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PLASMA ARC MACHINING PROCESS PARAMETERS, PROCESS CHARACTERISTICS

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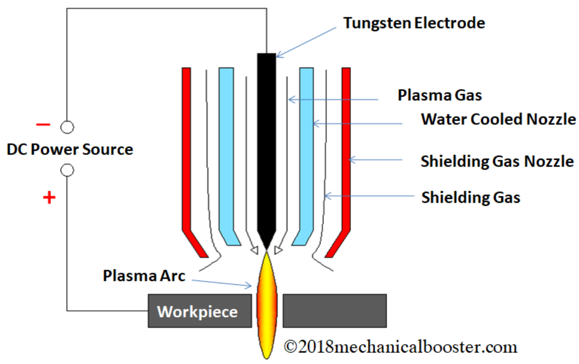
ABSTRACT: *Plasma jet machining (PAM) is a non traditional machining process which uses energy generated by plasma to remove unwanted material from workpiece. With the need in order to obtain high accuracy nowadays unconventional machining is used widely all over the world. In our work we discuss the different process parameters which affect plasma arc machining. This paper describes a variety of fundamental research on PAM prosses parameters which the below mentioned authors have performed recently. Some of the important process parameters and their effects on MRR and surface roughness are discussed. This paper deals with the review of papers by authors.*
KEYWORDS: *Plasma arc machining, process parameters, ANOVA*

INTRODUCTION

Plasma arc cutting was developed at the end of 1970 for cutting several hard metals. Plasma arc machining is used to remove metal by forcing a high velocity jet of high temperature ionized gas on the work piece. It is mostly used when we cannot perform the machining using oxyacetylene gas. This is used for cutting stainless steel and high melting point metals which are conducting in nature. it is usually supported by CNC attachments.



Plasma Arc Machining

Plasma is considered to be the fourth stage of matter after solid, liquid and gas .Plasma is a state which is obtained when gas is subjected to high amount of energy or electric field. Plasma is characterized by a high amount of disassociation and ionization.

PAM can be used for machining stainless steel, aluminum alloys, magnesium, titanium, copper, nickel and other alloys

POWER SOURCE

PAM process needed a high power DC supply to generate electric spark in between tungsten electrode and work piece. The tungsten part is made cathode and nozzle of gun is made as anode. Heavy potential difference is applied across electrodes to develop plasma state of gas

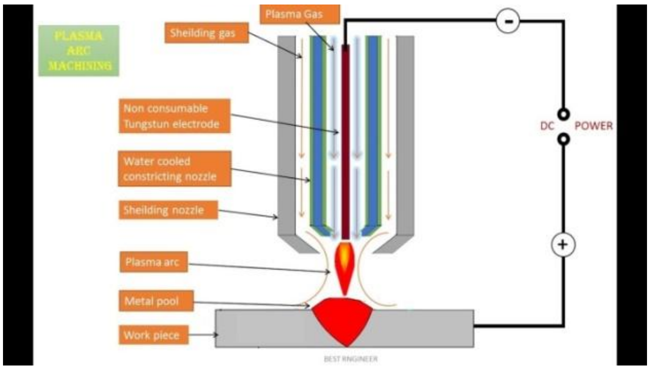
PLASMA ARC TORCH

This is most important part of PAM process. It consist four main parts which are tungsten electrode, collets, inner nozzle, and outer nozzle. The tungsten electrode is hold by the collet. The collet is available in varying diameters. The inner gas nozzle supply inert gases inside the torch to form plasma. The outside nozzle supply shielding gases which protect the work piece area from oxidation. These nozzles wear out rapidly. PAM torches are water cooled because arc is contained inside the torch which produces high heat, so a water jacket is provided outside the torch.

SHIELDING AND PLASMA GAS SUPPLY

Generally, plasma gas is same as shielding gas which is supplied by a same source. Mainly inert gases like argon, Helium etc. are used as both inert and shielding gases. This gas is supplied at

PAM SETUP AND WORKING



A plasma torch as shown in figure is set up which is also known as the gun or plasmatron, gases such as H2, N2, 02, etc. is passed through an orifice where high frequency arc is setup between the tungsten electrode (cathode) and the copper nozzle (anode) where the electrodes are water cooled.

The plasma gas is provided with inert gas shield to protect it from outside environment. When the gas is passed the high-velocity electrons generated by arc collide with the gas molecules and produce dissociation of diatomic molecules of the gas resulting in ionization of the atoms and causing large amounts of energy to be produced. The plasma forming gas is forced through a nozzle duct of the torch in such a manner as to stabilize the arc. The heating of the gas takes place in the compressed zone of the nozzle duct resulting in almost high exit gas velocity and high core temperature up to 16,000 °C. The relative plasma jet melts the work piece material and the high-velocity gas stream effectively blows the molten metal away.

ADVANTAGES OF PAM:

- It gives faster production rate
- Almost all metals can be machined. Very hard and brittle metals can be machined.
- Small cavities can be machined with good dimensional accuracy and with good aspect ratio

DISADVANTAGES OF PAM

- Its initial cost is very high.
- The process requires over safety precautions which further enhance the initial cost of the setup.
- Some of the work piece materials are very much prone to metallurgical changes on excessive heating so this fact imposes limitations to this process.
- It is uneconomical for bigger cavities to be machined.
- Non metals and ceramics cannot be machined

APPLICATIONS OF PAM

- Welding of cryogenic , aerospace and high temperature corrosion resistant alloys
- Nuclear submarine pipe system
- In tube mill application
- Machining of cases in rocket motors

LITERATURE REVIEW

Bhuvenesh et al.,(2012)conducted an experiments on plasma arc machining with AISI mild steel which was widely used in many industries. The input parameters that were considered for machining which affected the surface roughness and MRR were air pressure, cutting speed, cutting current, and air gap. Each of these parameters were varied and machined and then surface roughness and MRR were measured. They concluded the following things.

- Generally the SR values are inversely proportional to MRR values.
- The dimension of the dross determine the quality of plasma arc cutting in terms of surface roughness

Subbarao Chamarthi et al., (2013)[2] performed an investigation analysis on plasma arc cutting. The material he used was HARDOX-400. The investigation was carried on uneven surface. The three input parameters were cutting speed, voltage and plasma flow. He carried out the experiment for 16 trials by varying each parameter in different trails. The unevenness measured was tabulated in microns. The output parameters were surface finish and mrr. Using ANOVA analysis he concluded that cutting speed is inversely proportional to thickness of plate. The optimum values for performing this operation are of 70 L per Hr. of plasma flow rate, voltage of 125 V and cutting speed of 2100 mm per min.

Salonitis et al., (2013) [3] conducted an experimental investigation of plasma arc cutting process where he examined on S235 mild steel sheets considering different input parameters such as cutting speed, cutting current, plasma arc gas pressure, cutting height. The results were represented in terms of heat affected zone (HAZ), surface roughness, conicity of the cut geometry. Experimental results were obtained for 9 different trails by varying CS(1820 -2730 mm per min), CC(180-240 A), cutting height(4.1 to 8.1 mm), pgp (6.5 to 9.5 psi).Using design of experiments and analysis of variance(ANOVA) analysis it was concluded that surface roughness and conicity were mainly affected by cutting height and heat affected zone (HAZ) is mainly influenced by cutting current.

Milan Kumar Das et al.(2014) conducted an experiment on optimization of process parameters in plasma arc machining using a material called EN31 STEEL where 3 input parameters were considered. The input parameters considered were gas pressure, arc current and torch height. The parameters to be analyzed were surface roughness and MRR. Using ANOVA it was concluded that the gas pressure is the most influencing parameter that significantly affects MRR and surface roughness followed by arc current. Among the interactions, interaction between gas pressure and arc current has the maximum contribution on response

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