JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ABRASIVE JET MACHINIG

[1]Mr. Vineet Kumar Rai, [2]Sahil Khan, [3]Shudhanshu Kumar, [4]Ankit Yadav, [5]Murlidhar Yadav

[1]Assistant Prof. ME Department Institute of Technology and Management, GKP, UP, India
[2] Student, ME Department Institute of Technology and Management, GKP, UP, India,
[3] Student, ME Department Institute of Technology and Management, GKP, UP, India
[4]Student, ME Department Institute of Technology and Management, GKP, UP, India
[5]Student, ME Department Institute of Technology and Management, GKP, UP, India

Abstract : Abrasive Jet Machining (AJM) or Micro Blast Machining represents a non-conventional method where material is removed by the erosive force of a high-speed gas jet carrying fine abrasive particles, impacting the work surface. This process is ideal for cutting intricate shapes in hard, brittle materials that are heat-sensitive and prone to chipping. Similar to sandblasting, AJM effectively removes tough materials and has been utilized for tasks like deburring and rough finishing. As the demand for machining ceramics, semiconductors, electronic devices, and LCDs grows, AJM emerges as a valuable technique for micromachining**.**

KEY WORDS: ABRASIVE JET MACHINE (AJM), LCD, NOZZLE TIP DISTANCE (NTD), MATERIAL REMOVAL RATE (MRR)

INTRODUCTION

Abrasive jet machining (AJM) stands out as a non-traditional method for material machining, distinguished by its ability to operate without heat or shock generation, as well as without the formation of chips. While abrasive processes are typically associated with higher costs, they offer the advantage of achieving tighter tolerances and superior surface finishes compared to conventional machining techniques. In AJM, material removal occurs through mechanical erosion induced by the impact of high-velocity abrasive particles propelled by a suitable fluid, often gas or air, through a specially designed nozzle onto the workpiece. This versatile process finds application in various operations such as cutting, drilling, surface finishing, etching, grinding, honing, and polishing. Understanding the erosion mechanism in AJM involves two primary phases: firstly, addressing the transportation problem, which involves determining the quantity, direction, and velocity of abrasive particles influenced by the fluid flow dynamics of the solid-gas suspension; and secondly, assessing the material removal rate or erosion rate.

Surface erosion caused by the impact of solid particles is a process characterized by discrete, accumulative actions. Consequently, initial models are developed based on the impact of a single particle. The erosion mechanism in these scenarios is intricate, encompassing mechanical, chemical, and material properties.

PROCESS PARAMETERS OF AJM

NOZZLE: AJM nozzles are typically crafted from WC or Sapphire to withstand abrasive wear resulting from the high-velocity abrasive stream. These nozzles come in either a right-angled or straight-edge shape.

ABRASIVE: Abrasives come in various sizes, spanning from 10 microns to approximately 1.3 mm. Smaller sizes yield a finer finish and are appropriate for tasks such as polishing, cleaning, and grooving.

- Aluminum oxide is appropriate for cutting, grooving, and deburring tasks.
- Silicon carbide serves similar purposes but is particularly effective for harder materials.
- Sodium bicarbonate is beneficial for light-duty tasks such as cutting.
- Dolomite is suitable solely for fine etching or polishing work.
- Glass beads are effective for polishing surfaces to a matte finish.

VELOCITY OF ABRASIVE: The velocity of the jet is determined by both the pressure and design of the nozzle. The jet velocity typically falls within the range of 150-300 m/min.

WORK MATERIAL: The velocity of the jet is determined by both the pressure and design of the nozzle. The jet velocity typically falls within the range of 150-300 m/min.

NOZZLE TIP DISTANCE (NTD): This refers to the distance between the nozzle tip and the work material, also known as the Standoff Distance (SOD).

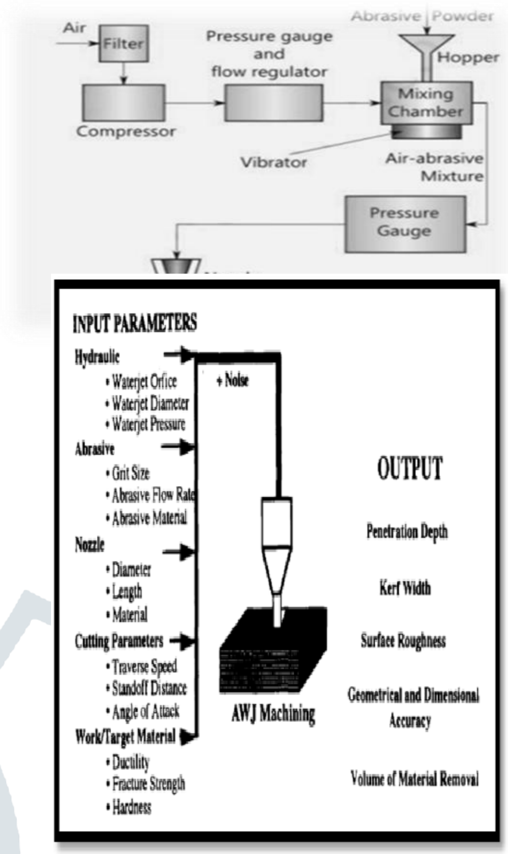

Figure 1(Process Parameter of AJM)

COMPONENTS OF AJM

- Compressor
- Working Chamber
- Work Piece
- Nozzle
- Nozzle Holder
- Mixing Chamber
- Air Filter

PROCESS

Glass served as the test specimen due to its widespread use in industrial applications and its representative properties for studying machining processes. The square and rectangular shapes allowed for a comprehensive evaluation of the machining capabilities of the AJM setup across different geometries.

Before machining, meticulous cleaning of the specimens ensured the removal of any contaminants that could affect the machining process or the accuracy of subsequent measurements. The use of an air jet for cleaning minimized the risk of introducing additional particles that could interfere with the machining operation.

The choice of abrasive particles, including SiC, Al2O3, and Sodium Bicarbonate, with varying grain sizes, provided a diverse range of abrasive options to explore their effects on material removal rates and surface finish quality.

The utilization of stainless steel nozzles of different diameters allowed for flexibility in adjusting the abrasive jet characteristics to suit the specific requirements of the machining task at hand. This adaptability is crucial for optimizing the machining process for different materials and surface finishes.

The enclosed working chamber with a transparent Perspex sheet facilitated direct observation of the machining operation, enabling real-time monitoring of the process parameters and ensuring safe operation.

Overall, the setup's simplicity in design, fabrication, and operation contributed to cost-effectiveness while maintaining high precision and reliability in the machining results.

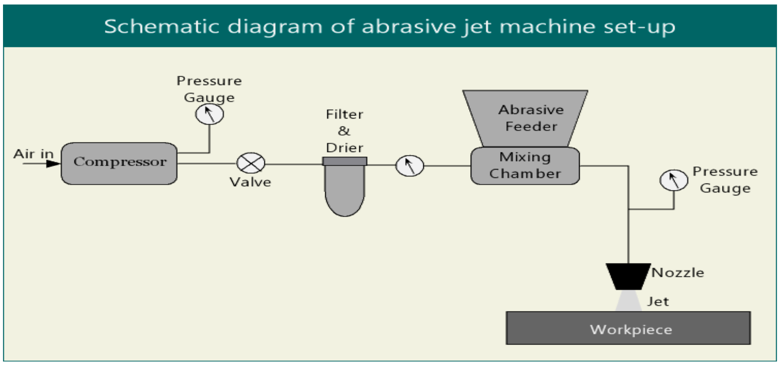

Figure 1(Process of AJM)

ADVANTAGES

- Capable of cutting intricate hole shapes in materials of varying hardness and brittleness.
- Capable of cutting fragile and heat-sensitive materials without causing damage.
- Maintains the original microstructure of the material as no heat is generated during the process.
- Characterized by lower consumption and capital investment requirements.
- No physical contact occurs between the tool and the workpiece.
- Achieves a good surface finish ranging from 10 to 50 microns using finer abrasive particles.

.

DISADVANTAGES

- Capable of cutting intricate hole shapes in materials of varying hardness and brittleness.
- Capable of cutting fragile and heat-sensitive materials without causing damage.
- Maintains the original microstructure of the material as no heat is generated during the process.
- Characterized by lower consumption and capital investment requirements.
- Achieves a good surface finish ranging from 10 to 50 microns using finer abrasive particles.

APPLICATIONS OF AJM

- Machining hard and brittle materials such as ceramics, quartz, glass, sapphire, and mica.
- Precision drilling and micro-welding.
- Machining semi-conductor materials.
- Crafting intricate profiles on hard and brittle materials.
- Cleaning and refining plastic compounds, for example, Nylon and Teflon.
- Engraving and etching intricate designs on delicate surfaces.

WORKING PRINCIPLE OF AJM

Tiny particles are propelled within a gas stream, directed towards the machining focal point. Upon impact with the surface, each particle induces a small fracture, and the gas stream carries away both the abrasive particles and the resulting wear debris.

Abrasive jet machining (AJM), also referred to as abrasive microblasting, pencil blasting, and micro-abrasive blasting, is a machining process that utilizes abrasives propelled by a high-velocity gas to erode material from the workpiece. The underlying principle of AJM resembles sandblasting, effectively removing hard and brittle materials. This technique finds applications in rough operations such as deburring and rough finishing, particularly adept at cutting heat-sensitive, brittle, thin, or hard materials.

Figure 2(Working of AJM)

CONCLUSION

It is evident that AJM stands out as a prominent non-conventional machining process, renowned for its versatility and effectiveness. It is considered one of the most efficient and cost-effective systems available, while also being environmentally friendly. Several Indian companies such as ABB, L&T, and ESSAR have already embraced this technology, integrating it with CNC programming for enhanced precision and control.

Additionally, AJM finds application as Water Jet Machining (WJM), wherein abrasives like garnet, diamond, or powders can be added to the water to create a slurry with improved cutting capabilities. Further advancements in WJM have led to the development of Hydrodynamic Jet Machining (HJM), which amalgamates the principles of Water Jet Machining and Abrasive Jet Machining processes.

Moreover, AJM serves as the basis for other machining techniques such as Abrasive Flow Machining (AFM) and Ultrasonic Machining.

REFERENCES

[1] ”EXPERIMENTAL STUDY OF ABRASIVE JET MACHINING”, A.P.VERMA and G.K.LAL
[2] P C Pandey and H S Shan. “Modern Machining Processes”, Tata McGraw-Hill publishing Co, New Delhi, 1980.
[3] A Bhattacharya. 'New Technology'. The Institution of Engineers (India), 1976. Fig -9: Vortex Type Mixing Chamber © 2019, IRJET
[4] “Elements of workshop technology”, S K HajraChoudhury, S K Bose, A K Hajrachoudhury, Niranjan Roy, Vol-II, Media promoters and media publications.
[5] “Modern machining process”, S Pandey and H N Shah, S. Chand and co.
[6] www.elgi.com