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IoT Based Controlling and Monitoring of CO_2 Gas in Welding Machine

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ABSTRACT: The paper describes efficient method of controlling excessive CO_2 gas emission in ARC welding machine. A solution is provided for controlling flow of CO_2 at the time of ARC welding. A database management system is developed and connectivity is established on web based system with offline and online monitoring. Real time data acquisition using arduino and Ethernet shield is implemented. The proposed work is validated using experimentation

KEYWORDS: Gas Metal ARC Welding, Arduino Ethernet shield, html tags, Arduino mega, Shunt Resistor, etc.

I. INTRODUCTION

The continuous developments and demand of various part such as automotive, aerospace structures and various machine component etc and production of those parts at high rate one of the most desired demand is automation as well as accuracy. Producing any assembled operation joint is one of the most important manufacturing requirement. Welding is an improved process of the conventional process so that it can be applied to various dimensional components. There are several welding method already established. Gas Metal Arc Welding (GMAW) is the most widely used welding method. All the major commercial metals can be welded by the MIG-CO2 process, including carbon steels, stainless steels, aluminum, and copper. Gas metal arc welding (GMAW) is an electric arc welding process which joins metals by heating them with an arc established between a continuous filler metal electrode and the workpeace. Shielding of the arc and molten weld pool is obtained entirely from the externally supplied gas or gas mixture. In this system design and implementation of IoT based controlling and monitoring of CO2 welding machine by using arduino mega is developed. Following parameters related to CO2 welding process are controlled in this project work :

(I) Controlling flow of CO2 gas during welding process
(II) Automatic switching of Solenoid valves in gas bank
(III) Over/ Under voltage protection

In this project implementation of Internet of Things (IoT) is used to access the pressure value of the gas for automatic switching of solenoid valves in gas bank. The programming of project is developed in C and HTML language on Arduino IDE software.

II. RELATED WORK

Hossein Sartipizadeh et.al. has proposed a system i.e. Control of Gas Metal Arc Welding by an Extended DMC. The designed extended dynamic matrix controller and applied on GMAW which is considered as nonlinear multiple input multiple output system, Open circuit voltage and wire feed speed are used for controlling action of welding current and arc length. In this paper author give structure and performance of proposed controller and then set of simulation results to verify the system [1]. Mohammad Mousavi Anzehaee et.al. has proposed a system which consist control of Gas Metal Arc with the help of different parameters. Author used the kalman filter to estimate Arc voltage and Arc length in a high level noisy environment of GMAW process in open loop and closed loop modes. Author developed a model

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predictive controller [2]. Huang Jiankang et.al. has been introduced a system i.e. Monitoring of Pulsed MIG Welding Process using Lab View.Pproposed a real time synchronous acquisition of various welding characteristics signal and control system to meet the requirement of controlling and monitoring of MIG welding machine for development of efficiency and control of response time by using data acquisition card and COM technology. In this Lab View software is designed by using virtual instrument and data acquisition that based on the algorithm of MATLAB complex welding visual processing. [3]. Priyam Parikh et.al. has designed swarm robot using arduino uno and WIRDIN 1186 wireless module for transmitting the information to control room. Control room has another wireless module to receive information from sensor mounted on swarm robots. Control room receive information in MATLAB graphical user interface. The used technique for finding root locus of the acquired signal by using real time wireless multichannel data acquisition [4]. The data acquisition is also possible using DSO and PC interfacing as described in literature [5].

III. SYSTEM DEVELOPMENT

Generally the gas metal arc welding (GMAW) machine are widely used in industrial fields, which can be classified as metal inert gas welding (MIG) or metal active gas welding (MAG) by shielding gas mixture. Among them CO2 MAG welding method is mainly taken because of low price of CO2. In industry many of CO2 gas welding machines are installed and during welding operation wastage of CO2 gas is more. It is observed that the pollution level is increased. Arduino mega is used to control the flow of gas, Ethernet shield is used to automate the switching of solenoid valves of gas cylinder, pressure sensor is used to sense the barometric pressure value.

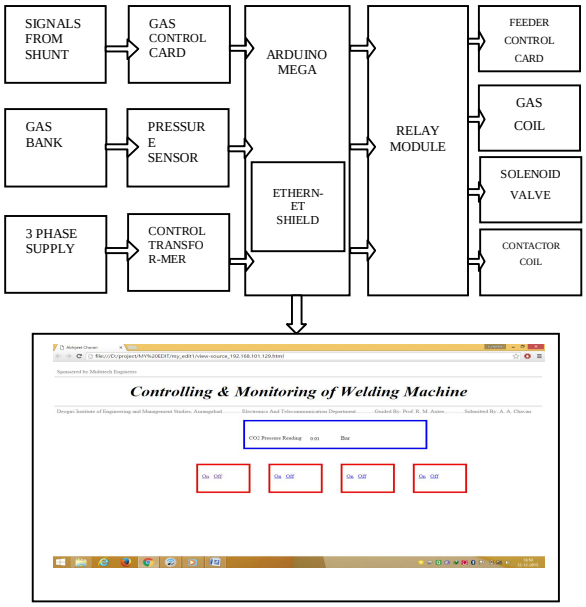

Fig.1. shows the block diagram of system, which consist of Arduino mega for control mechanism of solenoid valves and for protection of welding machine. Web page is designed for monitoring of barometric pressure value and manual control of solenoid valves. Arduino is a tool that makes the computers to sense and control the physical world. Arduino can be used to develop interactive objects. Taking inputs from a variety of switches or sensors, controlling of variety of lights, motors, and other physical outputs can be achieved. The Mega 2560 is a microcontroller board based on the ATmega2560. Four analog input pins are used in this system, analog output of barometric pressure sensor is fed to the analog input for controlling of solenoid valves of gas bank and output for this analog signal is taken from digital pin. Another analog input are taken from three control transformers volt for protection of welding machine, and its output is taken from digital pin To minimize the wastage of CO2 gas, control circuit is developed with the help of operational amplifier. Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 ethernet chip. The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. In this system easured

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barometric pressure value is displayed on web page. Also automatic and manual operation of solenoid valves which are connected in gas bank is done with the help of web page.

Current shunt resistors are low resistance precision resistors used to measure AC or DC electrical currents by the voltage drop those currents create across the resistance. Sometimes called an ammeter shunt, it is a type of current sensor. In the welding machine a current shunt whose resistance is 0.00018 Ohms having a current of 400 Amps flowing through it will produce a voltage of 75 mV (milli Volts). So by inserting a current shunt into a circuit whose current want to measure and by measuring the voltage drop across the shunt. In this system 75 mv measured voltage across the shunt is occurred only at the time of short circuit of phase and earthing i.e. at the time of welding, and which is used as reference voltage of gas control circuit, and with the help of this reference voltage the flow of gas can be controlled. In this way wastage of CO2 gas is minimized. Gas control circuit is designed to minimize the wastage of gas and to protect workers from different health issue like suffocation, lungs cancer, throat and eyes irritation, also it may cause on larynx and urinary tract. As per statistics, 30% CO2 emission is found be reduced.

The One of the major problems that the industries face is to counter the sudden over-voltage in the system which results in the deterioration of power quality and damages to equipments. The consequences of power incidents show that industrial and digital firms are losing crores per year due to power interruptions. The cost to replace equipments damaged because of voltage spikes is very high. Industrial business has to deal with loss of production. In this system, the focus of the study is the effects of transient overvoltage and under voltage on the substation equipment and the corresponding protection against it. A voltage which is below the optimum operational or rated value of a component, circuit or device is called an under voltage. Such a voltage may produce for instance a malfunction or failure of customer equipments. Under voltage is defined as a sudden drop in the root mean square (r.m.s.) voltage and is usually characterized by the remaining (retained) voltage. Under voltage is thus, short duration reduction in r.m.s. voltage, caused mainly by short circuits, starting of large motors and equipment failures. Hence for giving over / under voltage protection low rating transformers are used for three different phases, according to their analog output voltage the main contactor coil can be controlled.

IV. PERFORMANCE ANALYSIS

The system consists of analysis of welding machine, gas control circuit and protection circuit.

A. *Analysis of Welding Machine*

a) The Input voltage of welding machine = 440 VAC
b) Output voltage of welding machine = 36 VDC
c) Output current of welding machine = 400 A-DC

TABLE 1

Parameter	Voltage across Shunt(mv)	Current flowing through shunt(A_{DC})
OFF state of W/M	2	0
ON state of W/M	75	400

Fig. 2. Voltage and Current reading across shunt resistor

B. *Results of GasControl Circuit*

a) Input voltage given at Non- Inverting terminal pin no. 3 = 75 mv
b) Output voltage of Differential Amplifier = 10 V

TABLE 2

Sr. No.	System Connection	Phase Neutral Connection	Voltage Across Gas Coil
1.	System Not Connected	Open Circuit	110 VAC
2.	System Not Connected	Short Circuit	110 VAC
3.	System Connected	Open Circuit	0 VAC
4.	System Connected	Short Circuit	110 VAC

Fig. 3. Gas control circuit analysis

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TABLE 3

Observations	Job completed/ day	Amount of gas required / day(X)	Total cost of gas/day Y=15x(X)	Total cost of gas/month Z=(Y)x30	Total cost of gas / year(K)
Without System	1500	70 Kg	Rs. 1050	Rs. 31500	Rs. 3,78,000
With System	1500	52 Kg	Rs. 780	Rs.23400	Rs. 2,80,800

Fig. 4. Emission of CO2 Gas in terms of cost

C. *Results of Over / Under Voltage Protection*

In this protection circuit output of three transformers is continuous time signal, which is considered as analog input of arduino mega and these analog inputs are mapped in the range of 0.00 to 5.00 volt. According to the variation in this analog inputs protection get provided.

TABLE 4

Condition	Analog output of			
	1 st Transformer	2 nd Transformer	3 rd Transformer	Voltage across contactor
Normal Voltage	≈ 2V	≈ 2.2V	≈ 2.1V	110VAC
Over Voltage	≈ 5V	≈ 5.2V	≈ 5.4V	0 VAC
Under Voltage	≈ 0.8V	≈ 0.9V	≈ 0.7V	0 VAC

Fig. 5. Results of over / under voltage protection

V. CONCLUSION

Implementation of this system using arduino mega for intelligent monitoring is a new method to monitoring of pressure values and controlling of gas is done. It supports offline supervision and control within private network. It also save up to 30% of gas using gas control circuit and protects the human health. The result of this system shows that the system has fast dynamic response.

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