

## Research Article

## The effect of change in design of vibrating chamber for An Experimental analysis for sea sand as an Abrasive material in an Abrasive Jet machining Process for mild steel Nozzle

N. S. Pawar<sup>A\*</sup>, R.R. Lakhe<sup>B</sup> and R. L. Shrivastava<sup>C</sup>

<sup>A</sup> Department of Mechanical Engg, Government Polytechnic Nagpur, Maharashtra state, India

<sup>B</sup> Director, shreyas Quality Management system, Training and consultancy Maharashtra State, India

<sup>C</sup> Professor in Mech Engg Dept., Yashwantrao Chavan college of Engg. Nagpu

Accepted 10 January 2014, Available online 01 February 2014, **Special Issue-2, (February 2014)**

### Abstract

Invention was made to create the needs. Abrasive jet machining is also known as abrasive micro-blasting and it is traditional process. A number of investigations were carried out by imminent personality but no detailed information and design has provided about design of vibration chamber or mixing chamber. This change in shape gives better turbulence to abrasive particles and velocity of abrasive particles. This non sticking characteristic also gives the better effect of erosion of material on work piece and scattering of particle towards objects. The parameter material removal rate, standoff distance, variable pressure used for this experimental study. The work carried out with traditional nozzle like tungsten carbide, silicon carbide which available in market and new proposed mild steel nozzle. Powder flow rate is controlled by the amplitude of mixing chamber. The performance of sea sand in vibrating chamber show by using polynomial where R-square values very near to 1 i.e. 0.9687 using variable parameter

**Keywords:** vibrating chamber, Abrasive Jet Machine, sea sand, Nozzle, glass.

### 1. Introduction

The development of new method has always been Endeavour of engineering personnel and scientists. The main ideas behind the such Endeavour's have generally been the economic consideration, replacement of existing manufacturing methods by more efficient and quicker ones, achievement of higher accuracies and quality of surface finished, adoptability of cheaper material in place of costlier ones and developing a method of machining such material cannot be easily machined through the conventional methods etc of all those reasons. This process consists of directing a stream of fine abrasive grains, mixed with compressed air at pressure ranging from 5 kg/cm<sup>2</sup> to 12 kg/cm<sup>2</sup>. These particles impinge on the work surface at high speed and the erosion caused by their impact enables the removal metal.

The relative motion between the work piece and nozzle is obtained by cams, the compressed air along with the entrained abrasive particles of size 100-150 micron passes on the nozzle having its tip of tungsten carbide, alumina, and mild steel nozzle. Fine grained sea sand abrasive of grain size 100 to 150 microns powder is filled in a vibrating chamber, called mixing chamber. The air at high pressure is forced into this chamber, the pressure of gas varying from 5 to 12 kg/cm<sup>2</sup> it is passed through the mixing chamber vibrating at 50 c/s. from the mixing

chamber, The diameter around of 1 mm to 2 mm with a velocity of 150-300 m/ sec. This process is mainly employed for such a machining work which is otherwise difficult by referring no. of researcher's studies. This high velocity jet is then directed on the work piece surface and small pit of material gets loosened and then removed due to flow. Again the fresh surface gets exposed to the jet for further erosion. Torsional vibration is angular vibration of an object commonly a shaft along its axis of rotation. The fundamentals of vibration analysis can be understood by studying the simple mass-spring-damper model.

### 2. Vibrating Chamber as per design

As per the changes in the design of vibrating chamber we have selected the cylindrical vibrating chamber due to its several advantages. The dimension 160x110x4 (mm). The high compressed air inside the chamber which the cylinder walls and cover plate have to withstands. It was design and selected in a such way that the cover plate and cylinder wall should not bend due to the internal pressure and total leakages were avoided .and check the dimensions by considering the cover plate and the cylinder wall subjected to uniform pressure. The equation from design data for uniform pressure

$$T = a \times b \times c_3 \left[ \frac{p}{\sigma_1 (a^2 + b^2)} \right]^{1/2}$$

Where, p = uniform pressure, a = length of the plate in mm, b = breadth of plate in mm, c<sub>3</sub> = co-efficient = 0.49 from table

\*Corresponding author: N. S. Pawar

$$T = 0.49 \times 230 \times 160 \times [0.8 / \{(2302 + 1602)\}]^{1/2}$$

$$T = 4.85 \text{ mm}$$

$$T = 5 \text{ mm}$$

Vibrating chamber is a cylinder piece of M.S. pipe with rectangular base and head. The cylinder of dimension 160 x 110 x 4 mm was taken from the pipe having the same size and shape. The rectangular M.S. plate of dimensions (235 x 185 x 4 ) was also cut from M.S. sheet then by shaping the edges is made right angle. Two holes of inlet of compressed air and one hole for outlet are provided The design vibrating chamber has shown below.

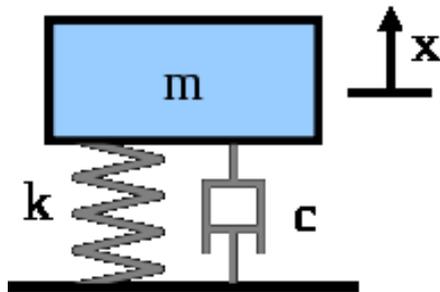


Fig.1. Mass spring damper model

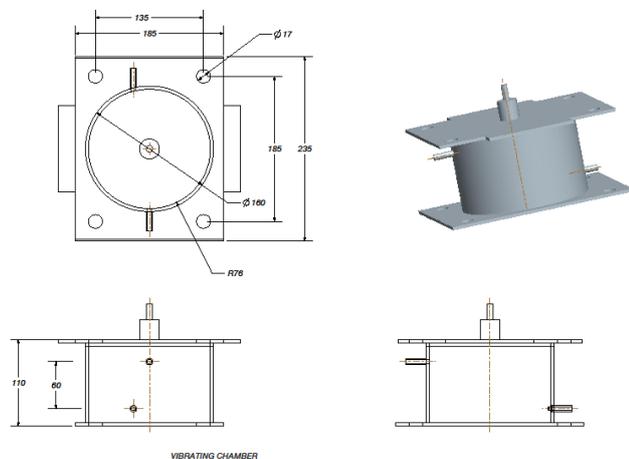


Fig.2: View of vibrating chamber

### 3. Cam for vibration chamber

Cam followers come in a vast array of different configurations, A cam follower, also known as a track follower, is a specialized type of roller bearing designed to follow cams.

- The eccentricity of cam = 10 mm
- Lift of follower = 20 mm
- Amplitude of Vibration = 10 mm
- External Diameter of cam = 60 mm
- Diameter of Shaft = 20 mm
- The thickness of cam = 16 mm
- External Diameter of Roller = 20 mm
- Thickness of Roller = 16 mm
- Pin Diameter = 16 mm
- The follower is roller follower
- External Diameter = 20 mm
- Thickness = 16 mm

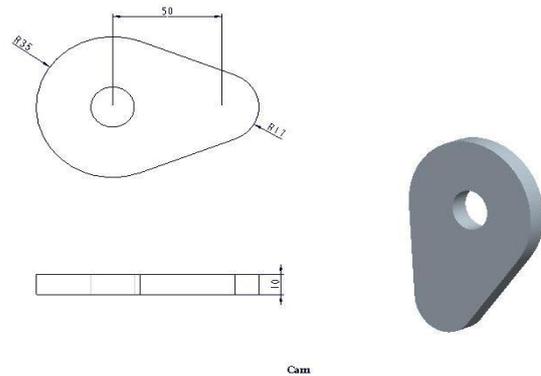


Fig.3: cam for vibration chamber



Fig.4: Experimental set up

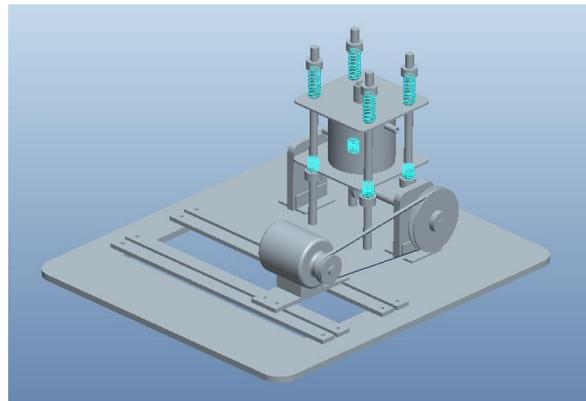


Fig.5: View of Experimental set up

Other operating specific are as follow:

- 1] Max. Working pr. = 5 to 12 kg /cm<sup>2</sup>
- 2] Design pressure = 60 kg /cm<sup>2</sup>
- 3] Factor of safety = 6
- 4] Stress across section of pipe is uniform (when d/t > 20)
- 5] Design material = mild steel
- 6] Allowable stress = 700 kg /cm<sup>2</sup>

Thickness of the cylinder can be found by Lames equation

$$t = \frac{1}{2} [ \{ (f_1 + P) / (f_1 - P) \} - 1 ]^{1/2}$$

$$= \frac{1}{2} [ \{ (f_1 + 60) / (f_1 - 60) \} - 1 ]^{1/2}$$

$$= 2.16 \text{ mm}$$

On the safe we will use thickness of cylinder as 3 mm.

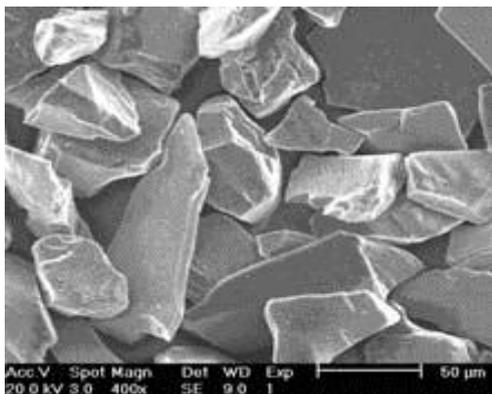


Fig.6: Photograph of sea sand

Specification of sea sand

Silica sand:

- Grain size = 100-150 micron
- Physical specification = 1.0 -2.5 mm
- Uniform coefficient = 1.3 - 1.7
- Specific gravity = 2.67
- Mohr's Hardness = 7
- Density = 105 – 115 lbs / foot cubic

4. Observation Table

- 1) Nozzle a) Material = Mild steel b) Diameter = 2.0 mm
- 2) Abrasive a) Material = aluminum oxide b) Grain Size = 100-150 μm
- 3) Work piece a) Material = Glass b) Thickness = 2 mm

Abbreviation used in this paper is  
 MRR-material removal rate gm/sec  
 PFR-powder flow rate gm/sec  
 SOD – standoff distance in mm  
 DOC-Depth of cut in mm  
 p- Pressure in kg per sq cm.

Table .1 observations for Mild steel Nozzle and abrasive

Sr. No	P Kg/cm <sup>2</sup>	SOD mm	MRR W/T = gm/sec)	PFR Wa/T = gm/sec	DOC mm
1	5	5	0.042	1.06	4.5
2	5.5	6	0.042	1.16	4.95
3	6	7	0.046	1.24	5.55
4	6.5	8	0.050	1.43	5.86
5	7.0	9	0.060	1.51	6.10



Fig.7: DOC of mild steel Nozzle

5 .Result and Discussion

The graph shows performance characteristic of MRR v/s PFR good fit for cubic polynomials where R square value is 0.9687 and the linear model for polynomial is  $f(x) = p1*x^3 + p2*x^2 + p3*x + p4$  where Coefficients (with 95% confidence bounds) value of p are  $p1 = 0.4976, p2 = -1.803, p3 = 2.183, p4 = -0.8392$

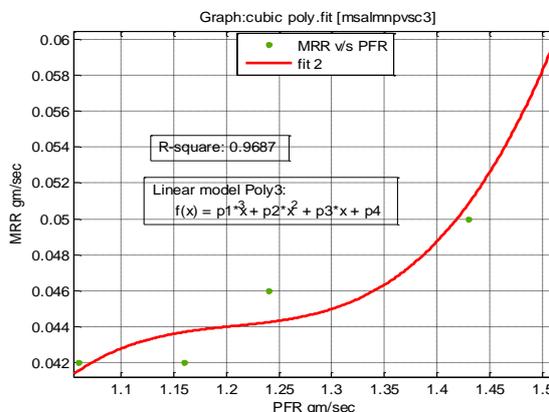


Fig.8: MRR v/s PFR

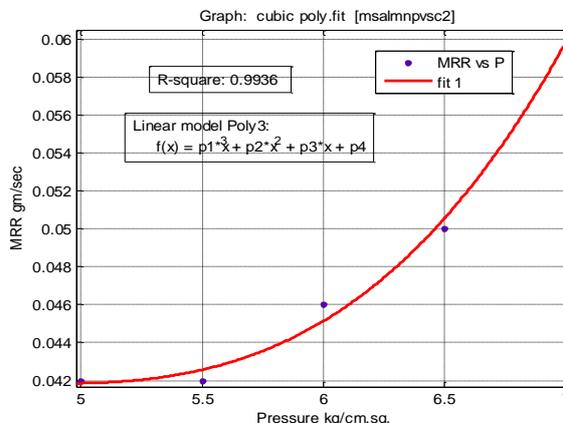


Fig.9: MRR v/s Pressure

6. Analysis

Analysis of above cubic polynomial with the 95 % prediction bounds are as follows by using 1<sup>st</sup> degree of derivation and 2<sup>nd</sup> degree of derivation.

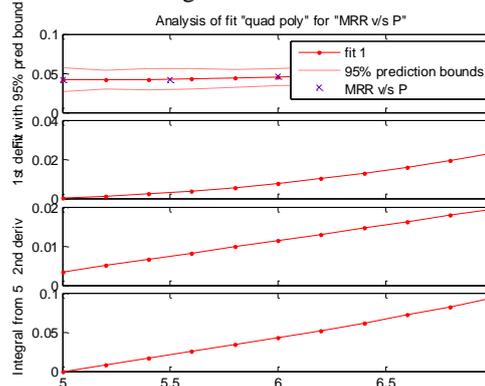
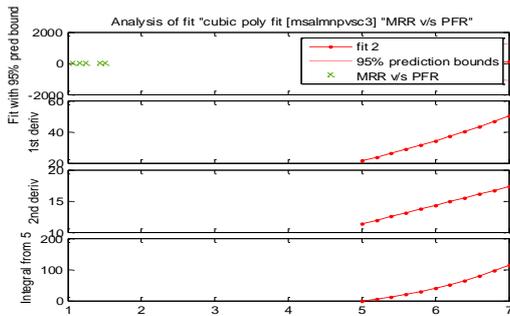


Fig .10: Analysis of fit for MRR v/s Pressure



**Fig.11:** Analysis of fit for MRR v/s PFR

**Conclusion**

- 1] As the pressure increases the material removal rate increases because of the increasing energy available for erosion.
- 2] The abrasive particles from the nozzle follow a parallel path only if pressure is increasing.
- 3] The powder flow rate is increasing as pressure increases because of proper mixing.
- 4] Life of mild steel nozzle is lesser than traditional nozzle as it is less hardness.

5] Sticking characteristic at corner is minimized due to cylindrical in shape, gives the proportionate mixing of sand abrasive and compressed air.

**References**

R. Balasubramaniam, J. Krishanan, N. Ramkrishanan, (2002), A study of shape of surface generated by abrasive jet machining, ELSEVIER, *the journal of material processing technology* 121 pg 102-106.

A.El- Domiaty, H.M.Abd El-Hafez, and M.A.shaker, (2009) drilling glass sheet by abrasive jet machining , *world academic science engineering and technology* 56, 61-67

Adnan Akkurt, (2009) the effect of material type and plate thickness on drilling time of abrasive water jet drilling process , ELSEVIER, *the journal of material and design* 30 pg 810-81

A.A.Khan, M.M. Haque, (2007) performance of different abrasive material during abrasive water jet machining of glass, ELSEVIER, *the journal of material processing technology* 191, pg 404-40

P.K.Ray, A.K.Paul ,(2 Nov 1997) some studies on abrasive jet machining, *the journal of institution of engineer (India)*,vol 68,pg 27-30,