SUPERFINISHING PROCESS FOR COMPLICATED SHAPES

GRAMA Lucian, GABOR Marius, POP Cosmin
University of Oradea, The Faculty of Electrical Engineering and Information Technology,
decanat_fei@uoradea.ro, 410087 Oradea, Bihor, Romania, 1, Universitatii street,
Tel/Fax:+40 259/408100, Tel:+40 259/408104; +40 259/408204

Key words: Superfinishing, Surface, Honing

1.ABSTRACT

In the paper is presented a possibility of modeling the surface roughness obtained by superfinishing, based on cutting material volume in unit time, through the influence of process parameters, of tool and of dimensional and geometrical accuracy from previous machining process.
Based on roughness is also shown the influence of these factors in some machining processes.
The limits of mathematical modelling showed in the paper is about the fact that wasn't into account two parameters with great influences on the surface finish: the granulation of abrasive stones and pressure between tool and workpiece surface which have influences especially on the process machining efficiency.
Due to the great demands regarding the surface roughness which has a great influence on the service life and reliability of parts and the researches of the technical and economical performances of finishing processes were made to optimize the process parameters and constructive parameters of the abrasive tools.

2.INTRODUCTION

The removal of superfluous material plays a key role in materials processing and hence abrasive as well as cutting processes are of vital importance in this regard. Product performance that are usually sensitive to surface quality are fatigue strength, corrosion rate, stress corrosion cracking, tribological properties such as lubrication, friction and wear, magnetic properties(memory discs). Hence the surface quality assumes greater importance for proper functioning of any product with due importance to aesthetic aspect also. This necessitates production of required surface texture to perform a specific function. Surface topography influences both mechanical and physical properties, apart from affecting functional applications of contacting parts. Improved product performance, minimum running in period, and enhanced product life all are highly surface dependent, since most of the failures are surface originated; achieving high surface finish is a challenging task with the development of high strength and hard to machine materials. In order to overcome the limitations of traditional finishing processes in meeting the surface finish of internal passages of high end technological products, some new approaches are called for. The process should employ some new form of "tool" that can assume the shape of the passage/hole and flows over the surface(1-2).
Extrusion honing (EH) is one such approach; a flexible honing process that can address these problems to greater extent with consistent results. It may be used for removing internal and external burrs, smoothing flow paths and surface enhancement. It is an unconventional finishing process that removes small quantities of material by flowing semi solid, abrasive impregnated putty, under pressure through or across work piece. It can finish, polish, or radius and induce compressive residual stress on the surface (3-5). Inaccessible, intricate, complex shapes, and difficult to machine internal or external surfaces can be finished with this process. The abrasion occurs only where medium flow is restricted. The other areas remain unaffected. Any product with a passage to flow could be a candidate to this process. It can process a selected passage or many passages of a component or more. Multiple holes, stepped passages, tapered holes can be finished with this process. Removal of sharp corners enhances the edge quality. It is a proven, reliable and accurate method that provides consistent results. Aerospace components, I.C. engine

manifolds, hydraulic components, electronic and biomedical parts are some areas of application of the candidate process. Improvement in air flow and fluid flow characteristics for injector nozzles of cast automotive engine components is one of the new applications. Traditional methods of finishing of manifolds involve cutting the manifolds, polishing it, and then rewelding. Extrusion honing eliminates these, by forcing flowable abrasive medium through the entire manifold. Besides providing a polished surface it produces a surface lay that is parallel to air flow which results in increase in air flow velocity that contributes directly to significant power gains. This process is not limited to engine manifolds alone. Carburetors, water pumps all are suitable as they all have internal passages.

3.EXPERIMENTAL

The work material considered in the current investigation is AISI 4419 steel which is used for manufacturing highly stressed components used in construction of engine and vehicles as well as gears and pumps etc. The carrier medium, apart from rheological properties has to possess properties of better grit retention, bond uniformity, and higher abrasive exposure for satisfactory performance. A select grade silicone polymeric medium is thoroughly mixed with a volume fraction of 25% SiC abrasives of 36 grit size using a polymer mixing device. An experimental set-up was designed and developed to implement extrusion honing process(Fig.1). Details of work material, carrier medium, process parameter used in the trials are presented in Table1.

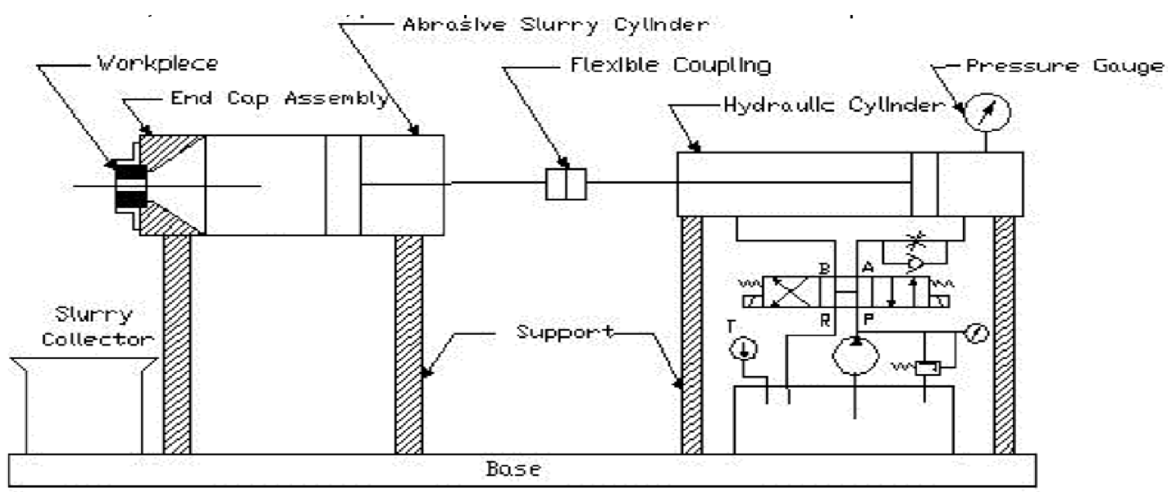


Fig. 1 Schematic Diagram of the Extrusion Honing Machine

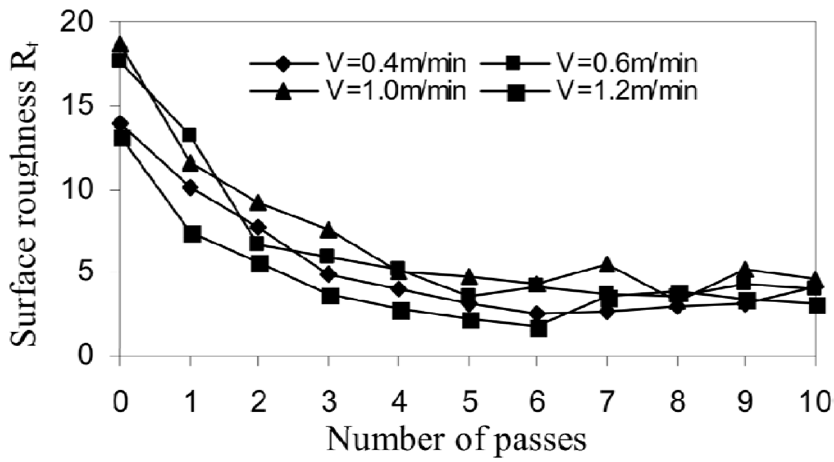
Work material		Carrier medium		Process parameter	
AISI 4419 steel		Silicone polymer			
Carbon (%)	0.18-.0.23	Appearance	Translucent	Temperature	Ambient
Tensile Strength (MPa)	431	Density (kg/m^3)	1.13X10^3	Volume fraction	0.25
Machinability (%)	65	Viscosity(Pa.s)	20250	Velocity (m/min)	0.4-1.2

Table1. Details of work material, carrier medium, process parameter

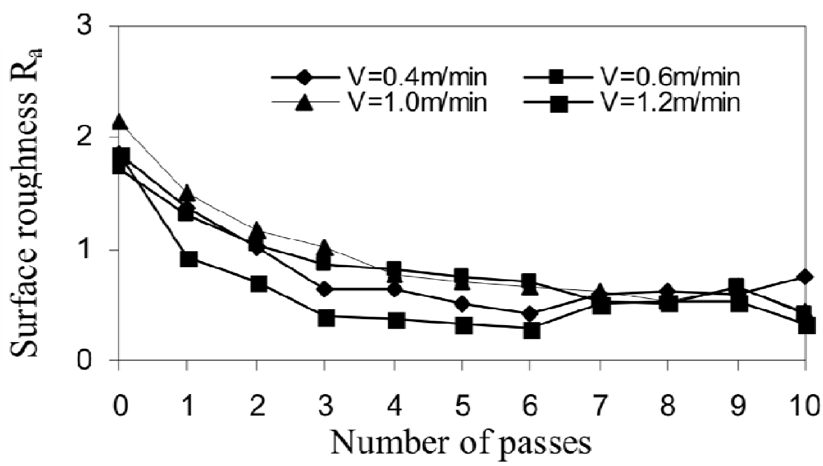
4.RESULTS AND DISCUSSION

4.1.SURFACE ROUGHNESS

Typical observed parametric influence of surface characteristics of extrusion honed AISI 4419 steel bored specimen is illustrated in Fig.2. It is seen that there is a visible / drastic reduction in Rt, Ra values during early phase of honing, followed by progressive reduction with number of passes. Removal of waviness/dominant asperities present over the bored surface during early phase of extrusion honing results in appreciable reduction in Rt, Ra values.



(a)



(b)

Fig. 2 Parametrical influence on surface roughness characteristics of AISI 4419 steel (a) Rt and (b) Ra

Typical observed variation of Rt/Ra with number of passes is illustrated in Fig. 3. In general it is seen that up to 6 passes, there is steady reduction in Rt/Ra followed by a rise, indicating that the workpiece attains a core roughness by 6 passes, after that deterioration sets in.

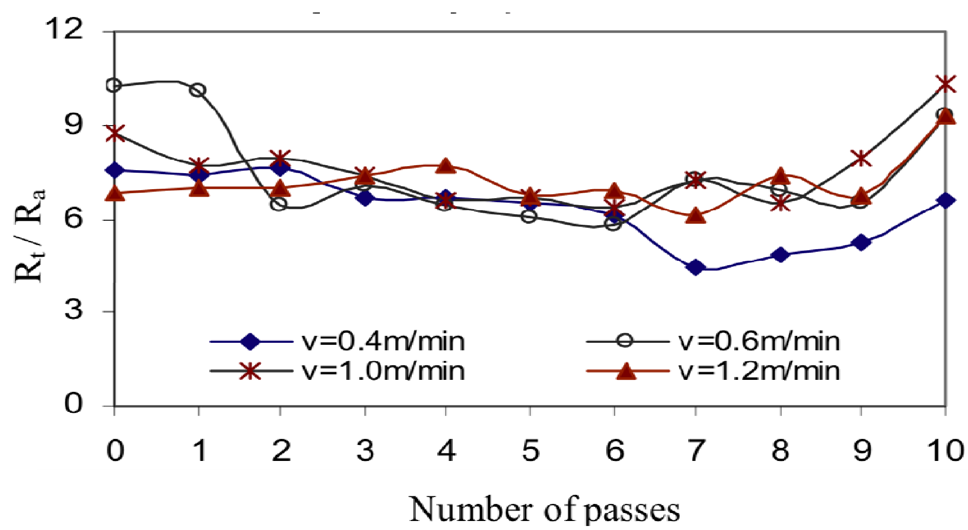
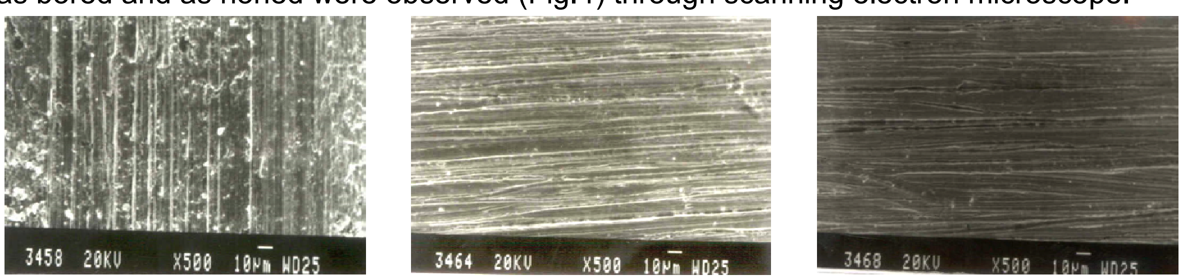


Fig. 3 Typical observed variation of Rt/Ra with number of passes

With the velocity of 0.4 m/min , there exists a steady reduction in Rt/Ra up to 6 passes, and during the seventh pass the ratio drops down to minimum and thereafter it shoots to maximum. After attainment of core roughness by the surface, the spalling of material will increase the Rt value that results in sudden rise of Rt/Ra values. Irrespective of the velocity, over a range of 3-6 passes most of these ratios are in closed range. This can be attributed to core roughness attainment during the process over this range and material spall out thereafter.

4.2.SCANNING ELECTRON MACROGRAPHS

For better understanding of the nature of texture produced by extrusion honing, surfaces as bored and as honed were observed (Fig.4) through scanning electron microscope.



(a) as bored (b) after 5 passes (c) after 10 passes

Fig.4 Scanning electron macrographs of surface at different stages of extrusion honing

After extrusion honing fairly uniform lay pattern with localized folding of asperity can be seen. Further, due to continuous honing, surface has experienced localized discrete glazed texture.

5.CONCLUSION

The major conclusions drawn based on the trials conducted are: a progressive improvement in surface roughness parameter is seen till eighth pass, beyond which the surface starts deteriorating; it is seen that up to 6 passes, there is steady reduction in Rt/Ra followed by a rise, indicating that the work piece attains a core roughness by 6 passes, after that deterioration sets in, and extrusion honing produces fairly uniform lay pattern.

6.REFERENCES

1. A.R.Jones., J.B.Hull., "Ultrasonic flow polishing", Ultrasonics , 36 (1998) 97-101

2. Chris J. Evans., James B. Bryan., "Structured", "Textured" or "Engineered" Surfaces Annals of the CIRP, Vol. 48/2/1999 541-556

3. J. Matechen, John., "Advantages of abrasive flow machining", Abrasives, (1995) 20-21

4. L J.Rhoades., H. A.Clouser., "Abrasive Flow Machining", ASM Metals Handbook,16 (1989) 514-519

5. R.E. Williams, K.P.Rajurkar, "Stochastic Modeling and of Analysis of Abrasive Flow Machining", Trans. ASME. Journal of Engineering for Industry 144 (1992) 74-81

6. Y. Matsumoto, F. Hashimoto, G. Lahoti, Surface integrity generated by precision hard turning, Ann.CIRP48/1(1999)59–62.

7. W. Koenig, R. Komanduri, H.K. Toenshoff, G. Ackeshott, Machining of hard metals, Ann. CIRP33/2(1984)417–427.

8. W. Koenig, A. Berktold, F. Koch, Turning versus grinding—a comparison of surface integrity aspects and attainable accuracies,Ann.CIRP42/1 (1993)39–43.