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THE ABRASIVE FLOW MACHINING MODELLING

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ABSTRACT: *The report deals the abrasive flow machining process modeling and done the simulation of the problem with CFD. More surface finishing is achieved by abrasive flow machining process. In this report, 2D ANSYS design is made to verify the radial stress and axial stress during machining process. Metal removal formulation has been modified as per given assumptions and conditions to derive new formula. Finally analyzed model in ANSYS to compare with previous done work and verified result that current work is going right direction.*
The surface removal and metal removal rate were calculated for titanium work piece with aluminum oxide as abrasive with grade abrasive media.

KEYWORDS: *MRR (metal removal rate), AFM (abrasive flow machining), aluminum oxide, polymer, titanium work piece*

INTRODUCTION

Abrasive finishing technique (methods) are created to minimize problem like cost of work and obtained high surface finish. Abrasive finish technique passed on broad number of bleed edges, Abrasive finishing process are regularly used due to capacity of finishing distinctive geometries (i.e round et cetera, level) with desired surface finishing and dimensional correctness.
Abrasive finishing techniques also remove the human effort and provided the high quality surface finish.

ADVACED ABRASIVE FINISHING METHOD

Micro and nano level finishing need expensive equipment and method because traditional finishing process cannot handle the complicates and meet the finishing level and Also it is more time consuming methods.
Abrasive flow machining is one of the new abrasive process, It have extensive usage; **MRR, MFP, MAF** are also some process which need not be discussed.

LITERATURE REVIEW

Abrasive flow machining process mechanism

- Williams and Rajurker [1]: There are performed additional experiments to know pressure of extrusion on metal removal rate and surface finishing and the effort viscosity of medium.
- Przyklenk [2]: There are performed experimental investigation, suggests hat, metal removing rate capacity of a abrasive medium with 300 times more viscosity than lower one. The factor affecting metal removing rate and velocity of medium- size, abrasive loading and medium viscosity

ABRASIVE FLOW MACHINING PROCESS

Abrasive flow machining (AFM) Process is used for edge contouring, surface finishing and debarring. Abrasive flow machining is capable of surface finishing areas. Which is not easy to reach by traditional methods by mixing the abrasive particle with polymer abrasive flow machining produces repeatable, predictable results and uniform on many finishing operation?

The medium in abrasive flow machining process play an important role. It should have visco -elastic properties and non sticky.

Aluminum oxide, boron carbide, carbine, silicon and diamond are generally used as abrasive gains in this process.

ABRASIVE FLOW MACHINING SYSTEM

Abrasive flow machining system consists of three different elements i.e Medium, Tool and Machine Medium: polymer based very high viscous medium to hold abrasive particle Tool: Holding and locating device

Machine: The design and size of abrasive flow machine

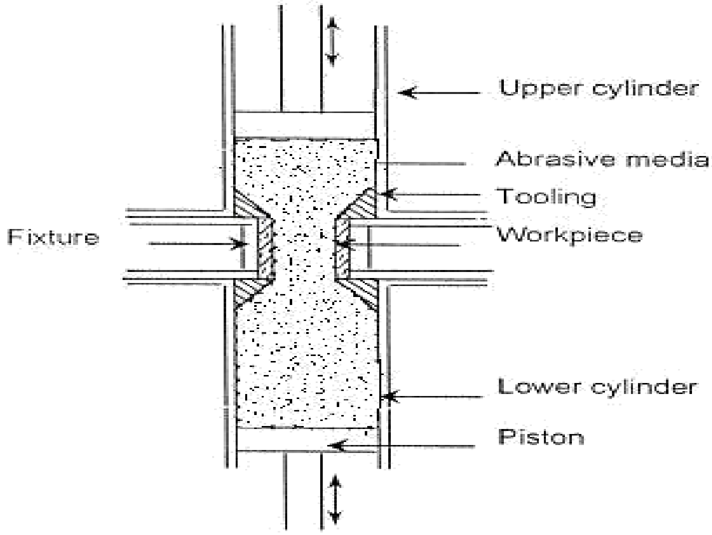


Figure No. 1: Abrasive Flow machining parts

FEATURE

- Polishing and debarring any complex areas is done by the media.
- Very high level of accuracy is achieved

APPLICATION OF AFM

Figure No. 3: AFM of some complex holes

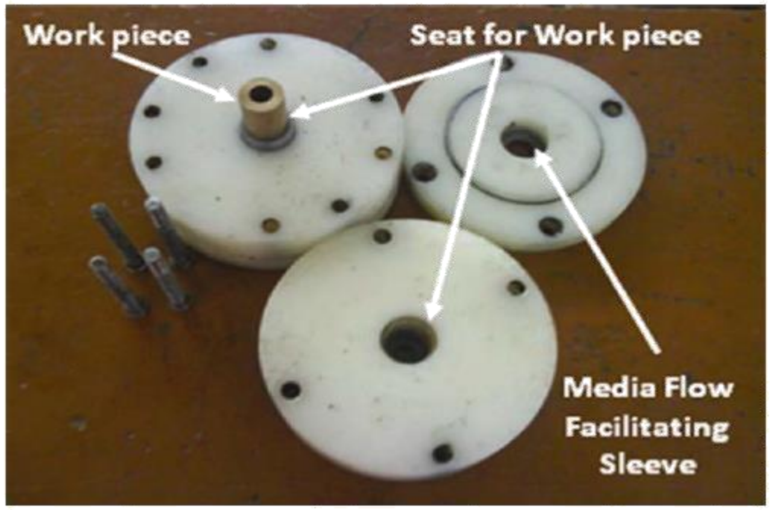


Figure No. 4: Tooling for AFM

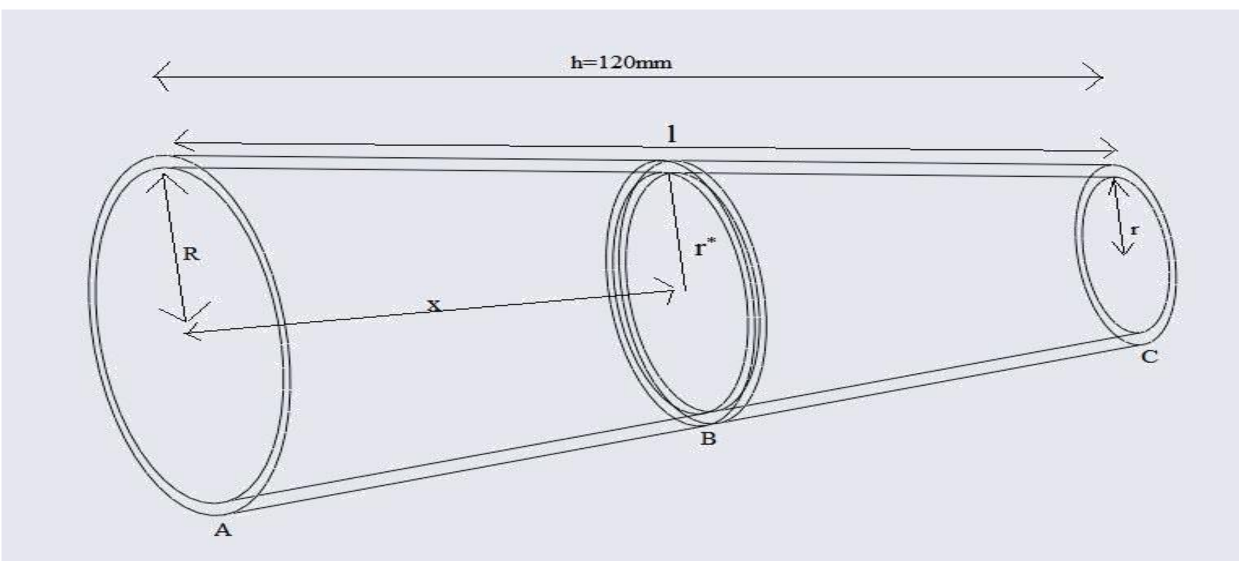
METHODOLOGY

A polymer based material is mixed with additives and abrasive particle, which is pushed into the work piece and it depending upon the setup. It may be pushed in one or multi pass.
The medium finish the work piece which medium travelling on the work piece. The fixture and tooling should be designed carefully.

EXPERIMENTAL SETUP

The all experiment took place in the mechanical engineering workshop department at I.T.S.ENGINEERING COLLEGE, BHIWANI, HARYANA, over a period of 7 months.
The experiment work involved test conducted with abrasive flow machine. In abrasive flow machining modeling, the metal removing rate on the work piece is high and also surface finishing is very high.

OBERVATION AND CALCULATION



In the present study we have taken this work piece and try to obtain a method to get MRR theoretically.
We know from eq. 4 the depth of indentation is $t = Da/2 – (Da^2/4 – F_n/\pi H_w)$

Radius of Indentation

For Da=40μm; Hw = 98; Fn= 4.308 x 10^{-10} From eq. 4 we get.

Fn= πHwr^2.

Radius of indentation Ri = 1.92 x 10^{-6} m.

4.2.2 Depth of Indentation

With the above values we can get the depth of indentation from eq. 4.

t = **3.559 x 10^{-8}.**

4.2.3 Calculation of MRR

The MRR of a single grain taking into account that the length of the work piece is the length of the grain traversal is same as that in eq. 9.

But when it comes to overall MRR a bit of changes are there.

Let the volume fraction of abrasive be x. then x% of the media is covered with abrasives.
And volume of unit thickness of media on work piece walls is = $\sqrt{h^2 + (\ \ -\ \ )^2}\ \pi(R+r)$.

R= 0.03 m

r= 0.015m

Da= 40μm

h= 0.12m

t= 3.559 x 10^{-8}

So MRR is calculated as = 55.23 x10^{-14}.

RESULTS AND DISCUSSION

- The CFD analysis gave a valve of 0.15 pa for radical stress. The crucial factor of the problem was calculated of proper indentation force or radial sress.
- The errors within the tolerance limits.
- The result is verified with previously done work on a cylindrical work piece.

LIMITATION

- Assume the medium is perfectly homogenous.
- The active particles assuming a unit thickness of medium on the inner wall.

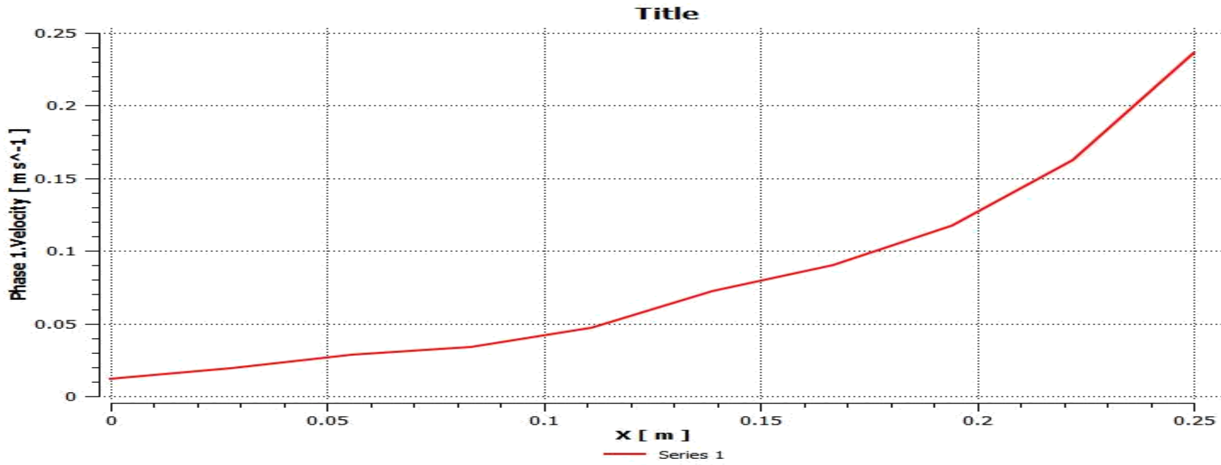


Chart 1.phase velocity vs position

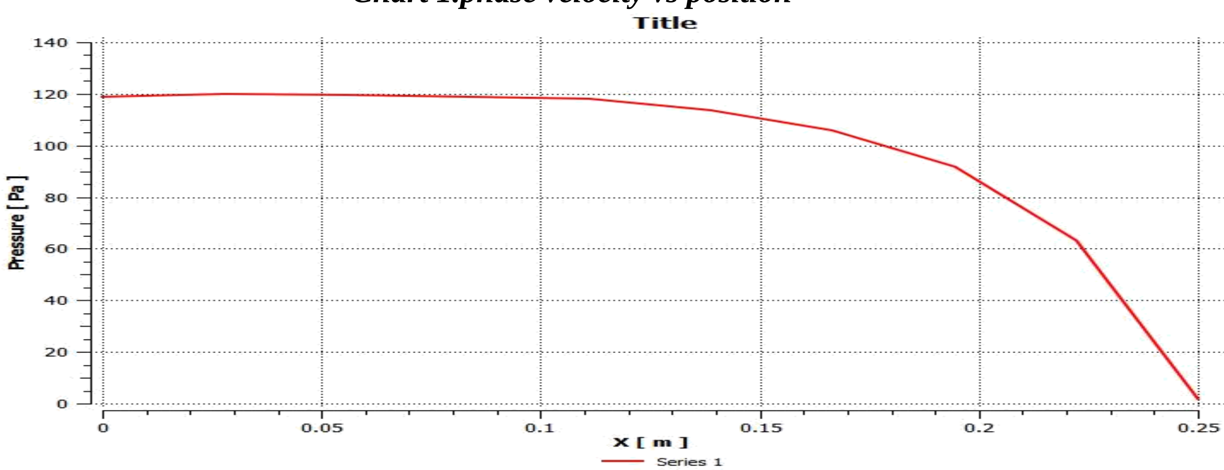


Chart 2.pressure vs position

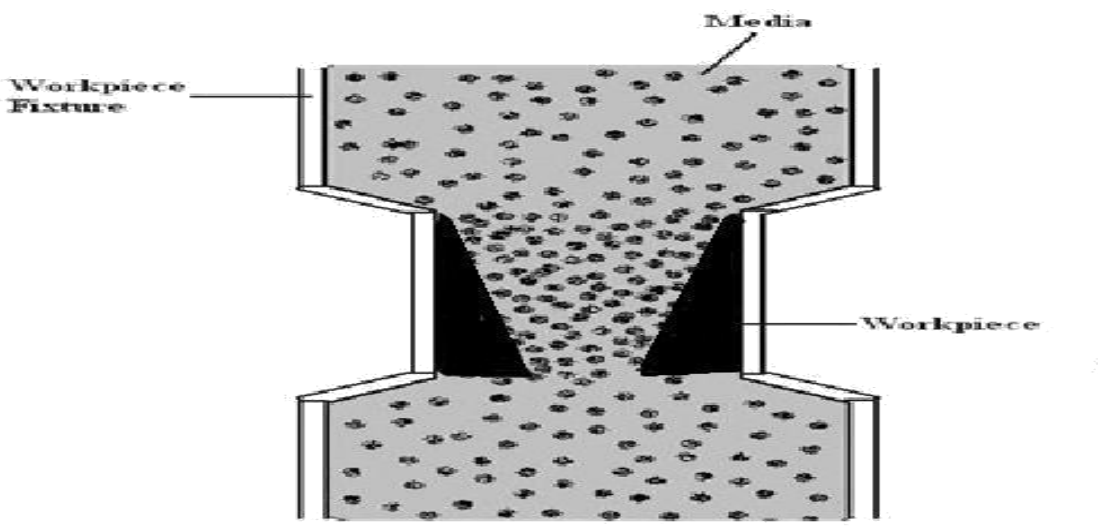


Fig. Work piece with fixture

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CONCLUSION

The following conclusion summarized for the work presented in this thesis.

1. The radial stress and axial stress at the work piece were found through CFD analysis
2. The material removal rate is calculated from this simulation.
3. The material removal rates were formulated from this simulation.
4. The result came with very little error due to taken assumptions during their calculations.
5. Future study into the modification and model can be done to the current model.

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