Evaluation of A Welding Power Source

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ABSTRACT

A number of power sources are available today from different manufacturers for MIG/MAG welding. Thyristor power sources and transistor power sources are gaining popularity. The performance of MIG/MAG welding power supplies is heavily dependent on their dynamic properties. However, present day codes are not adequate for evaluating the power source since dynamic properties are not taken in to consideration.

In this paper a simplified method is proposed for evaluation of a given power source which can form guidelines for ordering a new power source as well as to evaluate the same. Evaluation of arc stability, arc ignition and spatter level, are some of the factors considered in the present study.

1. INTRODUCTION

Welding with consumable electrode in shielding gas atmosphere (MIG/MAG) is one of the most commonly used welding methods. Both stability of the process and quality of welded joints depend on many factors, among which the properties of welding equipment, particularly welding power sources play a significant role.

2. PROPERTIES OF WELDING POWER SOURCES

There are two types of properties available for a power source for MIG/MAG welding.

2.1 Welding Properties

These are the properties of a power source on which the following factors depend.

a) Formation of weld in various positions.
b) Reliability and feasibility of initial arc ignition.
c) Arc burning and welding process stability.
d) Metal losses by fumes and spattering.

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2.1.1 Electrical Properties

The electrical properties are those which can be tested easily by conventional testing methods as per Indian Standards and British Standards under the categories of type tests and routine tests. A brief report of conventional testing procedures of Indian and British standards are given below.

2.2 Testing for the Electrical Properties

The Indian standards available (Ref. 1 to 4) in the field of welding equipments gives the following testing procedures for evaluation of arc welding equipment.

Type Test : Insulation test, High voltage test, open circuit test, load test, short circuit test, and temperature test.

Routine Tests : Insulation resistance test, High voltage test, open circuit voltage test and short circuit test.

3. EVALUATION OF WELDING PROPERTIES

3.1 Index of Weld Formation

This is evaluated according to appearance of weld bead. A ratio between bead height and its width h/b is calculated. Depending on the value of h/b and evaluation of bead surface, formation index is calculated (7). An evaluation according to a formation index testifies the suitability of for welding.

3.2 Spatter Coefficient

We can evaluate spatter coefficient as a ratio of mass of spatter to mass of molten wire, for a given power source.

3.3 Index of Arc Ignition

This is evaluated by a number of short circuits or breakdowns of welding circuit from the moment of the first contact of electrode wire with plate upto the beginning of that short circuiting after which the process continues without welding circuit break. The value should not exceed 3 short circuits (7).

4. TESTING FOR WELDING PROPERTIES

The welding properties of power supplies are defined by their static and dynamic characteristics. The static characteristics which are the correlation between output voltage and current for variable loads determine power supply suitability to a specific welding process. The dynamic characteristics, which are welding voltage and current waveform recordings caused by metal transfer across the arc, welding parameters, and electrical parameters of power source determine the stability of welding process.

If the dynamic properties of the welding power source are evaluated then there is no need to evaluate separately the index of weld formation, spatter coefficient and arc ignition characteristics.

The dynamic properties of power supplies are usually featured by the rate of rise of current during a short circuit by the rate of rise of current during a short circuit by metal drop dI/dt. The mean value of dI/dt which depends first of all on welding circuit inductance, determines the manner of metal transfer. Many authors [8,9], pointed out that the optimum welding conditions took place for such a value of inductance which enable to obtain the rising of current rate within the range 10-200 kA/sec.

5. METHODS OF RECORDING DYNAMIC CHARACTERISTICS

We can use a micro processor based data acquisition system, or PC based data acquisition system, or digital memory scope, or UV recorder for recording of dynamic characteristics.

6. WORK DONE AT WELDING RESEARCH INSTITUTE

A micro processor based data acquisition system has been designed and developed at WRI, for data acquisition from arc welding, along with suitable signal conditioners. Various welding trials were designed to study the performance of four different welding power sources, namely two transformer rectifiers, a thyristor rectifier and a transistor power source. The welding trials were carried out in both automatic mode and semi-automatic mode. The data thus collected from the welding trials were processed using a personnel computer. The dynamic characteristics were plotted for all the power sources for different parameters. From the dynamic characteristics the following aspects of the power sources were evaluated and a criterion was formulated.

6.1 Arc Ignition Characteristics

By recording the moment of arc ignition, the time required for the arc to reach stability is calculated and number of current pulses during the ignition time are counted. It was found that when the ignition time is less than 15 millisecs and the number of pulses are less than 3, the arc ignition characteristics are satisfactory.

6.2 Arc Stability Characteristics

Arc stability is to be evaluated mainly for the short circuit type of metal transfer mode in case of Mig/Mag welding. The arc is fairly stable in the case of higher voltage and current regions in which we obtain spray transfer and globular transfer provided proper parameters for welding are employed. During the short circuit mode of metal transfer the number of short circuits vary from 20 to 200. A short circuit current pulse is identified by the computer by calculating the number of times the current rises more than 125 percent of the average current. By calculating the average of all the current points, the average current value is obtained. By calculating the average of all the peak points, the average value of the current pulse can be determined. The deviation of the current pulses from the average current pulse can be calculated as a percentage variation of the short circuit current pulses. This percentage can be used as a factor for evaluation of the arc stability for a given power source. This percentage will increase with the lowering of the current value. Hence, the limiting current of a given power source below which the arc stability is poor can be decided.

If the arc stability factor is found above 75 percent, the stability and weld bead formation are satisfactory.

6.3 Spatter Characteristics

The difference between the average current and the average current pulse gives the factor which is proportional to the spatter level at given current level. If correct value of choke is chosen then this factor is minimum. If the difference is zero then it means that there is no current pulse. If the difference is large then it means that the current pulses are narrow and the choke value is less and there will be excess spatter. If the ratio of average current pulse to average current is more than 2, excessive spattering was observed.

Hence in this manner all the information about the arc, namely arc ignition, arc stability and spatter can be evaluated from the dynamic characteristics of the power sources. Few sample graphs recorded at WRI for different power sources are given in Fig 1 to 6.

7. CONCLUSION

It is clear that the present day codes available for testing of power sources are not adequate for evaluation of welding power sources as they evaluate only the electrical properties and not the welding properties of the power sources. Some of the methods suggested for evaluation of the welding properties of power sources are tedious, costly and time consuming. In this paper a simple, reliable and fast method of evaluation of the welding power source for Mig welding has been proposed, wherein recording and analysis of dynamic characteristics are to be carried out. By this method, the complete data regarding the quality of arc ignition, arc stability and spatter level during welding can be obtained and the power source can be evaluated quickly and also specific welding properties can be insisted upon for a given application by the user.

ACKNOWLEDGMENT

The authors express their sincere thanks to BHEL/ Trichirapalli management for permitting to present this work.

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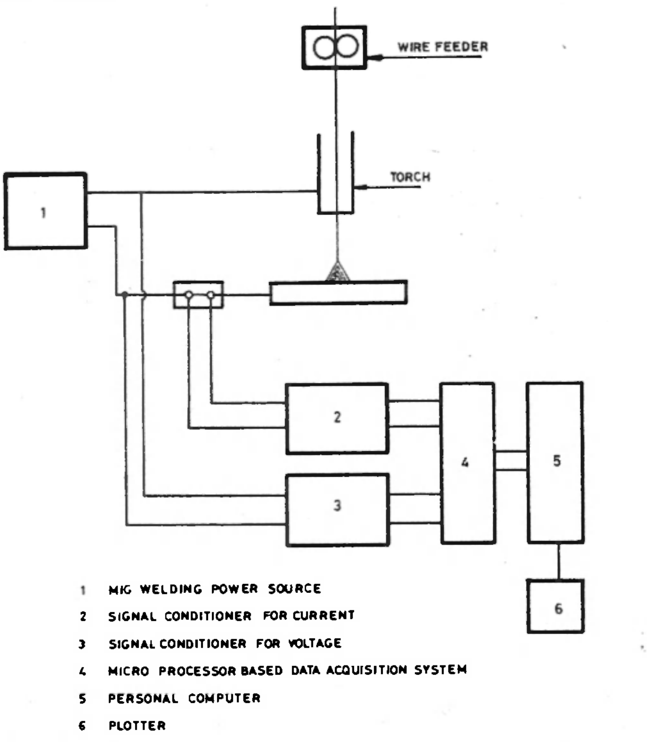

Fig. 1. *Recording of dynamic charecteristics of welding power source*

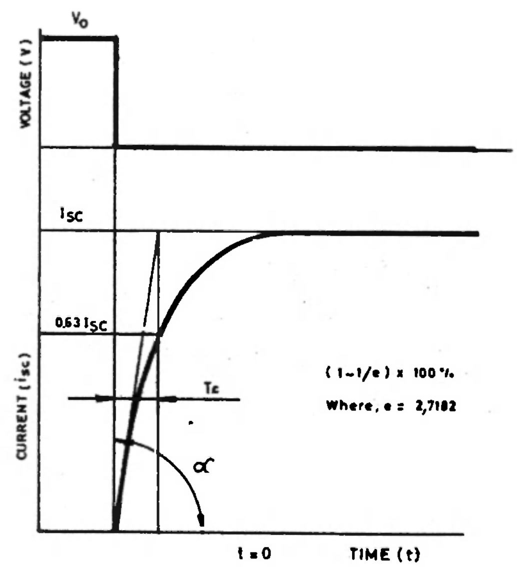

Fig. 2. *Calculation of time constant T_c for short circuit current wave form*

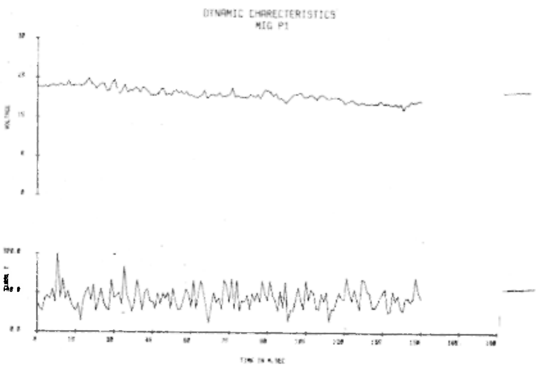

Fig. 3. *Trasistorised power source*

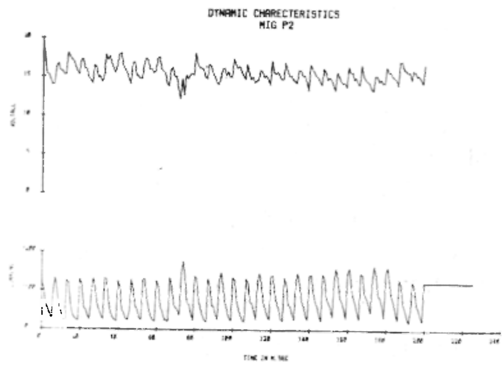

Fig. 4. *Thyristor power source*

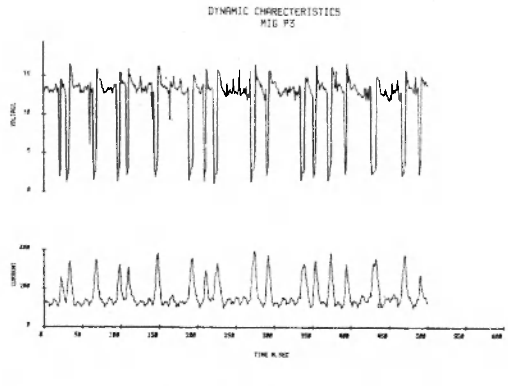

Fig. 5. *TR-Rectifier power source type - I*

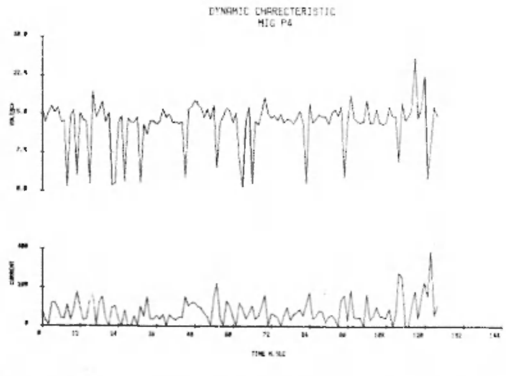

Fig. 6. *TR-Rectifier power source type - II*