DESIGN AND DEVELOPMENT OF THREE AXIS PLASMA CUTTING MACHINE

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Abstract

In last forty years there is tremendous research in machining and development in technology. With increase in competition in market and to attain high accuracy now a days the nonconventional machining is become lifeline of any industry. One of the most important non conventional machining method is Plasma Arc Machining. Its high accuracy, finishing, ability of machining any hard materials and to produce intricate shape increases its demand in market. In this paper presented the work design optimization of Plasma Arc Cutting Machine. In order to attain target and optimum results, Design of the machine will provide a knowledge of how to develop the machine using Design consideration. The cost of the machine will reduce as compare to market rate because of the material which is used in the machine is purchasing is very low cost. Maintenance as well as all the machining process will be done in the same industry. The plasma arc cutting machine is widely utilized in the market. The market for cutting machines and robots will keep on seeking fantastic, close resilience cutting from plasma cutting frameworks. Alluringly valued oxygen plasma and less complex and lighter low-amp units will contend positively with laser-cutting gear. Meser with its specialized authority, will keep on playing an overwhelming part in this market section.

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1. INTRODUCTION

Plasma cutting is a process that cuts through electrically conductive materials by means of an accelerated jet of hot plasma. Typical materials cut with a plasma torch include steel, aluminum, brass and copper, although other conductive metals may be cut as well. Plasma cutting is often used in fabrication shops, automotive repair and restoration, industrial construction, and salvage and scrapping operations. Due to the high speed and precision cuts combined with low cost, plasma cutting sees widespread use from large-scale industrial CNC applications down to small hobbyist shops. The basic plasma cutting process involves creating an electrical channel of superheated, electrically ionized gas i.e. plasma from the plasma cutter itself, through the work piece to be cut, thus forming a completed electric circuit back to the plasma cutter via a grounding clamp. This is accomplished by a compressed gas (oxygen, air, inert and others depending on material being cut) which is blown through a focused nozzle at high speed toward the work piece. An electrical arc is then formed within the gas, between an electrode near or integrated into the gas nozzle and the work piece itself. The electrical arc ionizes some of the gas, thereby creating an electrically conductive channel of plasma. As electricity from the cutter torch travels down this plasma it delivers sufficient heat to melt through the work piece. At the same time, much of the high velocity plasma and compressed gas blow the hot molten metal away, thereby separating i.e. cutting through the work piece. Plasma cutting is an effective means of cutting thin and thick materials alike. Hand-held torches can usually cut up to 38mm thick steel plate, and stronger computer-controlled torches can cut steel up to 150 mm thick. Since plasma cutters produce a very hot and very localized "cone" to cut with, they are extremely useful for cutting sheet metal in curved or angled shapes.

2. Review papers on parameters on plasma cutting machine

Subbarao Chamarthi [1] et al. presented that Plasma arc cutting (PAC) is a thermal cutting process that makes use of a constricted jet of high-temperature plasma gas to melt and separate (cut) metal [2]. In this study 12mm plate thickness Hardox-400 has been cut by high tolerance voltage, cutting speed, and plasma gas flow rate included as main parameters in the analysis and their effect on unevenness of cut surface is evaluated. The design of experiments (DoE) techniques is used in order to outline the main parameters which define the geometry of the cut profile, as well as its constancy for Hardox-400 material plate. Despite the value selected for these parameters, the analysis shows that Hardox-400 plates can have different profiles, depending on the specific side considered. Unevenness can be obtained as a result of an experimental investigation aimed at selecting the proper values of process parameters of PAC system. Results of this screening step are analyzed by means of the Analysis of Variance (ANOVA) technique with use of design expert software in order to clearly identify the main parameters, which define the unevenness quality attribute. The operating conditions have been carefully optimized through parameters adjustment like cutting speed, plasma gas and arc voltage in order to obtain good surface quality for all the sides of Hardox-400 plate. [1]

Milan Kumar das [2] et al. presented Investigates the effects and parametric optimization of process parameters for plasma arc cutting (PAC) of EN 31 steel using grey relation analysis. Three process parameters viz. gas pressure, arc current and torch height are considered and experiments are conducted based on orthogonal array (OA) Process responses via material removal rate (MRR) and surface roughness parameters of the machined surface are measured for every experimental runs. For maximum MRR and minimum surface roughness characteristics process parameters are optimized based on taguchi method coupled with grey relational analysis.

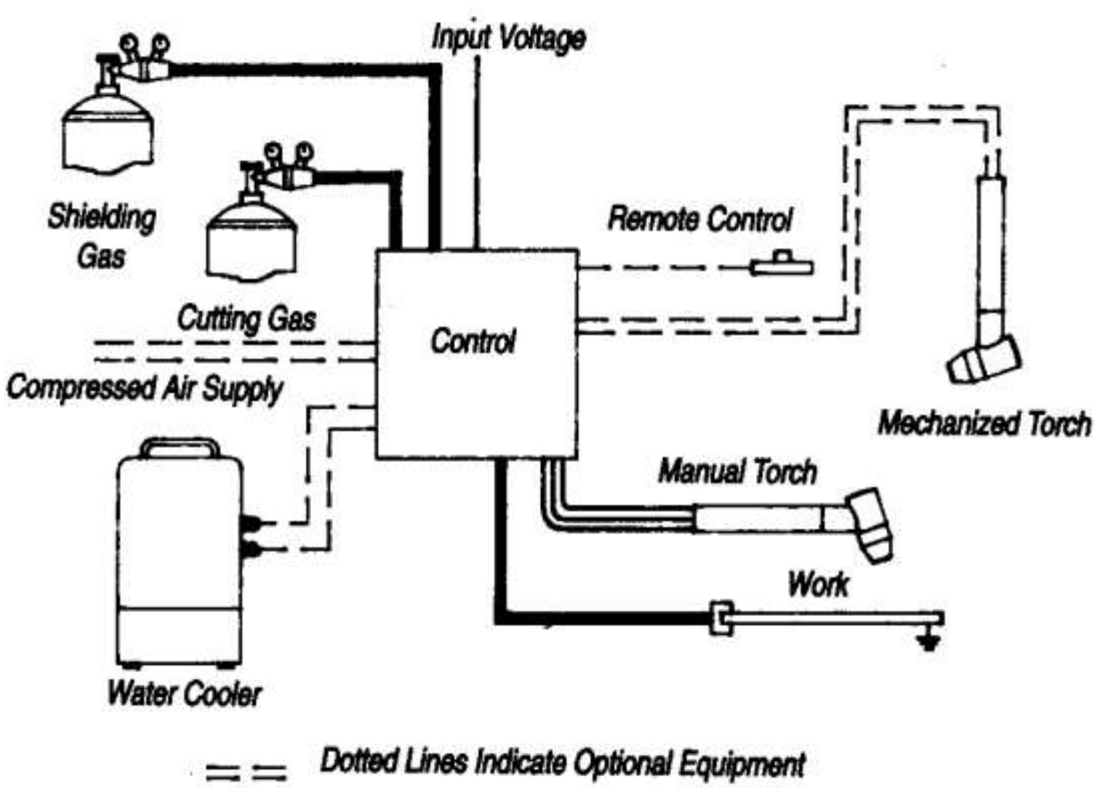
Dimos Paraskevas et al. [4] presented the work investigates the applicability of spark plasma sintering (SPS) as a solid state recycling method for magnesium alloy scrap. In this respect, machining chips from pure Mg and AZ31 Mg alloy ingots are chemically cleaned, cold compacted and SP Sed directly into bulk specimens. It is found that SPS can successfully establish full densification and effective metallurgical bonding between chips without altering compositional constituents. This is attributed to the dynamic compaction during sintering as well as to the disruption of the chips' surface oxide film due to SPS electric current based joule heating. Apart from the successful consolidation, micro structural analysis of the initial Mg ingots, chips and SPS recycled material reveals that the SPS microstructure was finer than that of the original ingots due to significant deformation induced grain refinement during machining. As a result, the recycled materials had a higher compression and shear strength than that of the starting ingot material. The findings indicate that SPS is an effective alternative method for solid state recycling of magnesium alloy scrap.[2]

R.Bini et al.[3] presented the work a high performance plasma arc cutting system is utilized to cut plates from 15 mm thick mild steel sheets metals. the technique is used in order to outline the main parameters which define the geometry of the cut profile, as well as its constancy Beyond arc voltage and cutting speed, plasma gas flow rate, shield gas flow rate and shield gas composition are included in the analysis and their effects on kerf position and shape are evaluated. The performed analysis indicates that cutting speed and arc voltage affect the kerf formation mechanism and their interaction is also important in defining the inclination of the cut.[3]

E.D. cabanillas [6] presented the work A high power industrial plasma cutting equipment was applied to carve a carbon steel. The usually discarded cut material was observed by scanning electron micro scopy(SEM) showing that hollow and entire micro spheroidal particles were produced. The analysis with X-ray diffraction evidenced that the composition of micro particles was FeO, Fe2O3 and Fe3O4 By transmission of electron microscopy it was found that spherical nano particles in the range of 2 to 150 mm in diameter were formed.[4]

3. Study of plasma cutting machine

Plasma arc cutting can increase the speed and efficiency of both sheet and plate metal cutting operations. Manufacturers of transportation and agricultural equipment, heavy machinery, aircraft components, air handling equipment, and many other products have discovered its benefits. Basically Plasma Arc Cutter comprises of 8 major parts such as air compressor, AC plug, power supply, plasma torch, ground clamp, electrode, nozzle and work piece.



PLASMA ARC CUTTER SYSTEM

The basic plasma arc cutting system consists of a power supply, an arc starting circuit and a torch. These system components provide the electrical energy, ionization capability and process control that is necessary to produce high quality, highly productive cuts on a variety of different materials.

The power supply is a constant current DC power source. The open circuit voltage is typically in the range of 240 to 400 DC. The output current (amperage) of the power supply determines the speed and cut thickness capability of the system. The main function of the power supply is to provide the correct energy to maintain the plasma arc after ionization.

The arc starting circuit is a high frequency generator circuit that produces an AC voltage of 5,000 to 10,000 volts at approximately 2 megahertz. This voltage is used to create a high intensity arc inside the torch to ionize the gas, thereby producing the plasma.

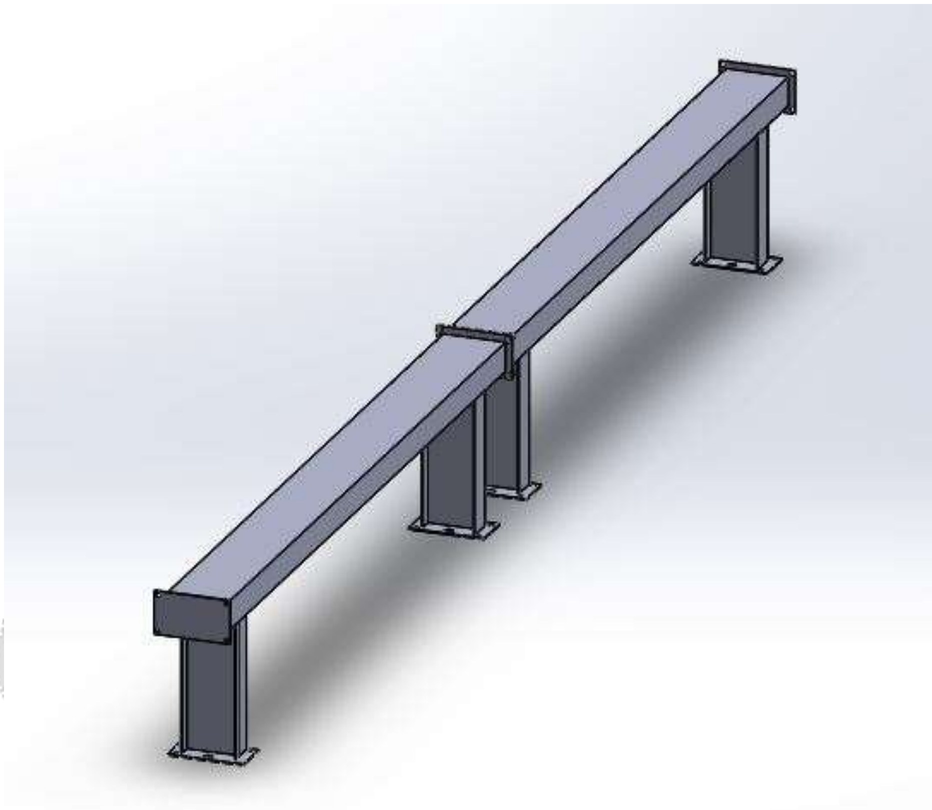
The Torch serves as the holder for the consumable nozzle and electrode, and provides cooling (either gas or water) to these parts. The nozzle and electrode constrict and maintain the plasma jet.

3.1 Objectives

- To Optimize the Design with Simplification of Fabrication.
- To improve machine flexibility with Hybrid Design.
- Need to reduce the cost considering different parameters of PCM.

4. Design of the machine

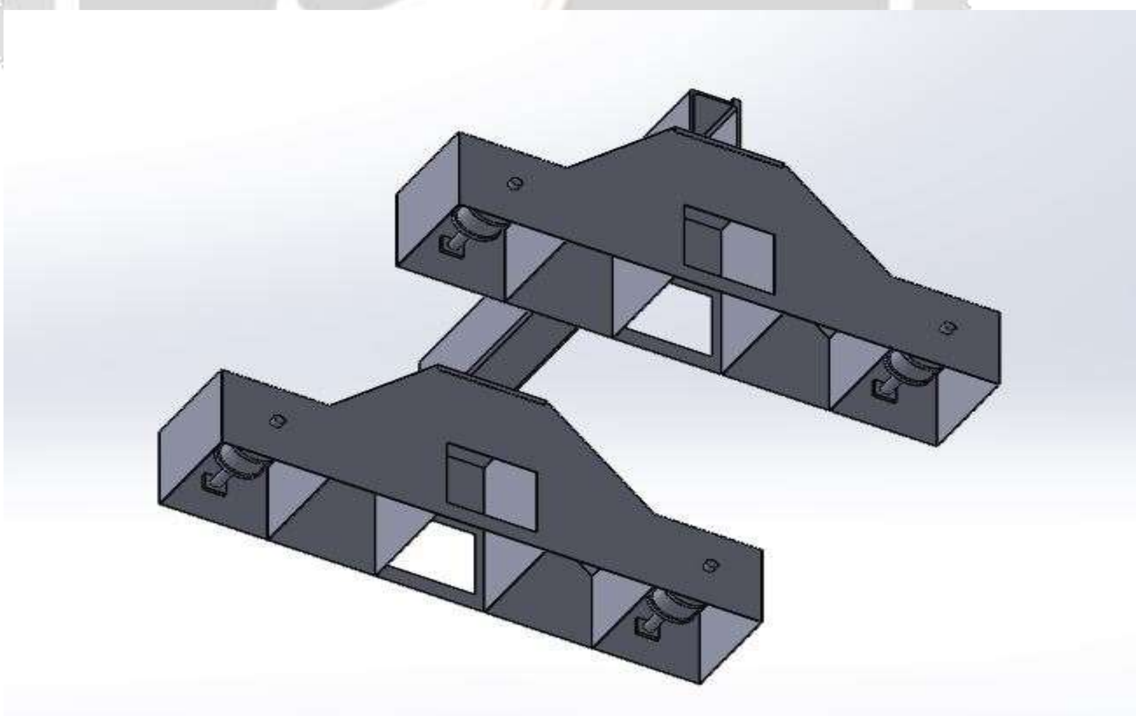
4.1 BED Design



DIMENSION : Base		
DIMENSION	**Inch**	**Mm**
HEIGHT	**24”**	**609.6**
LENGTH	**114”**	**2895.6**
BREATH	**6**	**152.4**

Total Number of Base : 2

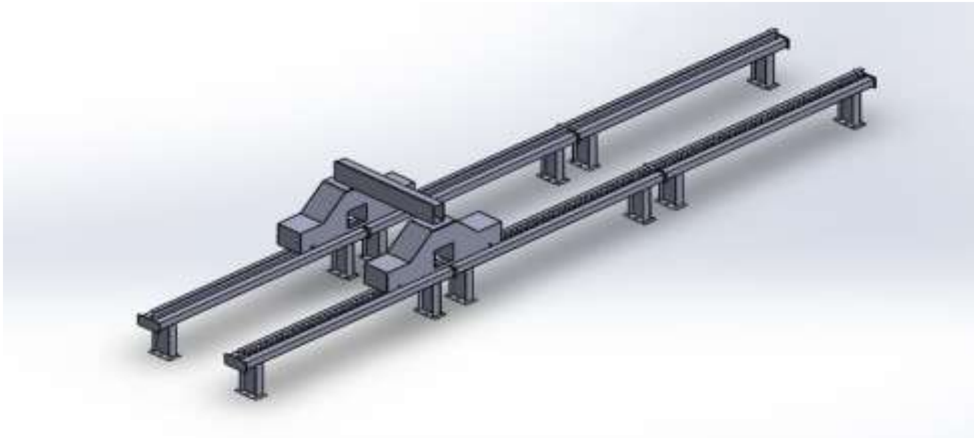
Fig 4.1 Base of plasma cutting machine (Omega CNC Automation)



DIMENSION : Bearing		
DIMENSION	Inch	Mm
DIAMETER	4.4”	115
SHAFT DIA.	1.25”	30
LENGTH OF SHAFT	5.8”	150
Total Number of Bearing : 4		

Fig 4.2 Roller of plasma cutting machine (Omega CNC Automation)

4.3 Assembly of the machine



Conclusion:

Plasma cutting process parameter study suggest that the cutting speed of increase or decrease is proportional to thickness of plate. For using different methods optimize the process parameters like MRR and surface roughness. For developing the plasma machine need to optimize the parameter to control the process and improve the performance of machining process. After frame work of these review papers I have try to developing the plasma cutting machine.

References

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