E. A Process Control System to Determine an Optimum GMAW-P Parameter on the Basis of Process-Integrated Quality Assurance

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Process-integrated quality assurance of the weld is possible on the basis of more uniform pulse power area for each pulse cycle time

In this research paper the results of investigation dealing with pulsed current gas metal arc welding (GMAW-P) with emphasis on process stability are presented. Selecting the parameters of GMAW-P is very important as melting phenomena of the filler metal, arc stability and quality of the weld mainly depends upon it. Selecting the most suitable GMAW-P parameter is very complex due to interdependence of parameters. In order to simplify this selection procedure, a process control system has been designed.

According to this process control system, an optimum GMAW-P parameter was selected on the basis of process-integrated quality assurance. Because, this basis enables online monitoring of welding power as well as the reproduction of welding data and complete documentation of all parameters and welding machine adjustments. The welding was carried out using a transistorized pulsed GMA welding power supply and solid filler metal ER 5356 Al-Mg alloy having a diameter of 1.2 mm (0.047 in.) and with the compatible AA 5083 Al-Mg alloy of 6.0 mm (0.236 in.) thick base metal.

The level of arc stability was assessed from the regularity of pulse power area for each pulse cycle time and used as an important parameter or indicator for optimizing the welding conditions. For this, first, the effects of GMAW-P parameters on the various types of droplet detachments were studied. Secondly, the pulse power area for each pulse cycle time was measured for all the welding experiments and the values of mean, standard deviation (S.D), and coefficient of variation (C.V) were calculated. The optimum GMAW-P was selected by choosing the pulse parameter which resulted in the least S.D and C.V of pulse power area. This enables to produce cost-effective, spatter free, high quality welds.

The lowest standard deviation and the lowest C.V for the pulse power area were observed for the weld, which was made with one droplet detachment during peak duration. The smaller the standard deviation and the smaller the C.V, the more uniform the pulse power is. That means this type of droplet detachment provides a droplet from the filler metal tip regularly during peak duration in order to produce spatter free, high quality, and stable weld. Hence, one droplet detachment during peak duration was considered to be the best for providing a more uniform pulse power area than the other types of droplet detachments.

Therefore, only the GMAW-P combinations, which provide one droplet detachment during peak duration, are suitable for carrying out good quality weld. The above parameter combination can be programmed to the computer so that whenever operator wants to use the particular wire feed rate, automatically this particular pulsed waveform is selected, and the operator gets good quality weld. Thus process-integrated quality assurance of the weld can be possible on the basis of the regularity of pulse power area for each pulse cycle time. This technique facilitates research into process-integrated quality assurance and to improve the design of GMAW-P equipment to ensure that preferred welding parameters are used and to research the cause of variable performance of GMAW-P equipment in actual practice. The study can also be extended to monitor the manual skill of welding machine operators during their training or actual work. Importantly during underwater welding, the instructor cannot find out the weld quality because of poor visibility of the prevailing or existing condition.