Performance of Abrasive Jet Machining

Asif Ali and Rajendra Kumar Gupta

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PERFORMANCE OF ABRASIVE JET MACHINING

Asif Ali,[1, a)] Mr. Rajendra Kumar Gupta[2, b)]

[1] *Student of Department of Mechanical Engineering JECRC Foundation, Jaipur (Raj.), India*
[2] *Assistant Professor of Department of Mechanical Engineering JECRC Foundation, Jaipur (Raj.), India*

[a)] *asifali.mech22@ jecrc.ac.in*
[b)] *rajendragupta.me@jecrc.ac.in*

Abstract: Scientists and technicians in the field of manufacturing face an increasing number of difficult difficulties as technology advances. The machinability of many novel materials and alloys created for specialised applications is extremely poor. Using traditional methods, producing complex shapes in such materials becomes incredibly difficult. To deal with such tough jobs, two techniques are possible: I modifying conventional procedures and (ii) developing new processes. This is a simulation of an Abrasive Jet Machine. In the workshop, the component parts are fabricated and assembled.

Abrasive jet machining is a useful machining technique for a wide range of hard and brittle materials. And it has a number of specific benefits over other non-traditional cutting methods, including great machining versatility, minimal work-piece stresses, high flexibility, little thermal distortion, and low cutting forces. This paper provides an in-depth examination of the current state of research and development in the field of abrasive jet machining. There will also be additional hurdles and the scope of future improvement in abrasive jet machining. This review study will be useful to a wide range of scholars, producers, and policymakers.

KEY WORDS: versatility, flexibility, non-traditional, performance, Abrasive jet machining.

INTRODUCTION

Abrasive jet machining (AJM) is a mechanical energy-based advanced machining method in which a high-velocity jet of abrasives is utilised to remove material from the work surface via impact, resulting in material erosion from the workpiece. Fine abrasive particles are accelerated in a highly compressed gas, also known as carrier gas, to produce the abrasive jet. A nozzle is utilised, which converts pressure energy into kinetic energy while also directing the jet towards the work surface at a specific angle known as the impingement angle. When hard abrasive particles collide, the erosion process begins, which is sometimes aided by brittle fractureIn terms of accuracy and precision, AJM outperforms the age-old sand blasting process by a significant margin. Alumina, silicon carbide, glass beads, sodium bicarbonate, and other abrasives are used in AJM, whereas silica sand is used mostly in sand blasting (SiO2). Although the goals of both procedures are similar, cutting parameters in AJM may be adjusted, resulting in greater accuracy and precision.

A low-pressure water jet device was patented in the 1930s and was successfully used to cut paper. After twenty years, a high-pressure hydraulic seal from the aviation industry was applied to water jet machining, resulting in a significant boost in process productivity. Cutting hard alloys and carbides became possible when working pressure increased steadily over the next few decades.

. High pressure, on the other hand, caused severe nozzle wear, rendering abrasive jet machining (AJM) economically unviable. Abrasive jet systems became commercially available in the 1970s once ceramic nozzles were produced, and within a short period of time, they had become the industrial mainstream, mostly used for cutting and cleaning. Further advancements in AJM technology have been made, mostly as a result of advances in material science and CNC conceptualization. In the twenty-first century, AJM development shifted to technology downsizing, with nozzle diameters shrinking from macro to micro.AJM is one of the most promising micro-manufacturing technologies today, thanks to sapphire orifices, super-hard abrasives, and dependable high-pressure pumps combined with a 6-axis that accurately manage and process monitoring systems, despite the fact that it has been employed for a century. There has been a steady increase in industrial interest in micro-AJM over the last 20 years. A large volume of research work in the domain reflects the evident reflection of industrial demands. Since 2000, the number of papers returned by Engineering Village and Science Direct databases while searching for "abrasive jet machining" has increased exponentially.

PERFORMANCE OF ABRASIVE JET MACHINE

The kinetic energy of a high-velocity (100–300m/s) abrasive jet is used to remove work material via impact erosion in abrasive jet machining. Sharp edges are required for smooth micro-cutting, and the abrasives must be sufficiently strong to avoid breaking after impact. Aside from flow rate and size, abrasive type has an impact on machining performance. The abrasive substance and associated parameters must be carefully chosen to achieve the desired result.

The next sections examine the effects of abrasives, including their type, shape, size, and flow rate.

1. Desired properties of abrasive particles

• Abrasive grits should have an irregular shape, but there should be little fluctuation in size within the total mass of the grits for easy micro-cutting action (better estimation).
• Metal particles in abrasive grits should be avoided since they can clog the pipeline.
• It must have good flow properties when mixed with carrier gas to ensure smooth flow in the pipeline; • It must have a high hardness and be rigid enough to not crumble into pieces when striking the work surface.
• The abrasives must not be wet, and they must be inexpensive and readily available.

2. List of abrasives used in AJM

Abrasives are often chosen depending on their intended use, while the average grit size is determined by the desired surface finish. Although aluminium oxide (Alumina—Al2O3) and silicon carbide (SiC) are two commonly utilised abrasives, there are a variety of additional abrasives that are used for a variety of reasons. The following is a list of abrasives and their applications. Continue reading: A comparison of the several abrasives used in AJM.
• Aluminum Oxide (Al2O3)—Alumina is used to clean, cut, and deburr materials that are mild to hard.
• Silicon Carbide (SiC) is a tougher abrasive than alumina. As a result, it can be used for all of the above tasks, although it's best for materials that need a lot of effort. Silicon carbide can significantly shorten the life of nozzles.
Glass beads—This is mainly used for producing matt surfaces for reducing transparency.
Crushed glass—For heavy cleaning, matting and peening operations.

3. Effects of abrasive flow rate on AJM performance

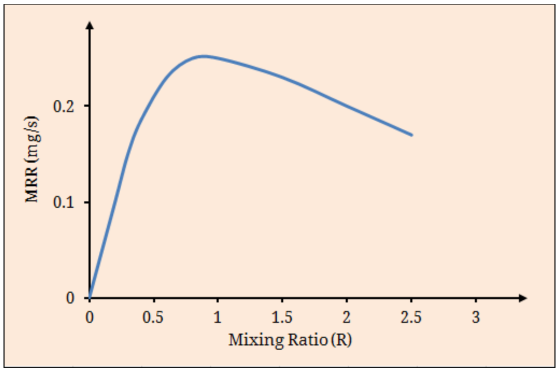

Figure 1

Material removal rate in Abrasive Jet Machining is affected by the mixing ratio (AJM) MRR rises with mixing ratio at first, then falls after reaching a maximum at a specific optimum value.

A phrase known as the Mixing Ratio is used to quantify and identify the mass flow rate of abrasive. The mass flow rate of abrasives divided by the mass flow rate of carrier gas is the ratio. If the mixing ratio is adjusted by raising the abrasive flow rate while keeping the gas flow rate constant, the MRR will increase. However, after a certain maximum flow rate, increasing the abrasive flow rate further reduces MRR. If, on the other hand, both the abrasive and gas flow rates are increased correspondingly but the mixing ratio remains constant, then a continuous increase in MRR can be observed.

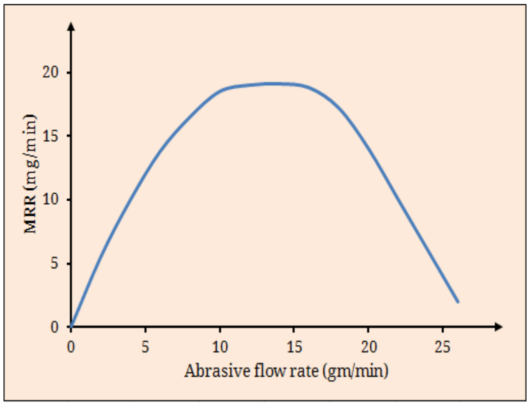

Figure 2

Effect of abrasive flow rate on MRR for constant mixing ratio

4. Effects of abrasive type on abrasive jet machining performance

AJM can be done with a variety of abrasives, including aluminium oxide, silicon carbide, grass bead, crushed glass, and sodium bicarbonate. It's worth mentioning that different abrasives yield varied MRRs, which fluctuates a lot depending on the process conditions.

The hardness of abrasive particles is responsible for variable MRR for different abrasives (when process parameters and geometrical features are indifferent). When the impacting abrasive hardness is extremely high, the work material's fracture toughness takes precedence. The larger the volume removal rate, the harder the abrasive is in comparison to the work surface hardness.

5. Effects of abrasive size on abrasive jet machining performance

Cutting performance is influenced by the size of the abrasive as well as the type of abrasive. Smaller grits produce a more polished surface, but they slow down the material removal rate (MRR), lowering productivity. Larger grits might cause problems in the pipeline when mixing and flowing. When abrasives contain a lot of moisture, a higher mixing ratio can cause the nozzle to clog. The average grain size of abrasives is between 10 and 50 microns. Smaller grain sizes are employed for both high-finish and low-duty activities (such as surface cleaning). Larger grains are typically employed with tougher materials in heavy-duty applications.

List of Factors That Affect Abrasive Jet Machining Performance

Abrasive jet machining (AJM) is a type of advanced machining in which a high-velocity abrasive jet is utilised to remove material from a work surface by erosion. Surface cleaning, coating removal, deflashing, trimming, engraving, deburring, drilling, parting, ceramic abrading, glass frosting, and other applications can all benefit from this technique. However, in order to successfully use the process and achieve the intended outcome, it is critical to understand numerous parameters and their effects on machining performance. In the next sections, such parameters and their effects are discussed.

Table 1

Influencing factors in abrasive jet machining			
Abrasive	**Carrier gas**	**Abrasive jet**	**Work material**
1. Material 2. Shape 3. Size 4. Size variation 5. Strength 6. Flow rate	1. Nature 2. Composition 3. Pressure 4. Flow rate 5. Temperature	1. Velocity 2. Mixing ratio 3. Impingement angle 4. SOD	1. Properties 2. Induced stress 3. Inhomogeneity

1. Influencing factors related to abrasive

• **Abrasive particle type—**Abrasive particles come in a variety of hardnesses. Softer abrasives tend to crumble upon impacting a hard work surface, but harder abrasives can fetch a higher MRR.
• **Abrasive shape—**When compared to spherical grits, irregular shape grits with sharp edges boost MRR.
• **Abrasive grain size—**The size of the indentation made by a single grit is related to the diameter of the grit. As a result, larger grits produce more indentation (and consequently a higher MRR), whereas smaller grits produce a smoother surface finish but a lower MRR.
• **Grain size variation—**commercially accessible abrasives come in a variety of sizes (it is not a fixed value). The lower the variance in diameter within the overall mass, the better the surface quality and MRR prediction.

2. Influencing factors related to carrier gas

• **Gas pressure—**After mixing with abrasives, the pressure of the carrier gas is turned into kinetic energy. As a result, a higher gas pressure suggests a faster jet velocity and, as a result, a higher MRR.
• **Gas flow rate—**The mixing ratio is influenced by the gas flow rate, and the MRR is highest when the mixing ratio is at its optimum value.
• **Moisture content—**Because very high pressure is used, steam in the gas can condense into water particles, which can grab abrasives and clump together into a big particle.

3. Influencing factors related to nozzle

• **Nozzle inner diameter—**For the same gas pressure and mixing ratio, a larger nozzle inner diameter suggests a lower jet velocity. As a result, the wrong jet diameter can affect MRR and surface quality.
• **Worn-out nozzle—**Due to wear, the diameter of the nozzle grows.
• **Nozzle material—**Nozzle material has a significant impact on nozzle life (wear rate).

4. Influencing factors related to abrasive jet

• **Jet velocity—**A quicker eroding rate is possible with a higher jet velocity, but it necessitates a high carrier gas pressure. As a result, the machine setup must be able to resist such high pressure without leaking.
• **Jet diameter—**This is determined by the inner diameter of the nozzle and the stand-off distance. Higher jet diameters can erode material from a larger area, but accuracy may suffer as abrasives in the jet centre have less of a chance to come out after impact and collide with the new jet.

5. Influencing factors related to process parameters

• **The mixing ratio-** It has a big impact on MRR and penetration depth (surface finish). A higher optimal level yields greater results.
• **Abrasive flow rate—**Abrasive flow rate is proportional to MRR.
• **Stand-off distance (SOD)—**As SOD grows, the diameter of the jet expands due to spreading. As a result of the increased SOD, the jet has a lower velocity but is wider. Small SOD, on the other hand, provides insufficient clearance for spent grits to exit the machining zone.

• Impingement angle—the It's angle formed by the work surface and the diameter of the jet. It's usually kept between 60degree and 90degree; a greater value results in a deeper cut. Based on work material and a variety of other factors, numerous studies show that MRR is greatest at an impingement angle of 70degree – 90degree.

6. Influencing factors related to work material

• **Poor working surface condition—**If the surface roughness is severe, cutting accuracy may be compromised. Similarly, because of the potential for abrasive bounce back, a highly polished surface reduces MRR.
• Material properties inhomogeneity—this might lead to machining error.
• Stress concentration—by reducing erosion rate, it can lower MRR.

7. Responses for measuring performance (output parameters)

The following three parameters are often used to assess the performance of abrasive jet machining. The productivity is determined by the rate of material removal, while the applicability is determined by the surface finish. Nozzle life, also known as nozzle wear rate, is another critical response to monitor, since a worn-out nozzle can compromise surface quality if not changed promptly. It also contributes to the total machining cost because nozzle life is short and changing them takes a long time. Nozzles are also more expensive.

- Nozzle life
- Surface finish
- Material removal rate (MRR)

FACTOR THAT AFFECTS PERFORMANCE

1. Effects of Carrier Gas on Abrasive Jet Machining Performance

Fine abrasive particles are accelerated by dry pressured gas and permitted to impact the work surface in the form of a jet with the help of a nozzle in abrasive jet machining (AJM). Carrier gas is the gas that abrasive particles are blended with. Dehumidification and dust removal are required for carrier gas. A list of carrier gas-related characteristics that can affect abrasive jet machining performance is provided below. In the next sections, the effects of such parameters are also discussed.

- Carrier gas pressure
- Carrier gas flow rate
- Carrier gas type (non-significant effect) (insignificant effect)

1.1. Effects of carrier gas pressure on AJM performance

An air compressor is used to compress dried and dust-free carrier gas to high pressure (15–20bar). In a mixing chamber (kept at constant pressure), abrasives are mixed with this compressed gas according to the mixing ratio. By significantly increasing velocity, a nozzle transfers hydraulic energy (pressure) of the gas-abrasive mixture to kinetic energy. For material erosion, this high-velocity jet (100–300m/s) is permitted to strike the work surface.

However, in order to improve MRR, carrier gas pressure cannot be increased indefinitely. The machine configuration must be able to tolerate such high pressure. Every machine setup has a rated capacity, and if certain factors surpass that limit, the machine may malfunction, leak, or even burst.

1.2. Effects of carrier gas flow rate on AJM performance

In abrasive jet machining, the flow velocity of the carrier gas has an impact on machining capabilities. If the mass flow rate of abrasives is not increased correspondingly, a larger volume flow rate under the same pressure can deteriorate mixing ratio. If more abrasives are mixed at the same compressor delivery pressure, the ultimate pressure after mixing will be lower since the abrasives are fed from ambient pressure (this is attributed to conservation of momentum before and after mixing).

2. Effects of Mixing Ratio on Abrasive Jet Machining Performance

In abrasive jet machining (AJM), fine abrasive particles, accelerated by pressurized dehumidified carrier gas are allowed to strike the work surface in the form of a jet with the help of a nozzle. Proportion of abrasive grit presents in abrasive jet is one crucial factor as it determines machining performance as well as quality of cut. This proportion is basically identified and defined by a parameter called Mixing Ratio.

2.1 Mixing ratio in abrasive jet machining

The mixing ratio (M) is the proportion of abrasive particle mass flow rate to carrier gas mass flow rate. It is a unitless and dimensionless quantity since it is the ratio of two mass flow rates. It basically determines the abrasive concentration in the jet. The mixing ratio can be stated mathematically as shown below.

In AJM, the mixing ratio is

$$Mixing\ ratio\ (M) = \frac{Mass\ flow\ rate\ of\ abrasive\ particles(\dot{m}_{abr})}{Mass\ flow\ rate\ of\ carrier\ gas\ (\dot{m}_{gas})}$$

2.2 Effects of mixing ratio on material removal rate When mixing ratio is increased

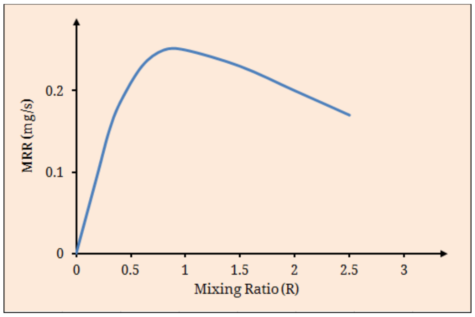

Figure 3

Effect of mixing ratio on material removal rate in AJM.

Increase the mass flow rate of abrasive grits while keeping the carrier gas flow rate constant to increase the mixing ratio. Because there are more abrasives in the jet, an increase in the mixing ratio generates more material degradation at first (thus higher MRR).

Lower jet velocity indicates that the jet has less kinetic energy and hence has less energy available for material erosion from the work surface. As a result, as the mixing ratio is increased, the material removal rate (MRR) begins to decrease. As a result, raising the mixing ratio only by increasing the abrasive flow rate while maintaining the gas flow rate constant results in a reduced MRR, which is undesired.

2.3 When mixing ratio is kept constant

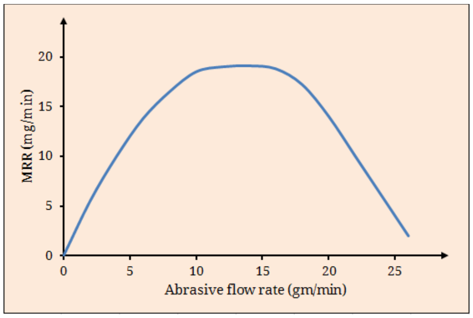

Figure 4

Effect of abrasive flow rate on MRR for constant mixing ratio.

The material removal rate can be enhanced by raising both the abrasive and gas flow rates at the same time while keeping the mixing ratio constant, as shown below. In this situation, the carrier gas must be used at a higher pressure. To manage such high pressure without leakage or rupture, thicker and stronger pipelines and other accessories are required. It is not practical to grow MRR indefinitely.

2.4 Effects of mixing ratio on accuracy of cut

Cut quality is also influenced by the mixing ratio. When abrasives abound in the jet, the machining zone fills up with surplus utilised grits, obstructing free flow of the jet through unplanned and recurrent collisions, resulting in jet spreading. Surface quality and tolerance of machined profiles deteriorate over time. In terms of surface quality and tolerance, an optimal mixing ratio produces better results.

3. Effects of Impingement Angle on Abrasive Jet Machining Performance

Abrasive jet machining (AJM) uses a high-velocity abrasive jet to impinge on the work surface and remove material by erosion. The jet is typically directed vertically to the work surface (i.e., the impingement angle is 90o); however, the jet may be directed at an angle other than 90o. The impingement angle (), also known as spray angle or impact angle, is the angle formed by the work surface and the abrasive jet axis, as shown in the diagram below. Its value can range from 60o to 90o in practise, depending on the location of the intended surface as well as the applications.

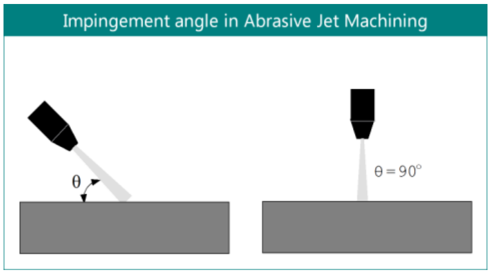

Figure 5

Impingement angle () can theoretically range from 0o to 90o; but, in practise, it is kept between 60o and 90o to get satisfactory results in AJM. When is not 90o, the abrasive jet's velocity has two components: one perpendicular to the work surface and the other parallel to it. The perpendicular component (60o is the most common) creates deeper penetration, but the parallel component increases the machined area.

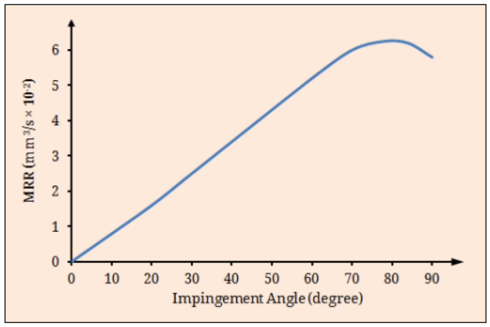

Figure 6

If the impingement angle () is too tiny (below 45degree), the jet will not have enough kinetic energy to erode material off the work surface, and will instead slide over it, leaving no visible erosion. Between 70o and 80o, the highest MRR is seen.

MRR will be reduced by a modest amount if the impingement angle is increased further. This is due to the fact that some abrasive grits bounce back after impact and collide with the incident jet when a high-velocity abrasive jet impacts the work surface perpendicularly. As a result, in abrasive jet machining, an impingement angle () of 70degree–80degree produces better results in terms of material removal rate.

4. Functions of Carrier Gas in Abrasive Jet Machining (AJM)

Abrasive jet machining removes material from a work surface by impact erosion using a high-velocity (100–300m/s) jet of fine grain abrasives mixed with pressurised carrier gas. As a result, this carrier gas is dehumidified before being compressed to a very high pressure (10–20bar) using an air compressor. This combination is then fed into a nozzle, which converts pressure energy into kinetic energy before releasing it to strike the work surface. The following sections go over the basic functions of carrier gas in abrasive jet machining.

4.1 Functions of carrier gas in abrasive jet machining (AJM)

• It helps generate an abrasive jet by speeding up microscopic abrasive particles.
• It blows away eroded metal particles and used grits from the machining zone.

4.2 Accelerating abrasive particles

Small abrasive particles are frequently retained in an atmospheric pressure chamber (abrasive feeder). In the vibratory mixing chamber, these abrasives are combined with pressured carrier gas. The volume or mass of abrasive to be mixed per unit volume of carrier gas is determined by a predetermined Mixing Ratio. The final mixture pressure is determined by the mixing ratio, carrier gas pressure prior to mixing, and momentum loss during mixing.

4.3 Forming abrasive jet

The pressure energy of the gas-abrasive mixture is converted to kinetic energy using a nozzle, resulting in a high velocity jet. Because abrasives are incompressible, forming a high-velocity jet requires the presence of at least one carrier medium. The abrasives are carried by carrier gas until they hit the work surface, where they erode the material.

4.4 Blowing away removed metal particles

When an abrasive jet impacts a work surface at a specific angle from a safe distance, it erodes the material into tiny metal particles. If metal particles and used abrasive grits are permitted to remain in the machining zone, they will collide with the fresh jet, reducing jet velocity.

5. Desired Properties of Abrasives Used in Abrasive Jet Machining (AJM)

In Abrasive jet machining (AJM) involves striking the work surface with a high-velocity (100–300m/s) jet of abrasive grits driven by dehumidified pressurised gas (called carrier gas) to remove material gradually. Machining capability is influenced by the type of abrasive, as well as its form, size, and other features. Abrasives used in AJM include aluminium oxide (Al_2O_3), silicon carbide (SiC), sodium bicarbonate ($NaHCO_3$), and glass beads. The qualities of abrasives that are desired for AJM are listed below.

5.1 Desired properties of abrasives for abrasive jet machining

• Sharp edges are required for easy micro-cutting action with abrasive grit. Although grits are considered to be spherical for modelling purposes, sharp edges are practically required otherwise MRR would be low and surface polish will be poor.
• Abrasive grits should have an irregular shape, but there should be little fluctuation in size within the total mass, or the MRR and surface quality will not match. Smaller grits tend to remain entrenched on the work surface, resulting in poor surface finish, whereas bigger grits create greater cavities, resulting in high MRR with poor surface finish.
• Abrasive grits must not contain metal particles, as this could cause a pipeline clog. As a result, reusing abrasives is not advised.
• It must have good flow properties in order to flow smoothly in the pipeline when mixed with carrier gas; • It must have a high hardness and be rigid enough not to crumble into pieces when impacting the work surface. Because different abrasives have varied hardness levels, they yield different MRR.
• It should be cheap and readily available—this is the apparent reason for decreasing production costs.
• It should not include moisture—otherwise, moisture may condense after mixing with compressed air, causing flow characteristics to be significantly hampered.

Table 2

Desired properties of abrasives for AJM
1. **Sharp edges**—for easy micro-cutting and better MRR
2. **Irregular shape**—to maximize MRR and productivity
3. **No impurity**—to reduce agglomeration and improve accuracy of cut
4. **Good flowability**—to reduce jamming
5. **High hardness**—to decrease fracture during impact
6. **Less impact on environment**—less trouble during disposal
7. No moisture content
8. Cheap and abundantly available.

5.2 Various abrasives used in AJM

Abrasives are often chosen based on their intended use, while average grit size is determined by the desired surface finish. Although aluminium oxide (Alumina—Al_2O_3) and silicon carbide (SiC) are two commonly utilised abrasives, there are a variety of additional abrasives that are used for a variety of reasons. The following is a list of abrasives and their applications. Aluminum Oxide (Al_2O_3)—Alumina is used to clean, cut, and deburr materials that are mild to hard.
• Silicon Carbide (SiC) is a tougher abrasive than alumina. As a result, it can be used for all of the above purposes, but especially for materials that need a lot of effort. Silicon carbide can shorten the life of nozzles.
• Glass beads—These are mostly employed to create matt surfaces that reduce transparency.
• Crushed glass—Use this for tough cleaning jobs, matting and peening operations.

Comparison among various abrasives used in AJM		
Abrasives	**Size (μm)**	**Applications**
Aluminum oxide	10 – 50	For cleaning, cutting and deburring of moderate to hard materials.
Silicon carbide	10 – 50	For cleaning, cutting and deburring of very hard work materials.
Glass beads	500 – 1500	For producing matt surfaces. Sometime for cleaning purpose also.
Crushed glass	100 – 500	For heavy cleaning, matting and peening operations.
Sodium bicarbonate	10 – 25	For light duty applications such as cleaning, cutting, etc. on soft materials.

Table 3

REASONS FOR INACCURACIES IN ABRASIVE JET MACHINING

1. Effect of stand-off distance (SOD)

When it comes to abrasive jet machining, the stand-off distance is the most important factor to consider when the accuracy of the machined profile is important. Stand-Off Distance (SOD) or Nozzle Tip Distance refers to the distance between the nozzle tip and the work surface (NTD). Before hitting the work surface, a high-velocity (100–300m/s) abrasive jet travels through this gap after leaving the nozzle.

As a result, as SOD levels rise, the cross-sectional area of the jet grows. Because the flow rate remains constant, increasing the cross-sectional area results in a decrease in jet velocity, and so the kinetic energy of the jet diminishes with SOD. As a result, a jet with a larger area but low kinetic energy contributes to erosion. The following figure shows how SOD affects channel depth and width.

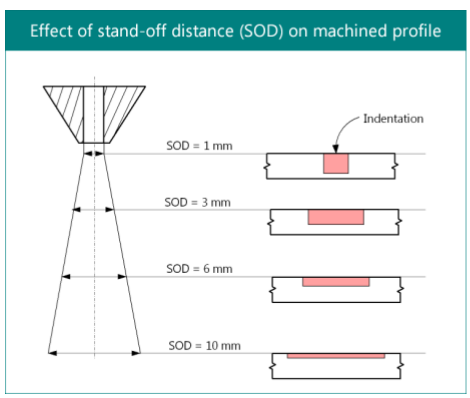

Figure 10

2. Effects of other parameters on machining accuracy

• **Abrasive grain size—**The size of the crater is determined by the average diameter of the abrasives. The larger the grit, the larger the hollow or indentation. A superior surface polish can be achieved with fine abrasives. Variations in process parameters, such as agglomerated abrasives and foreign particles, can also lead to inaccuracies. As a result, incorrect abrasive size selection might result in erroneous machining in terms of surface roughness, tolerance, and corner radius.

• Gas pressure and flow rate—Jet velocity is determined by the carrier gas pressure and flow rate. Feed rate is usually chosen based on jet velocity and expected MRR. As a result, any change in gas pressure or flow rate may result in erroneous cutting.
• Nozzle diameter and wear—Along with SOD, the nozzle's cross-sectional area controls the machined features' kerf width. However, as the nozzle wears down, the diameter rises.
• Impingement angle—cutting deeper and narrower slots or holes with a 90o impingement angle is possible. Any variation from 90o can result in slanted or incorrect cutting.
• Material properties—MRR can vary for the same process parameters if the material is not homogeneous. Surface treatment, residual stress, surface asperities, and other factors might cause abrasive jet machined features to be inaccurate.

APPLICATION OF ABRASIVE JET MACHINE

Abrasive Jet Machining has the following applications:

- Slotting and slicing narrow parts
- Drilling and contouring operations
- Deburring and creating shallow crevices.
- Creating complicated hole shapes in a brittle and hard material.
- Cleaning and polishing plastic, nylon, and Teflon parts.
- Frosting of glass tubes' inside surfaces.
- Etching of glass cylinder markings
- Super-alloys and refractory materials are machinable.

CONCLUSION

AJM is a progressive manufacturing method that is playing an increasingly important role in meeting current and future industrial demands. Future research on technological advancements will be necessary as a result. The movement from macro to micro size is a common tendency in AJM advancements. Current difficulties in AJM include further machining spot reduction, precision erosion forecasting, and process control. A wide range of AJM approaches and advances were examined. For environmental objectives, deep patterning, and big area machining, submerged, intermittent, and multi-jet circumstances were found to be useful. AAJM is a market leader in the manufacturing of surface micro-texture for tribological applications.

This document summarises the results of experiments on different thicknesses of glass plates with variable pressures and nozzle tip distances. The material removal rate (MRR), top surface diameter, and bottom surface diameter of the hole formed were measured and plotted as a function of their process parameters. These were compared to the Roopa Rani and S.Seshan data, and it was discovered that when the nozzle tip distance rises, the top and bottom surface diameters of the hole grow, as is the case in the abrasive jet machining process. The material removal rate (MRR) rose as the pressure increased.

FUTURE SCOPE OF ABRSIVE JET MACHINE

AJM is a progressive manufacturing method that is playing an increasingly important role in meeting current and future industrial demands. Future research on technological advancements will be necessary as a result. The movement from macro to micro size is a common tendency in AJM advancements. Current difficulties in AJM include further machining spot reduction, precision erosion forecasting, and process control. A wide range of AJM approaches and advances were examined. For environmental objectives, deep patterning, and big area machining, submerged, intermittent, and multi-jet circumstances were found to be useful. AAJM is a market leader in the manufacturing of surface micro-texture for tribological applications. Masked micro-blasting achieves a minimum channel width of 10 mm. However, for additional improvements in surface frictional behaviour, a feature size of less than 5 mm was suggested. As a result, various sectors are interested in improving surface micro-patterning resolution. AAJM has a lower MRR than liquid-based abrasive jet polishing, but it delivers superior surface roughness. CAAJM, an attempt to construct a bridge between air and water-based abrasive jet systems, was introduced with the goal of combining both advantages.

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