Chapter 14
Modeling and Optimization of Gas Metal Arc Welding (GMAW) Process

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ABSTRACT

Weld quality is greatly affected by the operating process parameters in the gas metal arc welding (GMAW) process. The quality of the welded material can be evaluated by many characteristics, such as bead geometric parameters, deposition efficiency, weld strength, weld distortion, et cetera. These characteristics are controlled by a number of welding process parameters, and it is important to set up proper process parameters to attain good quality. Various optimization methods can be applied to define the desired process output parameters through developing mathematical models to specify the relationship between the input parameters and output parameters. The method capable of accurate prediction of welding process output parameters would be valuable for rapid development of welding procedures and for developing control algorithms in automated welding applications. This chapter presents the details of various techniques used for modeling and optimization of GMAW process parameters. The optimization methods covered in this chapter are appropriate for modeling and optimizing the GMAW process. It is found that there is high level of interest in the adaptation of RSM and ANN techniques to predict responses and to optimize the GMAW process. Combining two optimization techniques, such as GA and RSM, would reveal good results for finding out the optimal welding conditions. Furthermore, efforts are required to apply advanced optimization techniques to find out the optimal parameters for GMAW process at which the process could be considered safe and more economical.

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INTRODUCTION

The gas metal arc welding (GMAW) process is a welding process that yields coalescence of metals by heating with a welding arc between continuous filler metal wire electrode and the work piece. The continuous wire electrode, which is drawn from a reel by an automatic wire feeder, and then fed through the contact tip inside the welding torch, is melted by the internal resistive power and heat transferred from the welding arc. Heat is concentrated by the welding arc from the end of the melting electrode to weld pool and by the molten metal that is being transferred to weld pool. Molten weld pool and electrode wire are protected from contaminants in the atmosphere by a shielding gas obtained from various combinations. Figure 1 shows the basic circuit diagram of GMAW process.

The basic circuit consists of the following:

1. Welding gun: It has a number of key parts – a control switch, a contact tip, a power cable, a gas nozzle, an electrode conduit and liner, and a gas hose. The control switch, when pressed by the operator, initiates the wire feed, electric power, and the shielding gas flow, causing an electric arc to be struck. The contact tip, normally made of copper, is connected to the welding power source through the power cable and transmits the electrical energy to the electrode while directing it to the weld area. Before arriving at the contact tip, the wire is protected and guided by the electrode conduit and liner, which help prevent buckling and maintain an uninterrupted wire feed. The gas nozzle is used to evenly direct the shielding gas into the welding zone.
2. Work piece: It can be a metal or alloy
3. Power supply: Most applications of GMAW use a constant voltage power supply. As a result, any change in arc length results in a

Figure 1. GMAW circuit diagram