Taguchi Based Parametric Analysis and Optimization of Power Consumption and Kerf in Plasma Arc Machining

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ABSTRACT

With increase in competition in market and to attain high accuracy now a days the nonconventional machining are become lifeline of any industry. One of the most important non-conventional machining methods is Plasma Arc Machining. Due to its high accuracy, finishing, ability of machining any hard materials and to produce intricate shape increases its demand in market .This work discusses Taguchi based parametric study for power and kerf optimization and suggest the optimum combination of input variables for the set conditions. This helps in minimum use of power and thus economic machining with less rejection.

Keywords—Machining, Taguchi Method, Kerf Optimization

I. INTRODUCTION

Advanced materials exhibit very excellent technical properties. However, the high cost of raw material and processing Limit their use alternatively. Advanced machining such as Plasma Arc Cutting is normally used in machining of harder materials. Advanced material such as nickel base alloys, titanium alloys and stainless steel can be used as the work piece in this type of cutting .The feasibility and effectiveness needs to be proven by experiment and by using Taguchi Method. This paper explains the Taguchi based optimization of kerf and power consumed in PAM using various process parameter to obtain the best factors combination With engineering advances in PAC equipment, all metals that conduct electricity, whether they are common or exotic metals, can be cut economically with one process. Since the plasma arc cutting process is capable of handheld or machine torch cutting metals [9] ranging from thin gauge aluminum to 5C60 mm carbon or stainless steel. It can be used in many applications, including stack cutting, beveling shape cutting, gouging, and piercing in all positions. The PAC process is used in industries such as metal fabrication, construction, metal salvage (scrap and recycling), automotive repair, metal art and sculpting.

II. LITERATURE REVIEW

Plasma cutting is a process that is used to cut steel and other metals (or sometimes other materials) using a plasma torch. In this process, an inert gas (Argon) is blown at high speed out of a nozzle and at the same time an electrical arc is formed through that gas from the nozzle to the surface being cut, turning some of that gas to plasma. The plasma is sufficiently hot to melt the metal being cut and moves sufficiently fast to blow molten metal away from the cut. Plasma can also be used for plasma arc welding and other applications [2]. Plasma is typically an ionized gas. Plasma is considered to be a distinct state of matter, apart from gases, because of its unique properties. Ionized refers to presence of one or more free electrons, which are not bound to an atom or molecule. The free electric charges make the plasma electrically conductive so that it responds strongly to electromagnetic fields [3]. Plasma cutting is typically easier for the novice to master, and on thinner materials, plasma cutting is much faster than oxy fuel cutting. However, for heavy sections of steel (1inch and greater), oxy fuel is still preferred since oxy fuel is typically faster and, for heavier plate applications, very high capacity power supplies are required for plasma cutting applications [4].

III. OBJECTIVES

This paper was developed to study about the plasma arc cutting parameter in smooth cutting using straight polarity process. The main purposes of this project are listed below:

a) To study about the influence of Plasma Arc Cutting Parameters on Stainless Steel.
b) To design a series of experiment using the help of Design of Experiments (DOE) layout in order to study
about Plasma Arc Cutting (PAC). c) To study about the best combination of solution for maximizing the Material Removal Rate (MRR) and for minimizing the Surface Roughness (Km) with Taguchi Method.

Plasma arc cutting can be characterized in terms of two distinct speeds. At cutting speeds above, the plasma jet does not cut through metal plate. At speeds below, the molten metal from the kerf \[10\] sticks to the bottom of the plate. Plasma can cut in a wide range of cutting parameters (currents, metal thicknesses and nozzle orifice diameters) for plasma arc cutting of stainless steel materials. The plasma arc cutting process employs a plasma torch with a very narrow bore to produce a transferred arc to the work piece at an average current density of within the bore of the torch. The energy and momentum of the high velocity plasma jet generated by the plasma \[8\] torch melts, vaporizes and removes the metal from the region of impingement of the nozzle.

IV. SCOPE OF WORK

This project focuses on the optimization of cutting parameters of Plasma Arc Cutting (PAC). 2. The material used to cut was Stainless Steel of specification ASTM A240 TP316 L. 3. Design of Experiments (DOE) layout will be used for testing and analyzing with Taguchi Method. 4. All of data was analyzed by using Minitab 15 Software to produce the best combination setting in plasma cutting for Stainless Steel. 5. The machine used was Silvering CNC Plasma Cutting Machine with Sharp line, Bombay make Burney 10 LCD to perform the machining operation.

V. DESIGN OF EXPERIMENTS (DOE)

Design of Experiments (DOE) is a powerful statistical technique introduced by R.A. fisher in England in 1920s to study the effect of multiple variables simultaneously DOE can highly effective when: a).

VI. TAGUCHI METHOD

The following seven points highlight the distinguish feature of Taguchi's approach which aimed at assuring optimum quality:
1. Taguchi defined the term quality as the deviation from on target performance which appears to be first paradox. According to him the quality of a manufactured product is the total loss generated by that product to the society from the time it is shipped.
2. In a competitive economy continuous improvement (CQI) and cost reduction are necessary.
3. A CQI programme include continuous reduction in the variation of product performance characteristic in their target values.
4. Customer loss attribute to the product performance variation is often proportional to the square of the deviation performance characteristic from its target value.
5. The finally quality and cost of a product manufactured depends primarily on the engineering design of the product and its manufacturing process.
6. Variation in the product depends primarily on the engineering design of the product and its manufacturing process.
7. Statically planned experiments can efficiently and reliably identify the settings of the product and process parameters that reduce performance variations.
VII. PROCESS PARAMETERS AND MODELING IN PAM

The Regression Equation for Kerf
\[ C_6 = -14614 - 70.3 \, C_1 + 214.77 \, C_2 + 121.24 \, C_3 + 0.173 \, C_4 \]

The Regression Equation for Power consumed
\[ C_5 = 0.261 + 0.0249 \, C_1 + 0.00324 \, C_2 - 0.00445 \, C_3 + 0.000280 \, C_4 \]

A] Taguchi Analysis: C9 versus A, B, C, D
TWO level

Response Table for Signal to Noise Ratios
Smaller is better

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Response Table for Means

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Regression Equation for Power consumed
\[ C_5 = 0.261 + 0.0249 \, C_1 + 0.00324 \, C_2 - 0.00445 \, C_3 + 0.000280 \, C_4 \]
### IX. CONCLUSION

This paper explains the parametric effect on kerf and Power consumed in PAM in which parameter x4, x1, x3 and x2 have influence on kerf and power and also the mean response and S/N curve depicts the optimum values. This work helps in tuning the PAM process for better accuracy with less kerf accordingly.

### REFERENCES


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