디지털 DC-ARC 용접기의 개발

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DEVELOPMENT OF DIGITAL DC-ARC WELDING MACHINE

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Abstract :This paper introduces the results of the development of a new mobile Digital DC-arc Welding Machine (DDWM). A simple PI controller is applied to the DDWM to control the output welding current tracking the constant setting current. Furthermore, a hot-start function, an anti-stuck function, a standby mode and an intelligential circuit breaker (ICB) are included in the DDWM. The DDWM increases welding quality and saves more power energy than a conventional welding machine. Because the DDWM is changed from ready mode into the standby mode automatically after 2 minutes interval from this unload start. Then the DDWM is changed into ready mode automatically since it is reused to weld. Mover, the DDWM increases welding quality, productivity and reduces costs of welding. So, the DDWM can have a great of contribution to the mobile welding industries. The effectiveness of the DDWM was proven by the experimental results and durable test.

Keywords:DC-arc welding machine, Power switching IGBTs, Hot-start function, Anti-stuck function

1. INTRODUCTION

To solve the problem of weight and size of DC-arc welding machine it is necessary to design an inverter which provides much higher frequency than 60Hz to supply for ferrite transformer. So ferrite transformer of much smaller mass is used to permit the handing of much greater powers output. The choice of 20 KHz for the DDWM was determined. The output welding current is controlled by controlling the power supplier for ferrite transformer at high frequency. A control circuit and an inverter are developed. The control circuit for driving the power switch IGBTs of the inverter is designed.

2. PROBLEM STATEMENT

The DDWM controls the output welding current by controlling the duty cycle of PWM. Based on the error between the values of feedback output welding current and the setting current, a PI controller is designed. The PI controller will adjust the $e \to 0$ as $t \to \infty$. Moreover, by using the hot-start function the output current of DDWM easily achieves the setting current at welding start of state.

3. HARDWARE AND SOFTWARE IMPLEMENTATION

3.1 Hardware Design

Three main parts of DDWM were described on Fig.1. First part is an inverter. Second part includes a ferrite transformer, a power rectifier and a filter of welding current. Third part is a control circuit.

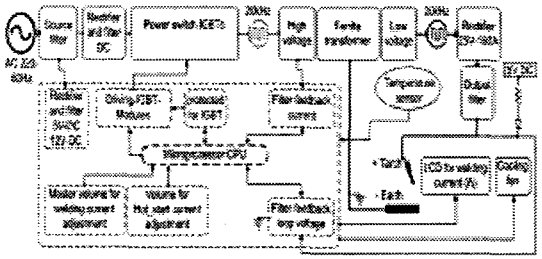

Fig. 1 Main part diagram of the DDWM

3.2 Feedback Controller Design

The proposed PI controller can be described as follows:

$$u = K_p e + K_I \left(\frac{1}{T_i} \int_0^{T_i} e dt \right) \quad (1)$$

In the discrete time signal the control signal in PI controller can be calculated from:

$$u_i = K_p e_i + D(i) \quad (2)$$

where

$$D(i) = D(i-1) + \frac{K_I * \text{Sampling time}}{2} \left(e_{(i-1)} + e_{(i)} \right)$$

u : The control signal,

i_{ref} : The reference welding current,

i_{out} : The output welding current of machine,

u_i, e_i : The control signal at i[th] sampling time and the control error at i[th], respectively,

t_d : The sampling time,

T_i : The integral time of the controller,

K_p : The proportional gain of the controller,

K_I : The integral gain of the controller,

P_w : The duty of PWM (%), $0 \le P_w \le 0.4$

4. EXPERIMENTAL RESULTS

The setting current and the output welding current are shown in Fig. 2, 3 respectively.

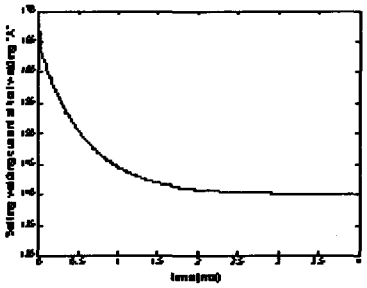

Fig. 12 Setting welding current at first welding

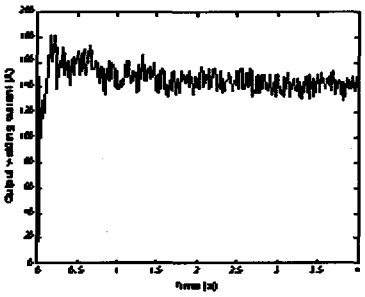

Fig. 13 Output welding current

5. CONCLUSIONS

A simple PI controller is applied to the DDWM to control the output welding current tracking the constant setting current and furthermore, a hot-start function and an anti-stuck function are included in the DDWM. The DDWM increases welding quality, productivity and reduces costs of welding. So, the DDWM can have a great of contribution to the mobile welding industries.

REFERENCES

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