International Conference on Science, Technology and Management (ICSTM-2020)
Guru Gobind Singh Polytechnic, Nashik, Maharashtra (India)
15th - 16th February 2020 www.conferenceworld.in ISBN : 978-81-944855-1-3

Abrasive jet machine working model as a teaching aid

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ABSTRACT:

Abrasive jet machining (AJM) also known as abrasive micro-blasting or Pencil blasting is an abrasive blasting machining process that uses abrasives propelled by high velocity gas to erode material from the work piece. It has been applied to rough working such as deburring and rough finishing, machining of ceramics and electronic devices. AJM has become a useful technique for micro machining. It has various distinct advantages over the other non-traditional cutting methods, which are high machining versatility, minimum stresses on the substrate. This paper deals with several several experiments that have been conducted by many researchers to assess the influence of abrasive jet machining (AJM) process parameters such as type of abrasive Particle ,Abrasive Particle size, Jet pressure Nozzle tip distance.

Various experiments were conducted to assess the influence of abrasive jet machine.

In mechanical engineering advanced manufacturing prosses is subject through which student will get theoretical and practical knowledge of different non-traditional machining process. For better understanding industrial visits play an important role. For teaching purpose as a teaching aids we are going to develop working model of abrasive jet machine.

Keywords:

Abrasive jet machining (AJM), stand-off-distance (SOD), nozzle-tip-diameter (NTD), material removal rate (MRR), flow rate.

INTRODUCTION

The Abrasive jet machining is the process of material removal process from a work piece by the application of a high speed stream of abrasive particles carried in gas medium from a nozzle. A focused stream of abrasive particles, carried by high pressure air or gas is made to impinge on the work surface of the work- piece through a nozzle and the work material is removed by erosion action by high velocity abrasive particles. Abrasive Jet Machining (AJM) is the removal of material from a work piece by the application of a high speed stream of

abrasive particles carried in gas medium from a nozzle. The AJM process differs from conventional sand blasting in that the abrasive is much finer and the process parameters and cutting action are carefully controlled. Abrasive air-jet is an abrasive machining process widely used for surface cleaning, and cutting. The nozzle is the most critical part in the abrasive air-jet equipment. The process is used chiefly to cut intricate shapes in hard and brittle materials which are sensitive to heat and have a tendency to chip easily. The process is also used for deburring and cleaning operations. AJM is inherently free from chatter and vibration problems. The cutting action is cool because the carrier gas serves as a coolant. Abrasive processes are usually expensive, but capable of better surface finish than other machining process. The process can be easily controlled by varying the parameters such as Velocity, Flow rate, Pressure, Standoff distance, Grit size.

Problem statement:

In mechanical engineering the industrial visits plays an important for better understanding of different machining processes , but every time it is not possible for industrial visit and it is also time consuming prosses so we develop the working model of abrasive jet machine as a teaching aid.

WORKING

The fundamental principle of Abrasive jet machining involves the use of a high-speed stream of abrasive particles carried by a high-pressure gas or air on the work surface through a nozzle. The metal is removed due to erosion caused by the abrasive particles impacting the work surface at high speed. With repeated impacts, small bits of material get loosened and a fresh surface is exposed to the jet.

This process is mainly employed for such machining works which are otherwise difficult, such as thin sections of hard metals and alloys, cutting of material which is sensitive of heat damage, producing intricate holes, deburring, etching, polishing etc.

A typical set-up for abrasive jet machining is shown in the figure. The abrasive particles are held in a suitable holding device, like a tank and fed into the mixing chamber. A regulator is incorporated in the line to control the flow of abrasive particles compressed air or high-pressure gas is supplied to the mixing chamber through a pipeline.

This pipeline carries a pressure gauge and a regulator to control the gas flow and its pressure. The mixing chamber, carrying the abrasive particles is vibrated and the amplitude of these vibrations controls the flow of abrasive particles.

These particles mic in the gas stream, travel further through a hose and finally pass through the nozzle at a considerably high speed. This outgoing high-speed stream of the mixture of gas and abrasive particles is known as abrasive jet.

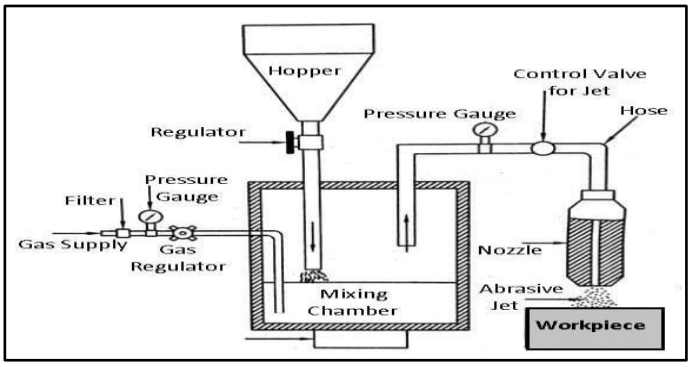

Fig. layout of abrasive jet machine

LITERATURE SURVEY:

The literature study of Abrasive Jet Machine reveals that the Machining process was started a few decades ago. Till date there has been a through and detail led experiment and theoretical study on the process. Most of the studies argue over the hydrodynamic charlatanistic of abrasive jets, hence as curtaining the influence of all operational variables on the process effectiveness including abrasive type, size and concentration, impact speed and angle of impingement. Other papers found new problems concerning carrier gas typologies, nozzle shape, size and wear, jet velocity and pressure, stand-off-distance (SOD), or nozzle -tip-distance (NTD). These papers express the overall process performance in terms of material removal rate, geometrical tolerances and surface finishing of workpieces, as well as in terms of nozzle wear rate. Finally, there are several significant and important papers which focus on either leading process mechanisms in machining of both ductile and brittle materials, Or on the development of systematic experimental -statically approaches and artificial networks to predict the relationship bet ween the settings of operational variables and the machining rate and accuracy in surface finishing.

The erosion of brittle materials by solid micro-particles is a complex process in which material is removed from ne target Surface by brittle fractures. The rate of material removal is one of the most important quantities for a machining process. Predictive mathematical models for the erosion rates in micro-hole drilling and microchannel cutting on glasses with an abrasive air jet are developed. A dimensional analysis technique is used to formulate the models as functions or the particle impact parameters, target material properties and the major process parameters that are known to affect the erosion process of brittle materials.

REQUIREMENTS:

1. **Abrasive jet**: It is a mixture of a gas (or air) and abrasive particles. Gas used is carbon-di-oxide or nitrogen or compressed air. The selection of abrasive particles depends on the hardness and Metal Removal Rate (MRR) of the workpiece. Most commonly, aluminium oxide or silicon carbide particles are used.

2. **Mixing chamber**: It is used to mix the gas and abrasive particles.

3. **Filter**: It filters the gas before entering the compressor and mixing chamber.

4. **Compressor**: It pressurizes the gas.

5. **Hopper** it used for feeding the abrasive powder.

6. **Pressure gauges and flow regulators**: They are used to control the pressure and regulate the flow rate of abrasive jet.

7. **Vibrator:** It is provided below the mixing chamber. It controls the abrasive powder feed rate in the mixing chamber.

8. **Nozzle**: It forces the abrasive jet over the workpiece. Nozzle is made of hard and resistant material like tungsten carbide.

ADVANTAGES:

1. This model of abrasive jet machine can be used as teaching purpose.
2. It can save the time of industrial visit.
3. It has low capital cost.
4. It can cut intricate holes in materials of hardness.
5. Ability to cut heat sensitive material without damage.

DISADVANTAGES:

1. Material removal rate is low and hence its application is limited.
2. Wear, misalignment, and damage to the nozzle.
3. The abrasive material may accumulate at nozzle and fail the process if moisture is present in the air.

APPLICATIONS:

The major application of Abrasive jet machining process is in the machining of essentially brittle materials and heat sensitive materials like g lass, quartz, sapphire, semiconductor materials, mica and ceramics. It is also used in cutting slot, thin sections, countering, drilling, for producing integrate shapes in hard and brittle materials. It is often used for cleaning and polishing of plastics nylon and Teflon components. Delicate cleaning, such as removal of smudges from antique documents, is also easily done with Abrasive jet machining.

CONCLUSION:

In this project a complete design of the Abrasive Jet Machine is given. The total assembly is designed taking in account of currently available components in the market. The designing and assembling at very large number of

components was a tremendous task and was completed on time. However because of some parts couldn't be purchased the whole assembly was limited to some basic manufacturing operation.

The project can go beyond its current position and capabilities by employing automat ion into this can be done by using stepper motors or DC servo motors interfaced with standard PCI controllers or standalone controllers. 2-D profiles can be converted into standard G-codes and M-codes and that can be sent to the machine to perform automated machining.

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