Chapter 5

Optimization of Process Parameters in Plasma Arc Cutting Applying Genetic Algorithm and Fuzzy Logic

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ABSTRACT

Plasma Arc Cutting (PAC) process is a widely used machining process in several fabrication, construction and repair work applications. Considering gas pressure, arc current and torch height as the inputs and among all possible outputs, in the present work Material Removal Rate and Surface Roughness would be considered as factors that determines the quality, machining time and machining cost. In order to reduce the number of experiments Design of Experiments (DOE) would be carried out. In later stages applications of Genetic Algorithm (GA) and Fuzzy Logic would be used for Optimization of process parameters in Plasma Arc Cutting (PAC). The output obtained would be minimized and maximized for Surface Roughness and Material Removal Rate respectively using Genetic Algorithm (GA) and Fuzzy Logic.

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INTRODUCTION

Presently Plasma Arc Cutting (PAC) process is a machining process that has wide variety of applications in various fabrication unit e.g. automotive repair shops, various fabrication shops, construction sector etc. In this technique a jet in accelerated state (accelerated jet) of hot plasma is used as the means for cutting through electrically conductive materials. Materials those can be cut using this method include steel, brass, copper, aluminium etc. When the cutting object gets in contact with the electrode in torch an arc discharge generates the heat. This generated heat is utilised for cutting operations. The arc discharge which is generated forms the working gas into the plasma with high temperature. When a gas is heated to very high temperature, then the molecules gain kinetic energy which makes them collide with each other producing electrically neutral state called plasma. This plasma in high temperature state is blown through the nozzle with a very high speed and the cutting material is fused to be cut. This method is used for cutting operations from large scale industries with CNC applications to small fabrication shops because of its high operating speed and low cost precision cutting characteristics.

Since the requirements of customers have become complex enough in the day to day life, the quality of the product to be developed and its quantity have become the primary motive. The systems and the technology nowadays are made in a way to meet the complex requirements of customers. Hence in this case the reconfigurable system designing plays a vital role in maintaining the high level performance by changing the functional requirements. This reconfigurable designing also considers many factors those affects the operations like that of time, cost and the quantity of production.

Plasma Arc Cutting (PAC) is one of the most dependable non conventional machining processes that work on the principle of thermal cutting. PAC has been a really useful technique in the cutting operations of stainless steel, high hardness metals and metals with high melting points. Many metals or alloys which are difficult enough for machining are generally machined using PAC. It acts as a replacement/alternate method to oxy-fuel process. In 1960s when Plasma welding process was considered as an effective method for joining process then PAC came out of this very technique. It was found to be an efficient method to cut sheet metal and plate in 1980s. Later CNC technology was incorporated into plasma cutting machines in 1990s. By incorporating the CNC technology it was found that PAC became even more flexible and many complex shapes were also easily cut using this technique. The only limitation with CNC plasma cutting machines is that they were limited to only some cutting patterns in two axes of X and Y.

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