Experimental Investigation on Dust Absorption AJM with Response Surface Regression Methods

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ABSTRACT

The contemporary era of advanced machining necessitates the production of components that preserve precision sharp edges, high accuracy, and correct dimensions. These specifications can be achieved by modern machining processes such as Abrasive Jet Machining (AJM). The experimental study was designed according to the Taguchi method. The experimental work involved altering various process factors that influence the performance of Abrasive Jet Machining (AJM). This study investigates an aluminum workpiece using silicon carbide (SiC) as the abrasive. Parameters that were examined include air jet pressure, stand-off distance, and abrasive particle size, derived using the Taguchi L27 orthogonal array, with corresponding material removal rate (MRR) values recorded. The workpiece is submerged in a liquid solution to mitigate silica dust. Analysis of 27 experimental sets utilizing Taguchi methodology reveals from the surface plots that the optimal material removal rate is achieved with an abrasive grain size of 120 grit, a stand-off distance of 1 mm, and an air jet pressure of 6 bar.

Keywords: Abrasive Jet Machining (AJM), Material Removal Rate (MRR), Stand Off Distance (SOD).

1 Introduction

AJM surpasses other methods that are not traditional owing to its distinctive advantages. Abrasive jet machining is appropriate for applications that require the concept of precision, cleaning of intricate and components that are delicate, along with polishing, deburring and cutting. Recent research has focused on comprehending removal of the materials in mechanics of Abrasive Jet Machining (AJM) and optimizing parameters for the process of various materials and applications. The selection of appropriate combinations of machining settings yields the desired surface finish and metal removal rate. Precise understanding of optimal parameters would enable a reduction in machining costs and enhancement of product quality. Air pressure, nozzle dimensions and configuration, abrasive mass flow rate, and stand-off distance are critical process parameters that influence material removal efficiency and effectiveness.

The Taguchi approach entails the selection of appropriate control parameters to achieve optimal process outcomes. Orthogonal Arrays (OA) are employed to perform a series of tests. The outcomes of these studies are utilized to evaluate the data and forecast the quality of manufactured components. This study aims to optimize the process parameters in machining to achieve superior product quality. Vineet Pawar et al. [1] conducted a comprehensive evaluation of the current research and development in the field of abrasive jet machining. The examination of the impact of abrasive flow rate on performance variables, such as material removal rate and taper angle, presents opportunities for enhancement. Inadequate architecture of the mixing chamber leads to issues such as abrasive powder stratification, powder compaction, and powder humidification. This adversely impacts the machining outcomes. Sidharth M. Nambiar et al. [2] A comprehensive report on the process parameters influencing the material removal

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rate in abrasive jet machining, this document examines the impact of these parameters on the MRR of the process. The article additionally addresses several current investigations and advancements in AJM process parameters. It is discerned from the existing literature Gas pressure, nozzle tip distance, and abrasive particle size. The extensive research and effort dedicated to this segment of non-traditional machining indicate that a comprehensive understanding of the relationship between process parameters and output necessitates the consideration and optimization of several factors to achieve superior accuracy, tolerance, and surface finish. Md Asfak et al. [3] This study provides a thorough examination of Abrasive Jet Machining (AJM), focusing on its principles, parameters, experimental analysis, and applications. It underscores the advancements and benefits of AJM in attaining precision that is high and superior finishes of the surface for intricate and components that are delicate within the aerospace, and sectors that include medical aspects and aspects that are electronical. This text discusses the essential principles, parameters of process, and methodologies of optimization for AJM, that also includes a comprehensive setup of the experiment to examine the impact of critical aspects of machining parameters and performance. Findings demonstrate that the pressure of air, flow rate that is abrasive , configuration of the nozzle, and distance of stand off are essential factors influencing removal rate of material (MRR), roughness of the surface, and precision that is dimensional. Pranav P Kulkarni et al. [4] conducted a study on the Abrasive Jet Machine, utilizing the experimental results to evaluate the validity of the suggested model in comparison to other models. As the nozzle tip distance (NTD) grows, both the top surface diameter and bottom surface diameter of the hole expand, which is a general observation in the abrasive jet machining process. As pressure escalates, the material removal rate (MRR) correspondingly rises. The current study presents a mathematical model, and the results gained have been compared with those derived via theoretical analysis. Goutam Shriyan et al. [5] conducted a study on the influence of process factors on the efficacy of Abrasive Jet Machining, detailing experimental work that involved varying numerous parameters impacting AJM performance. The experiments were structured in accordance with the Taguchi method. Experimental work was conducted by examining abrasive size, nozzle tip distance, and pressure as machining parameters to analyze material removal rate (MRR) and taper angle. The outcome was examined utilizing ANOVA. Analysis found that both pressure and abrasive size significantly affect material removal rate (MRR), but only pressure influences taper angle. Optimal individual parameter adjustments are implemented to reduce taper angle and maximize material removal rate (MRR). Sandeep Phogat et al. [6] This study provides a review of abrasive jet machining (AJM). A multitude of researchers has examined various process parameters in AJM. An experimental and semi-experimental study has been conducted to evaluate various parameters, including material removal rate (MRR), stand-off distance (SOD), and nozzle tip distance (NTD). This review study aims to delineate the scope of each experiment for subsequent investigation. A substantial amount of study is essential to devise a robust configuration and to regulate the process parameters in a manner that the desired outcome may be achieved efficiently. This work presents opportunities for further research on AJM. Kiran M et al. [7] The parametric investigation of abrasive jet machining examined the correlation between the top surface diameter, bottom surface diameter, and nozzle tip distance (NTD), revealing that both diameters rise as the NTD increases. A positive association exists between the applied pressure and the material removal rate (MRR). Abrasive jet machining (AJM) is a widely employed method in coarse machining, deburring, and surface finishing. Micromachining has shown to be an effective technology across various industries, including ceramics, semiconductors, electronic devices, and liquid crystal displays (LCDs). Ritesh Gour et al. [8] This study presents a comprehensive assessment of the analysis and advancements in Abrasive Jet Machining (AJM). The material behavior presents a significant opportunity to identify optimal values for essential controlling factors such as stand-off distance, pressure, and feed rate across various materials. AJM may represent an advanced manufacturing process with an increasing significance in meeting contemporary and future industrial requirements. Consequently, additional investigations into technological advancements are necessary. The trend in AJM projects may indicate a transition from macro to small-scale initiatives. Further reduction of the cutting area, precise erosion predictability, and dominant methodologies are current issues in Abrasive Jet cutting (AJM). An array of AJM techniques and advancements is examined. Thia Paul et al. [9] Advancement and Parametric Optimization of Abrasive Jet Machining This study has examined the application of the Taguchi technique to investigate the influence of input process parameters—namely pressure, stand-off distance, and nozzle diameter—on output responses, namely material removal rate (MRR) and taper, and has compared the results using ANOVA. Varun R et al. [10] A literature review on parameters influencing abrasive jet machining and abrasive water jet machining reveals that the significant process parameters affecting machining accuracy include nozzle design and stand-off distance (SOD), fluid and flow properties, particle type, size, shape, and hardness, velocity and jet angle, as well as traverse speed on surface profile and geometry.

2 Materials and Methods

This experimental study on Abrasive Jet Machining utilized Aluminium as the workpiece, measuring 6.5mm x 2.5mm x 1mm. The Taguchi technique stipulates that for three parameters, each with three levels, an L27 orthogonal array should be utilized for experimentation. Table 1 indicates that: Three process parameters are considered: Air Jet Pressure, Abrasive Grain Size, and Stand-off Distance.

Table 1: *Selection Parameters*

AJM Parameter	Condition
Pressure	4, 5, 6 Kgf/cm^2
Abrasive Grain Size	120, 240, 400 Grit Size
Stand-off-distance	1, 2, 3 mm
Nozzle Size	0.9 mm
Type of Abrasive Used	Silicon Carbide

EXPERIMENTAL SETUP

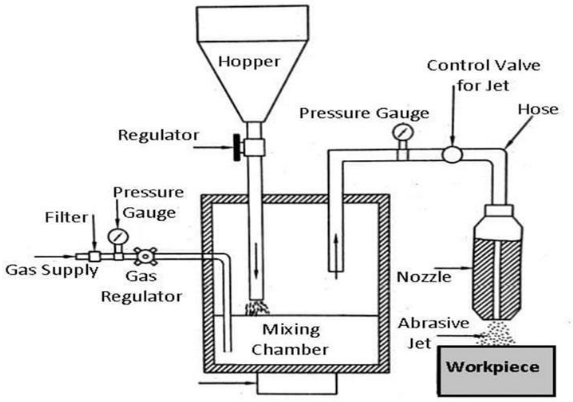

Figure 1: Experimental Setup

Figure 2: Abrasive Jet Machine

AJM is a machining technique that is a non - conventional method wherein material is eliminated by velocity stream of high gas or air combined with a mixture that is abrasive. Figures 1 and 2 demonstrate that:

A reciprocating air compressor is a positive displacement air compressor that draws air into a chamber and compresses it using a reciprocating piston. The fundamental operational principle of a reciprocating compressor resembles that of a crankshaft piston. The air enters the compression cylinder after traversing the air filter and through a suction valve. The air is subsequently pressurized via a crankshaft and piston, exiting through a discharge valve. The compressed air is subsequently kept in a storage tank.

A single-phase induction motor with a horsepower of 1.5 is utilized to vibrate the mixing chamber. The maximum revolutions per minute under loaded conditions is 200 rpm.

An electric motor speed controller regulates the motor's speed. A 4000W, 220V voltage regulator is employed for this function.

Air that is compressed from the air compressor, goes into the chamber that mixes. Abrasive particles are deposited in the chamber that mixes. Particles that are abrasive and compressed air are combined in the chamber that mixes with the assistance of a motor.

A distinct allowance is allocated for abrasive feeding. A pressure gauge is instilled into the chamber that mixes for pressure measurement. The abrasive mixture is ultimately sent to the nozzle after being mixed.

A nozzle is a device engineered to regulate the direction or properties of fluid flow, particularly to enhance velocity.

The working chamber is the location where the cutting action occurs. The mixture that is abrasive is directed through the nozzle to the workpiece. The nozzle's tip and the workpiece must maintain a minimal distance. When the abrasive particle impacts the surface, metal erosion transpires by chipping action and removal is executed.

EXPERIMENTAL PROCEDURE

Setting Up: The surfaces of the aluminum workpieces were meticulously cleaned to eliminate any pollutants that could impact the machining process. The test specimen was affixed to the worktable, and a nozzle with a diameter of 0.9 mm was chosen and connected to the AJM machine. The compressor which contained air was adjusted to the pressure that was specified and the feeder that was abrasive was loaded with SiC abrasive material. The workpiece is submerged in a liquid solution to mitigate silica dust.

Selection of Parameters : Essential process parameters, encompassing air jet pressure, grain size that is abrasive, and stand-off distance.

Machining Operation: The AJM process commenced, pointing to the jet that was abrasive at the surface of the workpiece. The period of machining was regulated to attain the specified cut of depth or feature dimension.

Analysis after machining: Following machining, the piece of work was meticulously extracted and cleansed. The surfaces that were machined were examined utilizing measuring techniques to assess the Removal Rate of material (MRR).

EQUATION USED

The removal rate of material (MRR) refers to volume of the material eliminated per unit of time during machining processes, including milling, turning, drilling, and grooving. Optimizing machining processes and enhancing productivity is key. The removal rate of the material (MRR) was quantified by recording the duration necessary for hole to drill and the volume of extracted material.

$$\text{MRR} = \frac{WB - WA}{TIME}$$

WB – weight of workpiece before machining WA – weight of workpiece after machining

Time – Machine Operation Duration

3 Analysis Of the Results

The table labelled number 2 illustrates the L27 series of findings derived from the experiments. Abrasive grain size, SOD, and air jet pressure are considered process factors at three distinct levels. The Removal Rate of the materials (MRR) is considered the response of the output. This table illustrates the correlation between MRR changes and the variations in Abrasive Grain Size, SOD, and Air Jet Pressure.

Table 2: *L27 series of observation*

Sl. No	Abrasive Grain Size (Grit Size)	SOD (mm)	Air Jet Pressure (bar)	Weight Before (g)	Weight After (g)	Time (s)	MRR (g/s)
1	120	1	4	4.5997	4.5776	13.54	0.00163
2	120	2	4	4.5997	4.5579	13.49	0.00309
3	120	3	4	4.5997	4.5467	13.46	0.00398
4	120	1	5	4.5997	4.5555	13.47	0.01070
5	120	2	5	4.5997	4.4151	13.41	0.01377
6	120	3	5	4.5997	4.5848	13.39	0.00761
7	120	1	6	4.5997	4.4274	14.35	0.00103
8	120	2	6	4.5997	4.4340	14.20	0.01167
9	120	3	6	4.5997	4.4205	13.58	0.01319
10	240	1	4	4.5997	4.4514	16.25	0.00913
11	240	2	4	4.5997	4.4489	16.19	0.00931
12	240	3	4	4.5997	4.5587	16.10	0.00225
13	240	1	5	4.5997	4.4601	15.31	0.00912
14	240	2	5	4.5997	4.5163	15.15	0.00550
15	240	3	5	4.5997	4.5563	15.01	0.00289
16	240	1	6	4.5997	4.4402	16.55	0.00964
17	240	2	6	4.5997	4.5173	16.39	0.00503
18	240	3	6	4.5997	4.5857	16.28	0.01022
19	400	1	4	4.5997	4.5250	12.56	0.00595
20	400	2	4	4.5997	4.5857	12.48	0.00112
21	400	3	4	4.5997	4.5840	12.35	0.00127
22	400	1	5	4.5997	4.5402	14.31	0.00417
23	400	2	5	4.5997	4.4438	14.28	0.01101
24	400	3	5	4.5997	4.5758	13.56	0.00177
25	400	1	6	4.5997	4.4772	13.48	0.00908
26	400	2	6	4.5997	4.5401	13.44	0.00443
27	400	3	6	4.5997	4.4591	13.31	0.01056

EXPERIMENT RESULTS

Top surface diameter of the machined holes in microns

Figure 3 illustrates the top surface of machined holes in an aluminum workpiece following Abrasive Jet Machining, utilizing three distinct settings, with measurements recorded in microns via Scanning Electron Microscope.

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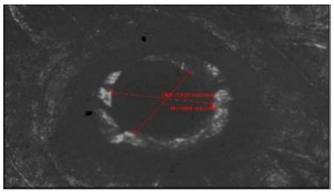
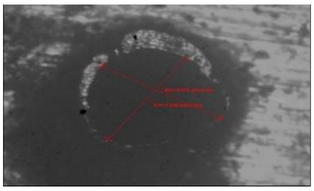
Top surface diameter of the machined holes in microns

1093µm, 980 µm



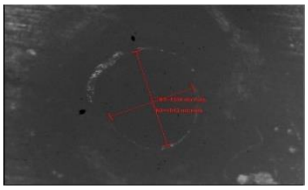
120 Grit Size, Pressure 4 bar, SOD 1mm

1476µm, 1396 µm



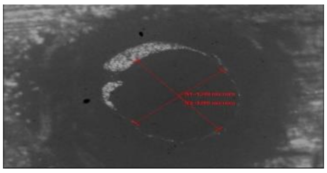
120 Grit Size, Pressure 4 bar, SOD 2mm

1350µm, 1012µm



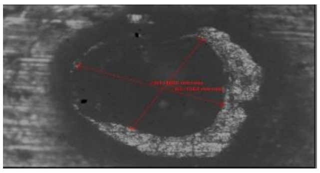
120 Grit Size, Pressure 4 bar, SOD 3mm

1349µm, 1209 µm



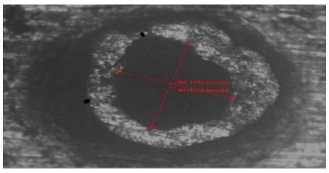
120 Grit Size, Pressure 5 bar, SOD 1mm

1645µm, 1562 µm



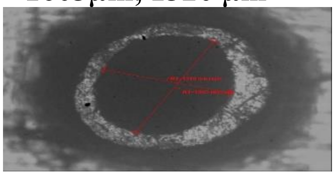
120 Grit Size, Pressure 5 bar, SOD 2mm

1319µm, 1236 µm



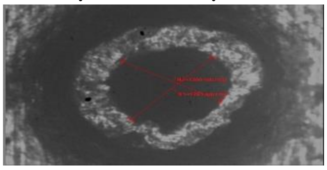
120 Grit Size, Pressure 5 bar,
SOD 3mm

1603µm, 1320 µm



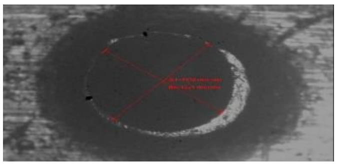
120 Grit Size, Pressure 6 bar, SOD 1mm

1293µm, 1200 µm



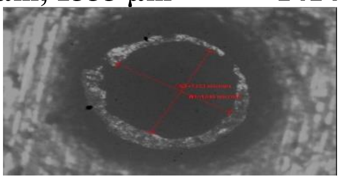
120 Grit Size, Pressure 6 bar, SOD 2mm

1530µm, 1521 µm



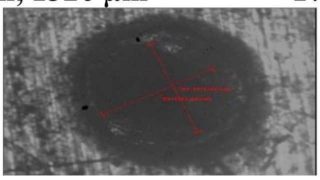
120 Grit Size, Pressure 6 bar, SOD 3mm

1346µm, 1333 µm



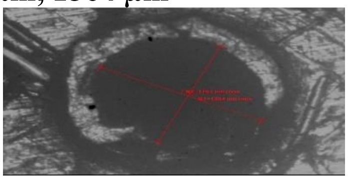
240 Grit Size, Pressure 4 bar, SOD 1mm

1414µm, 1326 µm



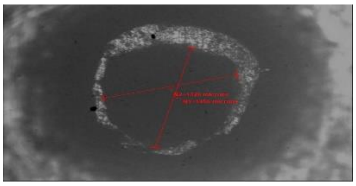
240 Grit Size, Pressure 4 bar, SOD 2mm

1762µm, 1564 µm



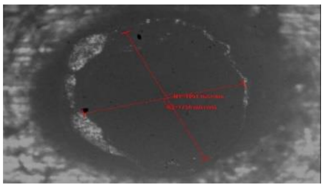
240 Grit Size, Pressure 4 bar, SOD 3mm

1456µm, 1720 µm



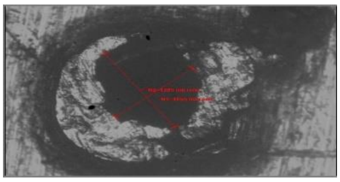
240 Grit Size, Pressure 5 bar, SOD 1mm

1951µm, 1730 µm



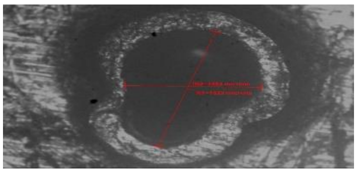
240 Grit Size, Pressure 5 bar, SOD 2mm

1285µm, 1056 µm



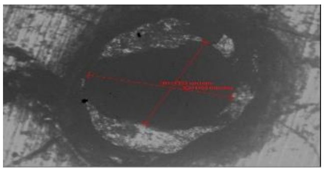
240 Grit Size, Pressure 5 bar, SOD 3mm

1822µm, 1284 µm



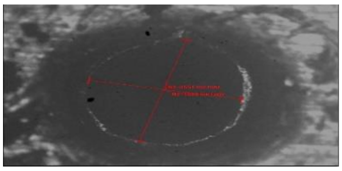
240 Grit Size, Pressure 6 bar, SOD 1mm

1535µm, 1409 µm



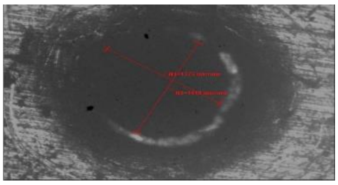
240 Grit Size, Pressure 6 bar, SOD 2mm

1624µm, 1551 µm



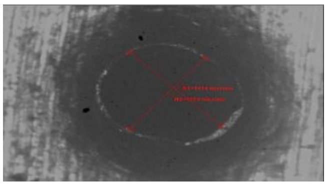
240 Grit Size, Pressure 6 bar, SOD 3mm

1419µm, 1375 µm



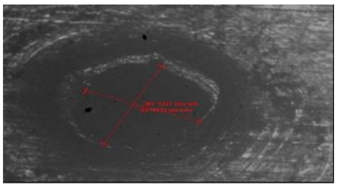
400 Grit Size, Pressure 4 bar, SOD 1mm

1414µm, 1275 µm



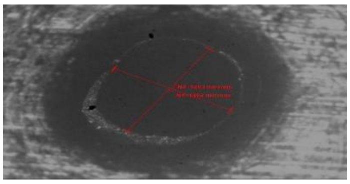
400 Grit Size, Pressure 4 bar, SOD 2mm

1235µm, 1227 µm



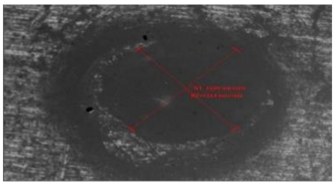
400 Grit Size, Pressure 4 bar, SOD 3mm

1402µm, 1263 µm



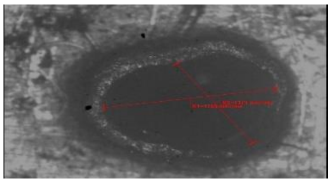
400 Grit Size, Pressure 5 bar, SOD 1mm

1554µm, 1509 µm



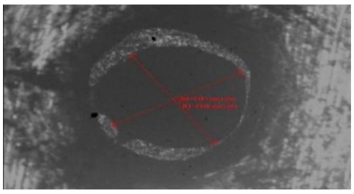
400 Grit Size, Pressure 5 bar, SOD 2mm

1799µm, 1375 µm



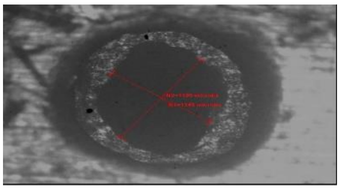
400 Grit Size, Pressure 5 bar, SOD 3mm

1401µm, 1398 µm



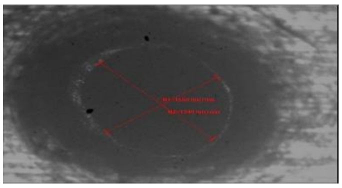
400 Grit Size, Pressure 6 bar, SOD 1mm

1346µm, 1190 µm



400 Grit Size, Pressure 6 bar, SOD 2mm

1550µm, 1340 µm



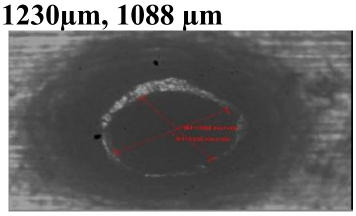
400 Grit Size, Pressure 6 bar, SOD 3mm

Figure 3: Top surfaces microscopic images

Bottom surface diameter of machined holes in microns

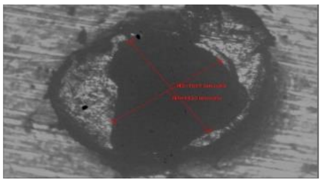
Figure 4 illustrates the bottom surface of machined holes in an aluminum workpiece following Abrasive Jet Machining, utilizing three distinct settings, with measurements recorded in microns via a Scanning Electron Microscope.

1230µm, 1088 µm



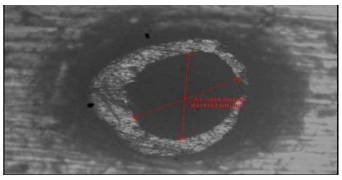
120 Grit Size, Pressure 4 bar, SOD 1mm

1531µm, 1433 µm



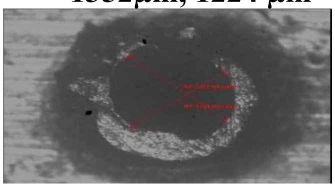
120 Grit Size, Pressure 4 bar, SOD 2mm

1249µm, 1182 µm



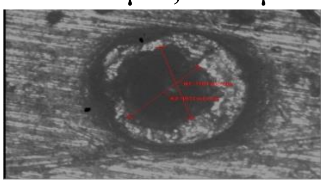
120 Grit Size, Pressure 4 bar, SOD 3mm

1352µm, 1224 µm



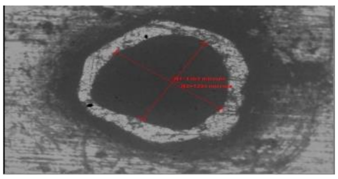
120 Grit Size, Pressure 5 bar, SOD 1mm

1104µm, 1033 µm



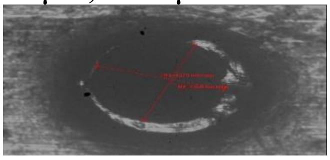
120 Grit Size, Pressure 5 bar, SOD 2mm

1362µm, 1294 µm



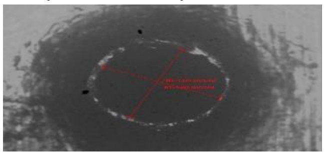
120 Grit Size, Pressure 5 bar, SOD 3mm

1370µm, 1356 µm



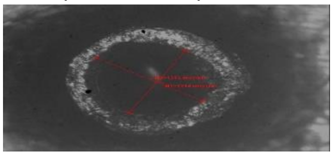
120 Grit Size, Pressure 6 bar, SOD 1mm

1325µm, 1265 µm



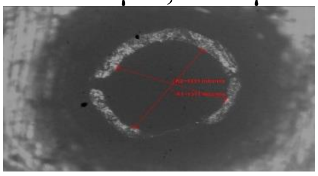
120 Grit Size, Pressure 6 bar, SOD 2mm

1315µm, 1214 µm



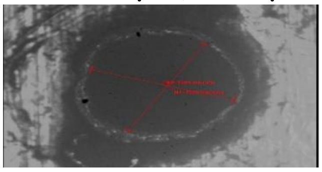
120 Grit Size, Pressure 6 bar, SOD 3mm

1371µm, 1251 µm



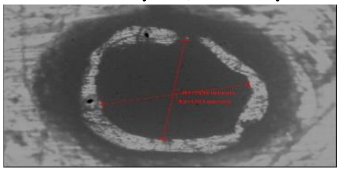
240 Grit Size, Pressure 4 bar, SOD 1mm

1599µm, 1552 µm



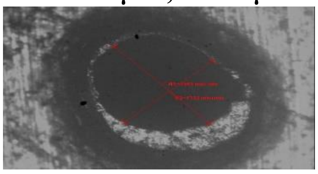
240 Grit Size, Pressure 4 bar, SOD 2mm

1550µm, 1503 µm



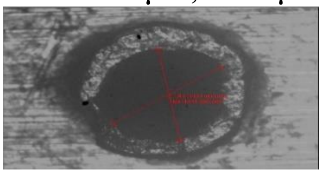
240 Grit Size, Pressure 4 bar, SOD 3mm

1565µm, 1332 µm



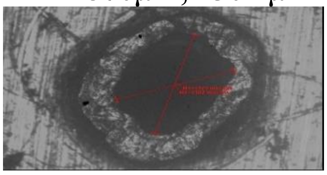
240 Grit Size, Pressure 5 bar, SOD 1mm

1433µm, 1431 µm



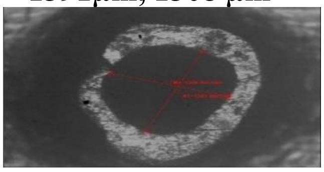
240 Grit Size, Pressure 5 bar, SOD 2mm

1570µm, 1302 µm



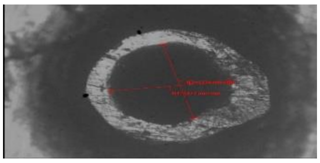
240 Grit Size, Pressure 5 bar, SOD 3mm

1391µm, 1308 µm



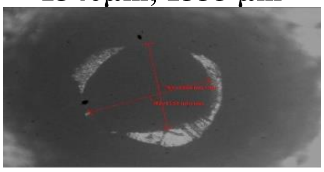
240 Grit Size, Pressure 6 bar, SOD 1mm

1277µm, 1234 µm



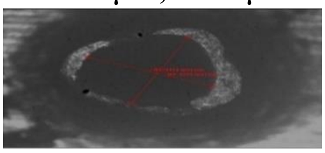
240 Grit Size, Pressure 6 bar, SOD 2mm

1340µm, 1335 µm



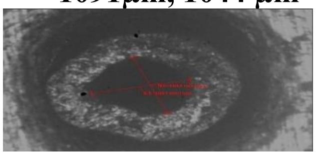
240 Grit Size, Pressure 6 bar, SOD 3mm

1412µm, 1325 µm



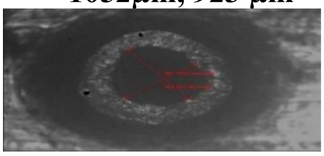
400 Grit Size, Pressure 4 bar, SOD 1mm

1091µm, 1044 µm



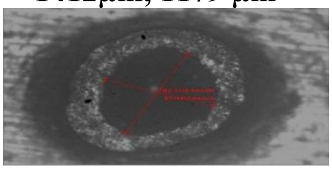
400 Grit Size, Pressure 4 bar, SOD 2mm

1052µm, 923 µm



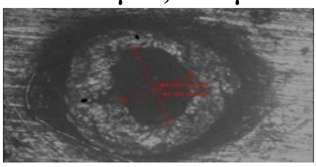
400 Grit Size, Pressure 4 bar, SOD 3mm

1412µm, 1179 µm



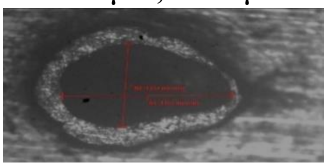
400 Grit Size, Pressure 5 bar, SOD 1mm

1231µm, 829 µm



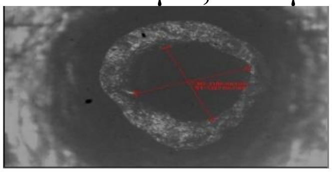
400 Grit Size, Pressure 5 bar, SOD 2mm

1753µm, 1332 µm



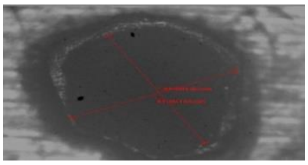
400 Grit Size, Pressure 5 bar, SOD 3mm

1223µm, 1196 µm



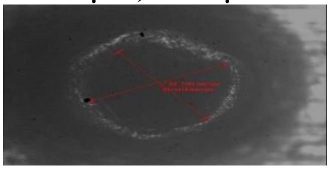
400 Grit Size, Pressure 6 bar, SOD 1mm

2014µm, 1943 µm



400 Grit Size, Pressure 6 bar, SOD 2mm

1368µm, 1479 µm



400 Grit Size, Pressure 6 bar, SOD 3mm

Figure 4: Bottom surfaces microscopic images

VARIANCE ANALYSIS

ANOVA is a method that is statical that is employed to differentiate variances among means. Table 3 indicates that: Degrees of freedom with several parameters are computed using the formula DF = N – P. Adjusted sum of squares for three elements is computed as SSR(X3 | X1, X2) = SSE(X1, X2) – SSE(X1, X2, X3). Adjusted mean squares are computed by dividing the adjusted sum of squares by the degrees of freedom. The F-value is determined by dividing two mean squares; a larger F-value indicates significance. The P-value assists in ascertaining the significance of analytical results; a low P-value indicates significance. The error degrees of freedom (df) is computed as n – p – 1, while the total degrees of freedom (df) is determined by the total number of observations minus 1. A model denotes the mathematical depiction of the influence of independent variables and additional elements, including interactions and random error, on the dependent variable. A two-way interaction refers to the manner in which two factors jointly affect the outcome, rather than only their separate influences.

Table 3: *ANALYSIS OF VARIANCE*

Source	DF	Adj SS	Adj MS	F - Value	P - Value
Model	9	0.000217	0.000024	2.03	0.100
Linear	3	0.000186	0.000062	5.23	0.010
Abrasive Grain Size	1	0.000044	0.000044	3.74	0.070
Air Jet Pressure	1	0.000124	0.000124	10.43	0.005
Stand-off-distance	1	0.000018	01000018	1.52	0.235
Square	3	0.000003	0.000001	0.07	0.975
Abrasive Grain Size*Abrasive Grain Size	1	0.000000	0.000000	0.04	0.851
Air Jet Pressure*Air Jet Pressure	1	0.000002	0.000002	0.14	0.711
Stand-off-distance*Stand-off-distance	1	0.000000	0.000000	0.03	0.855
2 – Way Interaction	3	0.000025	0.000008	0.69	0.570
Abrasive Grain Size*Air Jet Pressure	1	0.000010	0.000010	0.80	0.383
Abrasive Grain Size*Stand-off-distance	1	0.000002	0.000002	0.18	0.676
Air Jet Pressure*Stand-off-distance	1	0.000202	0.000012	1.09	0.311
Error	17	0.000202	0.000012		
Total	26	0.000419			

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REGRESSION EQUATION

A regression equation is a mathematical expression utilized in statistical analysis to delineate the association between a variable that is dependent and one or more of the variables that are independent.

MRR = -0.0137 + 0.000019 Abrasive Grain Size + 0.0075 Air Jet Pressure
-0.00437 Stand-off-distance + 0.000000 Abrasive Grain Size*Abrasive Grain Size
-0.00053 Air Jet Pressure*Air Jet Pressure
- 0.00026 Stand-off-distance*Stand-off-distance
- 0.000006 Abrasive Grain Size*Air Jet Pressure
- 0.000003 Abrasive Grain Size*Stand-off-distance
+ 0.001038 Air Jet Pressure*Stand-off-distance

A coefficient that is positive signifies there is a rise in the variables that are independent that correlates with an increase in the mean of the variable that is dependent. A coefficient that is negative indicates that an elevation in the variables that is independent correlates with a lowering in the variable that is dependent.

SURFACE PLOT

A surface plot is defined a wireframe graph that has three dimensions that effectively identifies optimal values and conditions that are operational. A surface plot comprises the subsequent components: Predictor values on the X and Y axes. A surface that is continuous that denotes the fitted response values along the Z-axis. A surface plot displays only two continuous variables simultaneously, while any additional variables are maintained at a constant level. Hold value refers to the value that remains constant.

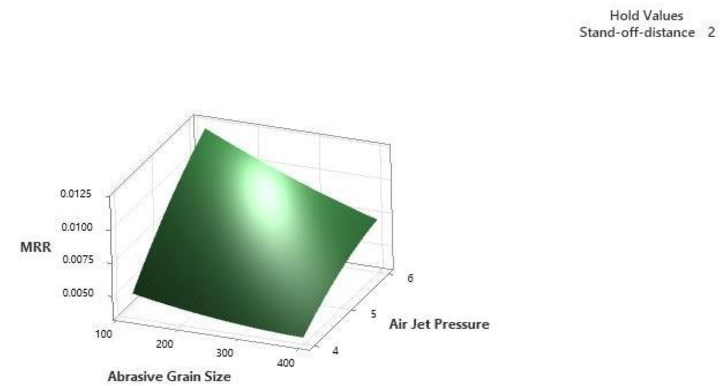

Figure 5: Surface Plot of MRR vs Air Jet Pressure, Abrasive Grain Size

Figure 5 illustrates that the maximum Material Removal Rate (MRR) is located in the upper left quadrant of the plot, corresponding to an Abrasive Grain Size of 120 grit and an Air Jet Pressure of 6 bar. The minimum MRR value is located in the plot at the corner at the lower right, corresponding to an Abrasive Grain Size of 400 Grit and an Air Jet Pressure of 4 bar.

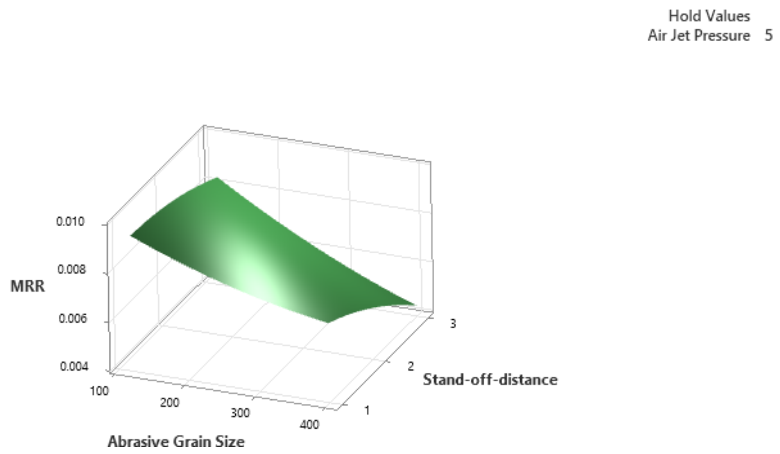

Figure 6: Surface Plot of MRR vs Stand-off-distance, Abrasive Grain Size

Figure 6 illustrates that the maximum Removal Rate of the Material (MRR) is located in the upper left quadrant of the figure, corresponding to an Abrasive Grain Size of 120 grit and a stand-off distance of 1 mm. The minimum MRR value is located in the plot at the corner to the right , that is lower which corresponding to an Abrasive Grain Size of 400 Grit and a Stand-off Distance of 3 mm.

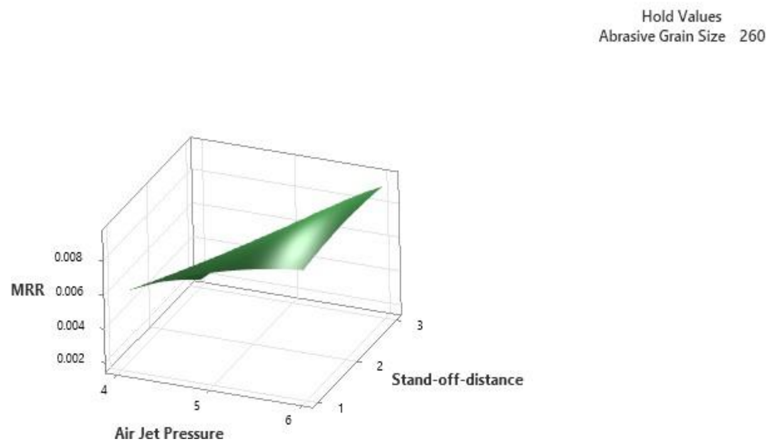

Figure 7: Surface Plot of MRR vs Stand-off-distance, Air Jet Pressure

Figure 7 illustrates that the maximum Removal Rate of material (MRR)mis located in position of upper right quadrant of the graph, corresponding to an Air Jet Pressure of 6 bar and a Stand-off Distance of 3mm. The minimum MRR is located in the right lower aspect of the plot, corresponding to an air jet pressure of 4 bar and a stand-off distance of 1mm.

4 Conclusions

This study conducts an investigation that is experimental on jet machining that is abrasive with an absorption device that contains dust. AJM is distinguished as a versatile and efficient non-conventional machining method. Notwithstanding its benefits, AJM encounters obstacles including noise, dust production, and process stability. The workpiece is submerged in a liquid solution to mitigate silica dust. The AJM process is environmentally benign due to the utilization of a dust absorption device. The tests were structured using the Taguchi method, with variations in process parameters that influence the performance of AJM. The Taguchi technique evaluates combinations of parameters, facilitating data collecting to identify the most significant influences on product quality while minimizing experimentation, so conserving time and resources. This method use orthogonal arrays to systematically arrange the parameters influencing the process. Work that was experimental was conducted by examining abrasive grain size, distance of the nozzle tip, and pressure of the air jet as parameters of machining to analyze the removal rate of material or (MRR), with aluminum denoting the workpiece and silicon carbide (SiC) as the abrasive. An L27 array was constructed via the Taguchi method, and the Material Removal Rate (MRR) was determined for each parameter set from the L27 array. Analysis of Variance, Regression Equations, and Surface Plots are derived from Minitab. According to the surface plots, maximal Material Removal Rate (MRR) is achievable with an abrasive grain size of 120 grit, a Stand-Off Distance (SOD) of 1 mm, and a 6 bar air jet pressure.

5 Publisher's Note

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How to Cite

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