field. Charged particles migrate towards electrode of opposite charge under the impact of DC electric field. This phenomenon is known as EPDAP.

1.1: Design of experiment – Taguchi design

General steps involved in Taguchi method include define the process objective, target value for a performance measure of the process – maximum or minimum. Next to determine design parameters affecting the process after which orthogonal array is created indicating number of conditions and level for each experiment. Experiments are conducted indicated in complete array their effects finally data is analysed to determine the effect of different parameters on the performance measure. Primarily taguchi is reduces variation of product or process to improve quality.

1.2: Experiment parameters:

Polishing parameters like rotational speed, polishing time, grit size, voltage, axial load, pH value, tool geometry, material properties, tool conductivity are some of the parameters.

II. LITERATURE REVIEW

In [1] surface topography analysis of EPDAP AISI316L stainless steel is studied. They made comparison between EPDAP and micro energy EDM to analyse the improvement in surface finish. It was reported that surface roughness value obtained 0.52μm by EDM process; however there is considerable improvement in EPDAP, surface finish was found Ra value 0.068μm.

In [2] during EPDAP of ss316L specimen observed similar trends as Rayate et al in 2010 that as the polishing continued for more time, some of the abrasive particle inside nonwoven fabrics loose their cutting ability and become dull. Similarly Gaike et al has observed that surface roughness and applied load are directly proportional. This is due to an increase in axial load on the workpeice causing increase pressure on the workpeice. Result more abrasive penetrate work surface, hence more friction between polishing tool and workpeice, results in increased surface roughness. In terms of as rotational speed increases from 800 rpm to 1500 rpm Ra declines. Rotational speed 1000rpm yields better result in terms of surface roughness.

In [3] authors conducted EPDAP experiment on SS 304 specimen, they found that for certain limit surface roughness Ra slightly increased after 10 min of polishing, also found that surface roughness increases as applied load increases.

In [4] authors has conducted EPDAP experiment on stainless steel 316l specimen, they observed that surface roughness Ra rapidly reduced to 0.08μm in the initial 2 min and then to 0.03μm as the polishing time increases further from 2 to 8 min. Further Ra reduced from 0.4μm for the increase in axial loading from 2N to 11N, however effect increase in axial loading from 11N to 14N lead to an increase in surface roughness. Effect of tool rotational speed on Ra decreases it from 0.5 to 0.03μm as tool rotational speed increases. As polishing feed rate increases from 60 to 300 mm/min, Ra increases from 0.02 and 0.04μm and beyond 200 mm/min Ra remains constant. However voltage does not significantly affect the surface roughness Ra.

In [5] experiment EPDAP polishing of zirconia ceramics studied effect of concentration of Al_2O_3 particle in electrolyte solution containing HCL. They observed that, as the particle concentration increased by keeping other parameter constant the deposition particle increases (12- 14%) after this it shows declining trend due to increase in viscosity of electrolyte solution affecting electrophoretic mobility of the particles. Al_2O_3 particle size 0.05μm and 0.30μm reported that applied voltage increases the deposition of particle on the electrode increases.

In [6] electrophoretic deposition of alumina on stainless steel from aqueous solution conducted experiment at constant voltage varying range 150V to 300V using DC supply, deposition time 2 min to 20 min, electrode were dried at room temperature 24 hrs. after deposition result – EPD yields of alumina on stainless steel from 30wt% suspension in butan-1-ol with varying applied voltage, deposition time 5 min.

In [7] experiment Zirconia specimen with alumina abrasive particles. They observed that the surface roughness decreases first and then increases, as axial loading becomes higher.

In [8] electrophoretic deposition of carbon nanotubes (CNT). A CNT film that has been coated and infiltrated with SiO2 nano particles obtained by CO^- electrophoretic deposition from aqueous suspension was studied.

In [9] EPD experiment on carbon nanotubes; they found that EPD time influence the thickness of zeolite film. The perfect time for this experiment is 5s.

In [10] finishing effects of spiral polishing method on micro lapping surface. The mechanism and mechanics of EPDAP process has been studied in the past by very few researcher that including study, Tusi et al studied electrophoretic deposition of SiC particles to polish Stainless Steel. They observed improvement in surface finish (R_a) from 0.5 μm to 0.02 μm in 8 min.

In [11] study of electrophoretic of zirconia ceramics using porous anodic film as binder of ultra fine silica abrasives.

In [12] experiment of polishing of AISI 304 steel found that when rotation speed of polishing tool increases from 1000rpm to 1500rpm, the percentage reduction in surface roughness (PRSR) increases from 94.26% to 95.22%. However when the speed gets higher beyond 1500 rpm PRSR declined.

Table: 2.1:- Summary of Literature Review

Author	Workpeice material	Polishing tool/wheel	Input parameters			Output parameters	Critical findings
			V	T	L		
Tani, et al. (1997)	Silicon wafers (8'' diameter)	Grinding wheel and colloidal silica	90 volts	30 min	-	Surface Roughness	Suppression of Electro osmosis enabled a mirror surface finish of 10.4 nm R_a with no scratches.

Ikeno, et al. (1994)	Brass	Brass, colloidal silica and PVA bonding agent.	10 volts	-	-	Surface roughness(R_y), growth rate of deposition layer	Surface roughness(R_y), growth rate of deposition layer
Tsui, et al. (2006)	SUS316L	Copper	10 - 50volts	2 to 12 min	2 to 14 N	Surface roughness	Mirror-like surface finish with an R_a of 0.03 μm in 8 minutes.
Gaikhe, et al. (2011)	AISI 316L stainless steel	Copper	20 volts	10 to 15 min	12 to 20 N	Percentage reduction in surface roughness	R_a obtained is 0.04557 μm and surface reduction of 93.92 % is achieved.
Abdullah, et al. (2008)	High purity titanium foils	1200 grit size abrasive paper	5-30 volts	-	-	Thicknesses of green TiO_2 films on Ti substrates.	Continuous rutile coatings in the thickness range 1-13 μm were produced.
Abdoli, et al. (2010)	Stainless steel electrodes in form of sheets having 300 μm thickness.	Aluminum nitride powder particle size of 2.9 μm and 50 nm.	100 volts	-	-	Weight of the deposit, drying behavior of coating.	Crack free surfaces were obtained for micro sized particles. The layer became denser as deposition time increased.

III. CONCLUSION

EPDAP produces very fine surface finish with ultrafine particle as compared to grinding and lapping. Research is available on polishing of flat surface but fewer studies has been reported on inner surface polishing of Stainless steel pipes using EPDAP. AISI304 Steel is finding application in defence military and communication device such as antenna, mirrors, metallic lens and hence it is selected for exploration. Operations like combined EDM with EPDAP and EPDAP with parameters like grit size, polishing time rotational speed and voltage are to be used for the experiment and comparing in terms of surface finish along with the effect of parameters affecting surface finish are to be studied.

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