TECHNICAL AND MANAGEMENT ASPECTS REGARDING THE REDUCTION OF POLLUTION GENERATED BY WELDING PROCESSES

Liliana LUCA, University "Constantin Brancusi" of Targu-Jiu
Amalia Venera TODORUT, University "Constantin Brancusi" of Targu-Jiu
Catalina IANASI, University "Constantin Brancusi" of Targu-Jiu

ABSTRACT. *This paper presents some technical aspects related to welding processes in the context of reducing environmental pollution. The authors propose a series of actions to make the welding process environmentally friendly. Also, the paper presents schematically the main stages in the management of welding processes, from the perspective of an ecological approach.*

KEYWORDS: welding process, pollution, actions, management

1. INTRODUCTION

Today, the global economic system, with uncontrolled growth, is increasingly endangering the natural basis of life and coexistence on earth. We are committed to protect the planet from harm, including through sustainable consumption and sustainable production. In this sense, three main objectives are imposed: reducing CO_2 emissions, reducing excessive consumption by rethinking a new lifestyle, the use of eco-technologies.

Eco-technologies represent the totality of technologies from socio-economic activities through the use of which the environment is protected. In the field of industrial engineering there are concerns for finding innovative and environmentally friendly technologies. In the field of machine building there are many technologies that pollute the environment, among them are welding technologies. Welded constructions are widely used in machine building. Welded assembly is a highly polluting technological process, producing negative effects on air, soil and water.

Pollution caused by welding processes has been a research topic addressed by many specialists in this field. Thus, Amza and Dobrota in [1] present the values of the pollutants determined for a company that produces welded constructions and the hazard ratio was calculated. The paper [2] presents the influence of the welding process on the environment and calculates the pollution coefficient defined based on the material balance equation. Another paper that deals with the pollution produced by the welding operation presents studies on the pollution produced by the welding reconditioning processes for crankshafts [3]. The papers [4, 5] present a study on the negative impact on the environment produced by smoke and toxic gases generated by the welding process, as well as the negative impact on the health of the welder. Mostafa and Mohsen Fard investigated the lack of awareness of the effects of welding processes on the environment and the health of the welder and proposed several solutions to overcome these major hazards [6]. Another interesting study on the effects of welding smoke on the environment and the health of the welder was conducted and published by Pankaj Kumar [7]. Vladimirov investigates air pollution caused by electric arc welding and oxyacetylene cutting, for different conditions and technological circumstances [8]. The issue of eco technologies has become a topical issue for the industry of highly

developed countries. The paper [9] addresses in an original way aspects of implementing the change of industrial organizations into eco-technological organizations. Paper [10] show how a tehnological process should be analyzed by highlighting the relationships between elements of the industrial process, according to some scheme, precisely to obtain so-called „clean technologies".

The specialized literature offers many studies on the negative consequences of welding operation on the environment and people. Worldwide, welding is a very common operation in many industries and jobs. Therefore, there are still strong reasons for the study of welding processes and the impact on the environment. This paper presents some technical aspects related to welding processes in the context of reducing environmental pollution and actions of managing these processes from the perspective of an ecological approach.

2. WELDING TECHNIQUES AIMED AT REDUCING ENVIRONMENTAL POLLUTION

Non-removable assembly by welding is a highly polluting technological process, with negative influences especially on air and soil. The formation of gases in the technological process of welding is the result of burning electrodes, fluxes, formation of the molten metal bath and the realization of the welding seam. The smoke resulting from welding is largely due to the melting of the deposited material. Vaporized metals enter the surrounding air and chemical reactions occur that generate metal oxides that condense and form a consistent smoke of particles. Harmful by-products of harmful welding processes have been classified into two main categories: toxic emissions and process heat. These by-products affect the immediate environment of the welder the most and the areas farthest from the place of the welding operation. It should be mentioned that for the welding processes are also needed: electricity, consumables, shielding gas, electrodes, etc. They also have environmental costs, but are less visible.

Pollutants differ depending on the process and material. In principle, they are classified into: particulates and gaseous. Emissions and polluting by-products resulting from a welded construction by classical methods, can be: dust in the air, CO, CO2, SO2, SO4, NOx, NH3, CH4; flue gas; heavy metal particles; slag; waste additives; metallic waste; splash; steam; volatile organic compounds; volatile dusts; steam; powders and oxides; aromatic hydrocarbons; residual solutions resulting from treatments; wastewater resulting from treatments.

Different welding techniques generate different amounts and types of pollutants, so the choice of welding technique leads to a greater or lesser negative impact on the environment. The most well-known and used fusion welding processes are those that use inert shielding gas mixtures, called MIG and WIG, respectively. It has been found that pulsed arc MIG welding has the advantage of having lower smoke emissions than manual MIG welding. Modern CMT (Cold Metal Transfer) welding technology has also been developed, which meets the increasingly stringent requirements for the stability of the welding process, but also the profitability of the automotive industry. CMT is a digitally controlled technology that allows the transfer of material at a very low current flow. Studies have been performed and it has been determined that the level of micro particles in the atmosphere in the case of CMT welding is lower than in pulsed arc MIG welding and much lower than in manual MIG welding.

Solid state welding techniques can also be used, which create less pollution: friction

agitation welding (FSW) and magnetic pulse welding (MPW). These two technologies eliminate the need for fillers or flows and have the advantage that they do not produce dangerous vapors. Another solid state technique is diffusion welding which greatly reduces the negative impact on the environment, but can only be applied to not very large welding works. Other attractive techniques that have created less negative impact on the environment include laser-arc hybrid welding (LAHW). This technology has a very low consumption of filler material, electrical energy and shielding gas, compared to other techniques such as MMAW-Manual metal arc welding or SMAW-Shielded metal arc welding. The inverter welding machine uses advanced IGBT (Insulated-Gate Bipolar Transistor) technology and has two important advantages: it reduces the used energy and greatly reduces noise pollution. The device is characterized by a significant reduction in magnetic losses and resistance and thus obviously improves the efficiency of the transformer and the energy saving effect. The working frequency is outside the audio limits, which contributes to a very high reduction of noise pollution.

Regarding the classic procedures for cleaning welding seams, most of them produce an aggressive pollution of the environment. Cleaning of welding seams by the two classical methods (with brush tools, abrasive discs, paste or stripping gels) cause substantial environmental pollution. A modern method that can increase environmental protection is the use of special inverter equipment. The inverters use electric current and a special electrolytic solution to efficiently remove the oxidized layer and to passivate the welded components. When welding stainless steel, an electrochemical method can be used to clean and passivate the parts (by means of special inverters).

The gases emitted during the welding process are very harmful to the health of the welders, these gases must not be inhaled. Therefore, it is necessary to achieve a proper ventilation of the space where the welding process takes place. You can opt for a ventilation of the hall where the welding processes are performed, but you can also use welding smoke extraction systems. Extraction systems are classified into: Spot extraction (high-vacuum spot extraction, Low-vacuum spot extraction systems), Torch-integrated spot extraction systems), Extraction hoods (used in automated or robotic welding processes), General ventilation system for hall), [11].

Welding processes also produce high noise pollution. Noise during these processes can severely affect the hearing of welders. Antiphonic equipment or other protective systems may be used. For example, acoustic barriers can be installed between the welding sections and the rest of the sections (panels with sound-absorbing and sound-insulating properties).

An ingenious example of good environmental protection practices is given by Lincoln Electric, which has proposed greening the welding process starting with virtual training of welders. Virtual tools are used that substantially reduce training costs and eliminate the impact on the environment produced by effective welding [12].

3. ACTIONS TO REDUCE ENVIRONMENTAL POLLUTION GENERATED BY WELDING PROCESSES. MANAGEMENT OF WELDING PROCESSES

In order to transform an organization with welding construction production activities into an eco-technological organization, a series of actions are proposed in order for the welding process to be environmentally friendly and to ensure long-term sustainability. The proposed actions are the following:

a. Investments in new machines / welding equipment

b. Investments in control devices and monitoring of environmental factors,
c. Adequate design of welded joint design
d. Adequate design of the technological process (including indication of pollution prevention and reduction measures at each stage of the technological process)
e. Ensure adequate general ventilation
f. Use of local ventilation systems to evacuate smoke and gases from the welder's breathing zone,
g. Construction of welding booths,
h. Efficient use of energy and cleaner energy sources,
i. Minimizing waste production,
j. Material waste recycling
k. Adequate training of welders in the spirit of eco-technologies,
l. Application and maintenance of the integrated quality-environment management system,
m. Elaboration and implementation of an Environmental Management Plan.

These actions are grouped in two main objectives and a tree diagram is drawn up, given in figure 1, which shows in a graphic form what are the actions to be taken to reduce the environmental pollution caused by the welding processes. Two main objectives are established: 1) the use of welding techniques and related equipment that reduce environmental pollution; 2) adoption of technical-economic policies regarding the reduction of environmental pollution. We specify that the tree diagram is a tool used in quality engineering which highlights the measures/actions needed to solve a problem. Modern and classic quality management tools can be used in many fields of activity in order to substantiate quality improvement decisions. The specialized literature offers many studies in this regard. Papers such as [13, 14] present case studies for the application of modern quality management tools, and papers such as [15, 16, 17, 18, 19, 20, 21] refer to solving quality problems with the help of classic quality management tools.

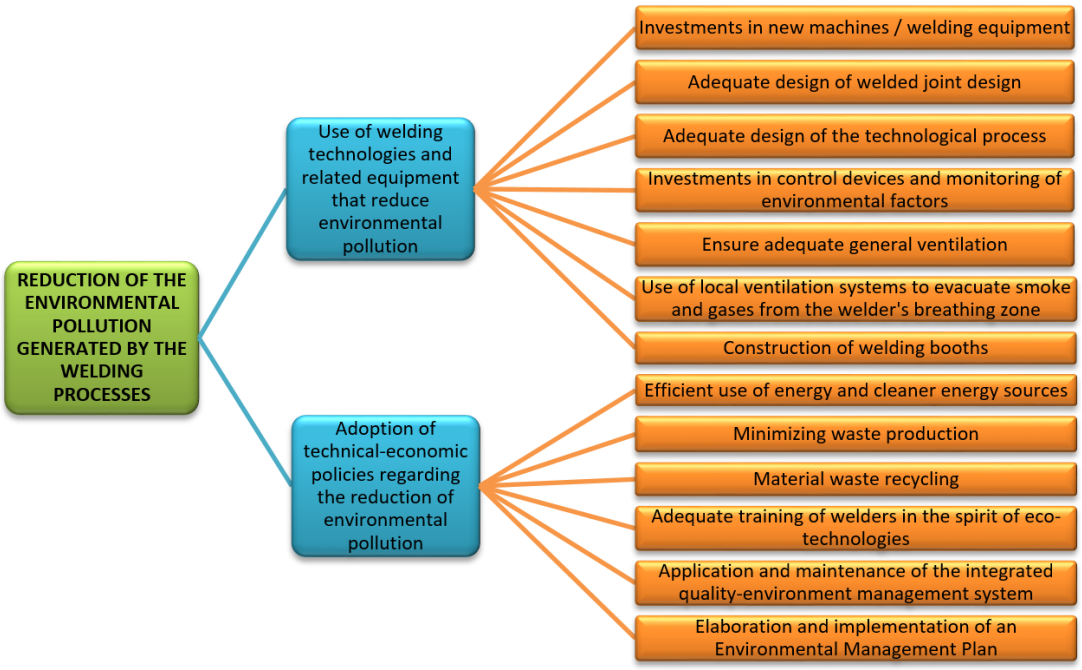

Fig. 1. Tree diagram

At present, it is necessary for organizations to be concerned with achieving environmental performances by controlling the impact of their work on the environment. The management of welding processes from the perspective of an ecological approach, is presented schematically in figure 2. The main stages for the implementation of welding eco technologies are highlighted.

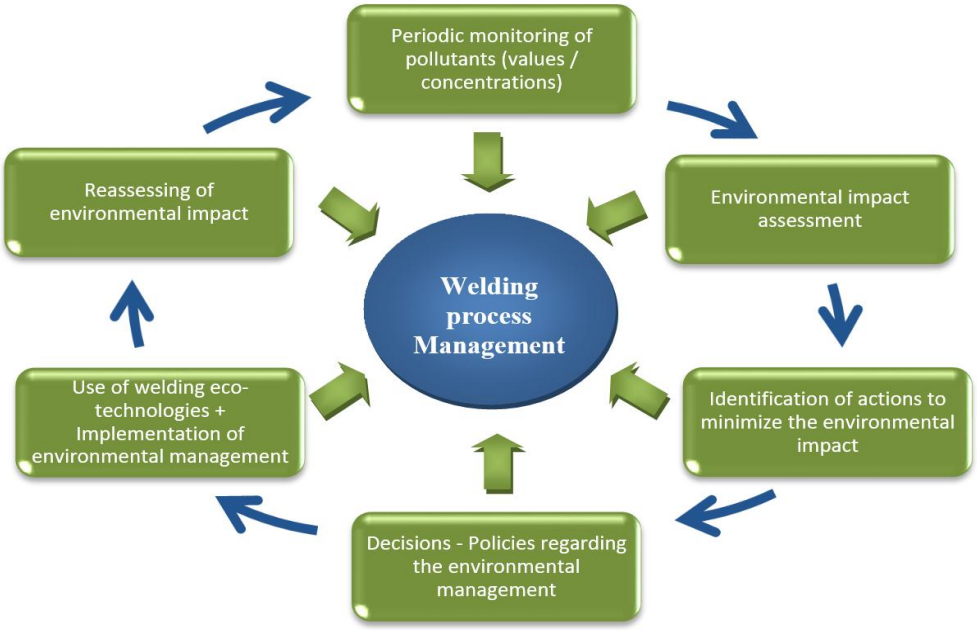

Fig. 2. Welding process management scheme

4. CONCLUSIONS

Different welding techniques generate different amounts and types of pollutants, so the selection of the technique has a great relevance on the environmental impact. Actions to reduce pollution generated by welding processes can be transposed into a graphical representation of the tree diagram type, which is useful in quality management and environmental management. For a sustainable development and for the transformation of the industrial organization into an eco-technological organization, a greater concern on the part of the management team for the environmental aspects is necessary. Great imbalances have been created on our planet, which can only be corrected by adopting clean technological solutions and a sustainable way of life.

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