UDC 65.011.56:678.029.4
DOI: 10.7562/SE2012.2.02.05
Original article
www.safety.ni.ac.rs

KATARÍNA SENDERSKÁ[1]
ALBERT MAREŠ[2]
JÁN ZAJAC[3]
SLAVICA CVETKOVIĆ[4]

[1,2,3]Technical University of Kosice, Faculty of Mechanical Engineering
[4]Faculty of Technical Sciences, Kosovska Mitrovica

[1]*katarina.senderska@tuke.sk*
[2] *albert.mares@tuke.sk*
[3] *janoch@netkosice.sk*
[4]*smijoc@yahoo.com*

INNOVATION OF WELDING WORKPLACE EXHAUST SYSTEM

Abstract: *The paper presents an example of automation of the existing welding workstation exhaust system that can be similarly implemented also in other closed welding workplaces inside the buildings. The automation of previously non-automated process of exhausting the harmful chemicals and aerosols from the welding workstation create better conditions at workplace from point of view health care and safety. It also can save costs spent on the non-regulated exhaust system without decreasing the exhaust effectiveness.*

Key words: automation, welding, workstation.

INTRODUCTION

Welding is a technological process of material joining to achieve non-separable joints. In terms of harmfulness it is the fusion welding methods that have the greatest impact on the human organism. Using these methods generates a lot of unwanted harmful and risk factors. One of them are the smoke exhausts generated during the welding process as a result of high temperature metallurgical and physical-chemical reactions. Long-term exposure of human organism to exhausts can cause intoxication and pathological changes.
Harmfulness of fumes depends on the chemical composition of additional materials and welded materials, used welding mode, welding parameters, surface treatment of the welded materials, application of protective gases, welding technology and welding temperature.

Occupational health and safety in the field of welding is one of the priorities. It is desirable, if the solution is also relatively simple and cost effective. One of the possibilities is to innovate the existing workplaces and workshops, i.e. to find optimal solution for a particular situation. This approach has been proposed within the innovation of the smoke exhaust system in a welding school. The mentioned innovation is based on the automation of the existing solution.

EXISTING EXHAUST SYSTEM AT WELDING WORKPLACES

The welding workstations in the welding school (Fig. 1) are equipped with a fixed local exhaust system including separate exhaust fans, common manifolds, and manual switching. Air from the respective workstations is exhausted by several fans that force the sucked air with fumes through the collecting manifolds into a filter. After the filtration, the air is led out through a stack. Centrifugal blade fans are impassable when they are in the idle mode, this means that check valves are not necessary in the pipeline. The disadvantage of this system is its manual control, which significantly reduces the effectiveness. This problem can be solved by the elimination of the human factor, e.g. by replacing the manual control with an automated system that can significantly increase the effectiveness.

Figure 1. *Exhaust system in the welding school*

CONCEPT OF THE EXHAUST SYSTEM AUTOMATION

To provide a solution, a separate exhaust system was designed including central data collection, where each welding workplace has a separate independent circuit for exhaust control and a single-chip microcomputer collecting and storing the data from each workstation in a memory. The basic parts of this solution are constituted by a light ray sensor, signal conditioning circuits, electric motor power switches, a single-chip microcomputer (MCU) and a PC program (Fig. 2).

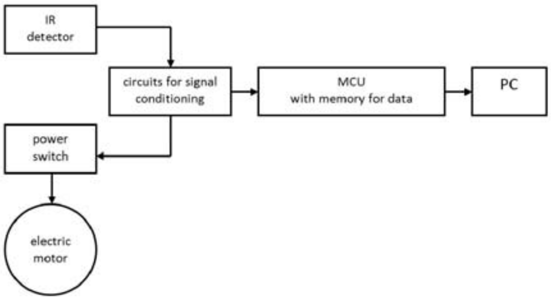

Figure 2. *Exhaust system control diagram*

In addition to a variety of waste products, the electric arc in welding also emits a mixture of different types of radiation into the environment, such as.: electromagnetic, electrostatic, full spectrum light, including ultraviolet (UV) and infrared (IR) radiation. It is this light rays that can be used for monitoring and recording of welding operations.

To provide for IR radiation detection the use was made of a phototransistor (VT1) that has a scanning range of light wavelength from 360 to 930 nm. The transient current of the phototransistor is 20-75 microamperes when its base is illuminated, and therefore it must be amplified. To amplify this current, a unipolar (field effect) transistor MOS-FET was used. Due to its sensitivity it is sufficient to use only one transistor (VT2) as an amplifier. The sensitivity of the amplifier and the sensitivity of the whole equipment to the light radiation is fine-tuned by a trimmer (R1). To suppress the undesirable disturbing voltages, a capacitor (C1) is connected to the control electrode of the transistor (VT2). It is preferable to use shielded wires instead of conventional wires for the connection, as they also minimize the disturbing voltages. The output of this amplifier is the change of direct current voltage DC 0/5 V depending on the phototransistor TV1 being illumined or not. Picture of phototransistor and its wiring diagram is shown in Fig. 3.

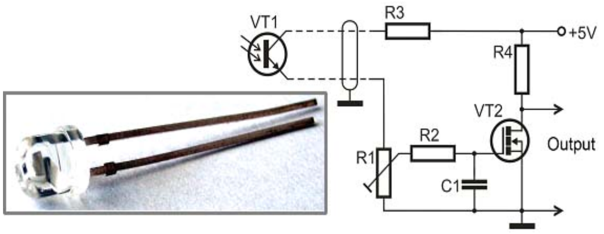

Figure 3. *IR detector (phototransistor) and its wiring diagram*

Intensity and duration of the conditioned electric signal from the phototransistor are further processed. If this electrical signal corresponds to the requirements, it is then sent to the motor power switch that turns on the three-phase power supply and starts the electromotor that will be power-supplied for about another minute after the welding is finished in order to ensure sufficient exhaust of welding fumes and smoke. Power switch diagram is shown in Fig. 4.

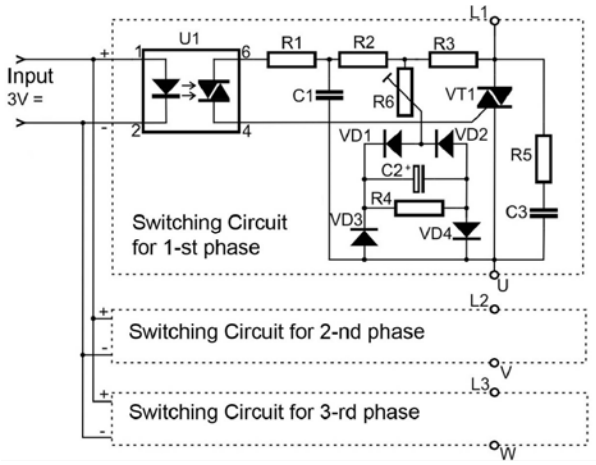

Figure 4. *Power switch diagram*

The switch wiring scheme is based on the wiring recommended by the optocoupler manufacturer (Texas Instrument) and is supplemented with standard semiconductor protection circuits required for inductive load and a smooth motor start-up circuit.

The signal controlling the exhaust motor start-up is also sent to the single-chip microcomputer that records the beginning and the end of the welding. The single-chip microcomputer is connected to a conventional personal computer that is able to download, process, display and archive the data collected from welding by using the software. The location of single-chip microcomputers is shown in the Fig. 5. Each welding workstation (welding box) is also equipped with a conventional manual switch to enable also the manual control of the exhaust system in case of a failure of any part of the circuit. The manual control is also registered by the single-chip microcomputer.

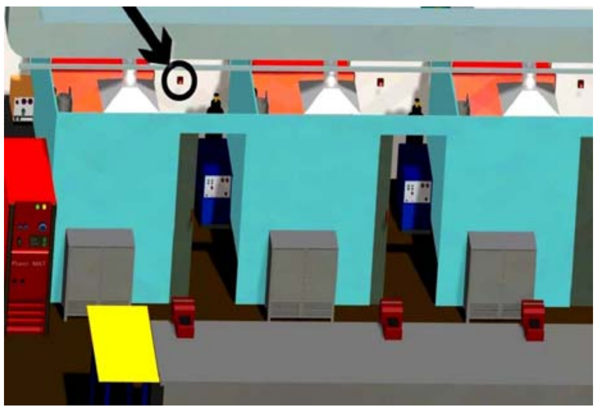

Figure 5. *Single-chip computer location – 3D model of welding workplaces*

VERIFICATION OF FUNCTIONING

To verify the functioning of the solution, a control electronics circuit with a light ray detector and an electric motor with a power switch were set up (Fig. 6 - left).
After electric arc ignition for more than 0.5 seconds, the control circuit receives a signal to turn on the electric motor, which practically means that the fan suction will start. This moment has been experimentally tested (Fig. 6 - right). The given figure clearly shows the burning electric arc and the running electric motor (the fan impeller rotating on the electric motor). The electric motor is also switched on when the welding is finished. This time can be set in the timer circuit for a period of up to 1 minute. In practice it means that the device is still exhausting the residual fumes contained in the air for the defined period of time after the welding is finished. After this time the motor (exhausting) is automatically turned off.

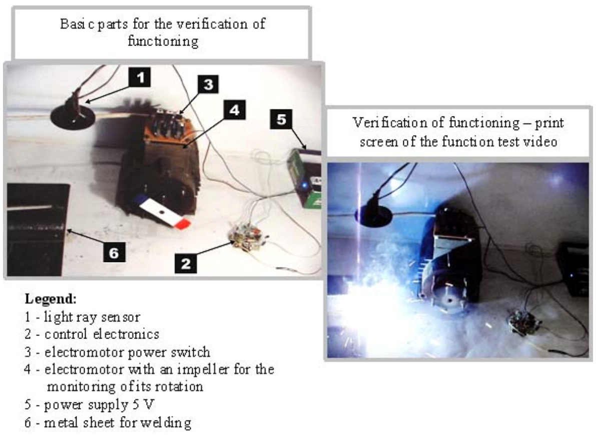

Figure 6. *Verification of the solution functioning*

SOFTWARE

The presented solution also includes software developed for storing and processing of the data about the utilization of the respective welding workplaces. The software was created in MS Visual Studio .NET developing environment. The signal for necessary data processing is drawn from the delay circuit and is used also as an output for the MCU. At this point the circuit output signalizes the real status of the welding process at the workstation. There are 10 welding boxes in the workshop, which means that there is a requirement for a circuit, which is able to process 10 inputs simultaneously. For this purpose it is sufficient to use a very frequently used single-chip microcomputer from the Microchip company, known as the PIC 16F88.

All the sensed and stored data can be visualized and statistically processed. For this purpose a common personal computer with MS Windows XP will be used. This computer will contain software, which can communicate with the microcontroller and can process the data provided by the microcontroller and display this data as a graphic output. The program is written in a Microsoft Visual Basic. NET programming language. It is easy to use and has minimal system requirements for the computer parameters, which means that it is able to work in a computer with a single core processor such as Intel Celeron with the frequency from 500 MHz and with minimum memory requirements. The only necessary requirement is the .NET Framework version 2.0 installed in the Windows XP operating system.
The communication with the microcontroller is ensured by a parallel communication port (LPT). After data loading into the PC the data will be displayed in a graphic form. Each welding box is assigned with a separate column with the value of the actual welding time for the given period, e.g. since the last data download from the single-chip microcomputer (Fig. 7). The time display can be distinguished by different colors (depending on the program parameter settings).
The data is stored in a database. Record size is minimal (maximum 50 bit), which means that all records can be stored without a need of sorting or deleting the older records. Due to the simplicity and easy access to the data by means of other programs, the structure of the database is provided as a standard text. Individual records are written as single lines and values are separated by a comma. The configuration file of the program settings is formatted in a similar way.

Figure 7. *Examples of the software screens*

CONCLUSION

Presented solution shown possibility how to make working conditions better by automate of existing solution. Application of the proposed solution can reduce the cost of the electricity needed for the electric motor power down to a minimal level and also extend its lifetime, because the exhaust function is provided only for the time necessary for welding. Blocking the air ducts in unused boxes can increase the suction performance at the used workplaces. Automatic exhaust control device is an extension of the original exhaust system, which means that it does not require any intervention into the original parts of the equipment.

REFERENCES

[1] JAKUBČÍK, L.: Použití některých odsávacích systému na svářečských pracovištích. Zváranie – Svařování, 46, č.6. 1997, 136-140

[2] KOSNÁČ, Ľ.: Ochrana zdravia a bezpečnosť pri zváraní, Weldtech, Bratislava,1998.

[3] TURŇOVÁ, Z.: Bezpečnosť a ochrana zdravia pri zváraní. In.: Zvárač, roč.3, č.2, 2006, s.29-30.

[4] ZAJAC, J.: Modernizácia odsávania zváracej haly, Bakalárska práca, SjF, TU v Košiciach, 2008

[5] DIMMEROVÁ, J.: Zdravotní rizika při svařování a řezáni. Zváranie – Svařování, č.11-12. 2006, 313-320

[6] SPIŠÁK, E. et al.: Strojárske technológie. Košice – TU v Košiciach. 2011, 388 p. ISBN 978-80-553-0820-3

ACKNOWLEDGEMENTS

This contribution is the result of the project implementation: Center for research of control of technical, environmental and human risks for permanent development of production and products in mechanical engineering (ITMS: 26220120060) supported by the Research & Development Operational Programme funded by the ERDF.

BIOGRAPHY

Katarína Senderská was born in Košice, in the Slovak Republic, in 1958.
She received the diploma in Mechanical technologies and the PhD. degree in Mechanical engineering technologies and materials from Technical University of Košice, Faculty of Mechanical Engineering. Her main areas of the research include the assembly technologies, computer aided assembly planning and workstation design.
She is currently working at the Department of Technologies and Materials of the Faculty of Mechanical Engineering, Technical University in Košice.

INOVACIJA IZDUVNOG SISTEMA STANICE ZAVARIVANJA

Katarína Senderská, Albert Mareš, Ján Zajac, Slavica Cvetković

Rezime: *Rad predstavlja primer automatizacije izduvnog sistema postojeće radne stanice zavarivanja, koji može biti koriščen i u drugim zatvorenim radnim stanicama zavarivanja unutar zgrade. Automatizacija prethodno ne automatizovanog procesa iscrpljivanja štetnih hemikalija i aerosola iz radne stanice zavarivanja, stvara bolje uslove na radnom mestu iz tačke gledišta zaštite zdravlja i bezbednosti. Takođe može smanjiti troškove za ne-regulirani izduvni sistem bez smanjenja efikasnosti.*

Ključne reči: automatizacija, zavarivanje, radna stanica.