

# ENVIRONMENTAL POLLUTION AND SOCIAL ASPECTS OF THE WELDING TECHNOLOGIES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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**ABSTRACT:***The paper presents the technical, economic, environmental and social aspects of welding processes. There are presented modern welding equipment and processes, the effects produced on the environment by welding technologies as well as negative effects on the health of the welders. The paper schematically shows the relationships between sustainable development and the three factors that determine it, for welding technologies. The paper presents schematically too the link between sustainable development and the application of ISO 9001, ISO 14001 and ISO 45001 standards.*

**KEYWORDS:** welding technologies , pollution, social, sustainable development

## 1. INTRODUCTION

The theory of sustainable development began in the early 1980s. In Stockholm, in 1972, the first UN conference on development addressed the topic of eco-development. Subsequently, a new attitude towards development and the environment developed. This is when the UN started to set up the World Commission on Environment and Development. Officially, the term sustainable development was launched with the publication of the Brundtland Report of the World Environment Commission in 1987. According to this report, sustainable development is officially defined as the type of development that meets the needs of the present without compromising the ability of future generations to also satisfy their own.

In 1992, the UN held a conference in Rio de Janeiro and then for the first time, the connection between science and politics was made, by which the political factors accepted the signals drawn by the scientists regarding the need for policies to support a sustainable development. At present, the issue of sustainable development has become quite a different issue from one country to another. At the beginning of the third millennium, it can be said that sustainable development becomes an objective necessity generated by the global ecological crisis. Environmentally friendly and human-friendly technologies must be used, but this requires investment in anti-pollution equipment and technology. The current orientation is towards sustainable economic development, but at the same time towards sustainable human development.

## 2. WELDING TECHNOLOGIES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

Economic development has many positive effects, but it also has negative effects that directly affect the environment and endanger human health and even the existence of humanity. We live a real drama, we talk daily about the pollution of the environment. For manufacturing processes and products, environmental and social problems are often considered and insufficiently respected. However, the negative effects on the environment and people are constantly accumulating and causing changes that are often irreversible.

Welding is one of the most important non-removable assembly technologies. Today, welding plays an essential and irreplaceable role in the manufacture of many products. Welding technologies are used in almost all industries: construction of automobiles, equipment and tools for navy, shipbuilding, aerospace, industrial hall construction, petrochemicals, etc. Welding processes require large amounts of energy and resources, which are of course critical from an environmental perspective. At present, the social aspects of welding are being discussed more and more. These mainly involve effects on the health of the welders.

Unfortunately, it can be observed that most of the specialized literature focused on the technical and economic aspects of the welding process, and less on the environmental and social aspects. In the last period there is a concern of researchers in the field of welding in 3 directions: technical and economic aspects, environmental and social aspects. The research results help the industry in the development and selection of sustainable welding technologies.

At present, from a technical and economic point of view, there is a development of the manufacture of welding equipment with the highest performances.

Modern welding equipment using MULTIMATRIX technology has been designed and built. MULTIMATRIX technology makes it possible to quickly adapt to welding operations that use data exchange via USB flash memory or LAN/Wi-Fi networks, [1]. This technology has a number of advantages, such as: ensuring high welding quality, working process efficiency, industry 4.0, optimal energy efficiency, etc. A high welding quality is obtained if the causes that can cause weld defects are removed, [2].

Another category of modern, professional welding devices is those that use inverter welding technology. The inverter devices allow the welding profile to be adapted and offer a constant quality of the welding cord. The use of inverter welding technology increases productivity, speeds up production and increases accuracy. It is more performance than welding with traditional machines. Figure 1 shows a professional welding machine model Velt TIG/MMA 180. This is a welding device with latest generation inverter technology, recommended for industrial welding or maintenance applications. It is equipped with the way of initiating the electric arc at a distance, without touching the piece electrode (high frequency). The device is recommended for welding alloy steels and stainless steel. The TIG/WIG welding process involves the use of protective gas (inert gas) which is usually high purity argon or combined with helium. The TIG/MMA 180 welding apparatus has both the TIG/WIG welding function and the MMA welding function (manual welding with coated electrode).



Figure 1. Welding apparatus - Velt TIG/MMA 180 [3]

An innovative welding technology is presented in the paper [4]. The authors present research on the use of ultrasound in the welding process to improve the properties of welded

parts. Research has shown an improvement in hardness, shock resistance, bending resistance.

The paper [5] shows that small and medium-sized enterprises use very little innovative welding technology. This is because technological innovation has a positive but also negative impact on the productivity of companies.

From the technical perspective of the welding process one can discuss a major problem represented by the quality assurance and evaluation of welds. In this sense, different methods can be used to control, assure and evaluate the quality of welded constructions. In this sense, the classic tools of quality management have applications in many fields of activity [6, 7, 8, 9], as well as the modern tools of quality management apply to products and processes in many sectors of activity [10, 11, 12]. The tools of quality management can offer the possibility of identifying the causes that generate defects or of the measures for quality assurance and in the case of welding processes.

The paper [13] presents studies on the environmental impact and the social impact produced by three welding processes: Gas Metal Arc Welding (GMAW), Manual Metal Arc Welding (MMAW) and Laser Arc-Hybrid Welding (LAHW). GMAW technology is widely used as it offers a high level of productivity and flexibility as well as low material consumption, which proves to be an environmentally friendly process. LAHW technology is a new and modern technology that is characterized by very high productivity and resource saving, and thus its use ensures sustainable production. MMAW technology consumes more energy and materials than GMAW and LAHW technologies and consequently produces a greater negative impact on the environment.

The welding process with shielded metal arc welding (SMAW) is widely used in different industrial sectors. In [14] Ibrahim Alkahla and Salman Pervaiz present a study on the SMAW process regarding the sustainability approach. The authors of the study make recommendations regarding the achievement of the SMAW welding process in an economical and sustainable way.

There have been many studies on the shielded metal arc welding (SMAW) welding process. In another paper, [15], we present studies on the harmful substances determined following the experiments using the manual welding process with shielded metal arc welding (SMAW) electrode. The influence of the main parameters of the welding process on the pollution coefficient is also presented.

During the welding operation a smoke is generated which causes air pollution. It has resulted in a concern for reducing welding fumes, so for reducing air pollution. Thus, different welding technologies have been studied to compare the impact on the environment. Sproesser, within a research team [16], used life cycle analysis (LCA) to compare several welding processes, such as: manual metal arc welding (MMAW), metal arc gas welding (GMAW), laser arc hybrid welding (LAHW). The study showed that the greatest negative effect on the environment is given by the MMAW process. It would be desirable to develop the implementation of the LCA method for welding operations.

The paper [17] presents an interesting study regarding the impact on the environmental pollution produced by the gases resulted in the welding process with oxyacetylene flames. In the paper the pollution coefficient is defined based on the equation of the material balance.

Companies that produce large quantities of welded construction on a monthly basis cause quite a lot of air pollution. A study carried out over a period of 3 years showed the environmental effects produced by such a company. The concentrations of the identified pollutants were measured and the hazard ratio was calculated [18].

There are concerns regarding the reduction of the environmental pollution generated by the welding rehabilitation processes of some welded joints that have certain defects. The paper [19] includes such a study and proposes several methods for preventing and reducing the environmental impact of this rehabilitation process in the case of welded bridges. Also, the paper [20] presents studies on the pollution produced by the welding reconditioning processes for Crankshafts.

The smoke and toxic gases generated during the welding operation have a great negative impact on the health of the weld [21]. Inhalation of smoke by the welder is one of the major health hazards present in the SMAW operation. The SMAW process is commonly used in industry because it is cheap and can weld most commonly used metals and alloys. Exposure of sweat to the smoke resulting from the welding process often causes lung disease, lung cancer, heart damage, central nervous system disorders. In this regard, several studies are noted [22, 23, 24, 25].

In the specialty literature, a method of evaluating sustainability is proposed where all economic, environmental and social aspects are considered. The method is called triple bottom line (TBL) or three-pillar approach [26].

The elements of the system that contribute to the manufacture of welded constructions are: welders, equipment/appliances, welding processes, materials, management of welding process activities. At the end of the welding process we have 3 categories of results: a production of welded constructions with certain technical-economic characteristics, pollution of the environment and problem with the health of the welders. A schematic representation is given in figure 2.

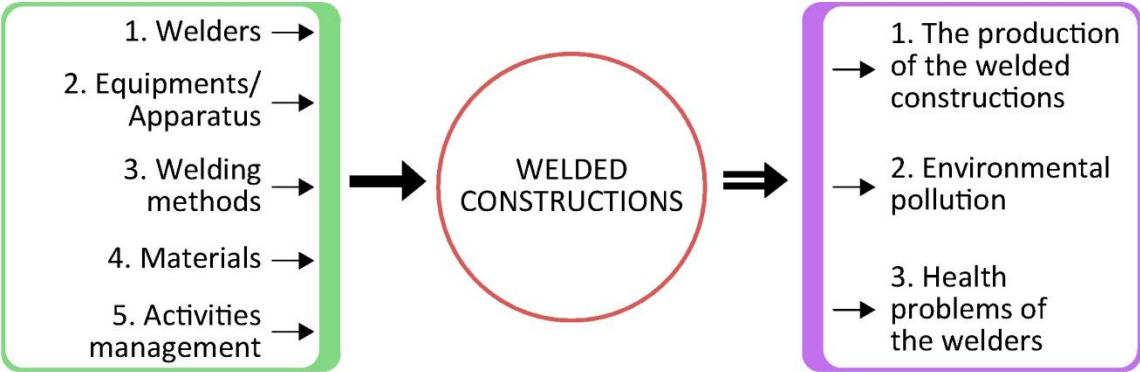


Figure 2. The scheme of the welding process factors

In the case of welding technologies, the scheme presented in figure 3 has been drawn, which shows the relationships between sustainable development and the three factors that determine it.

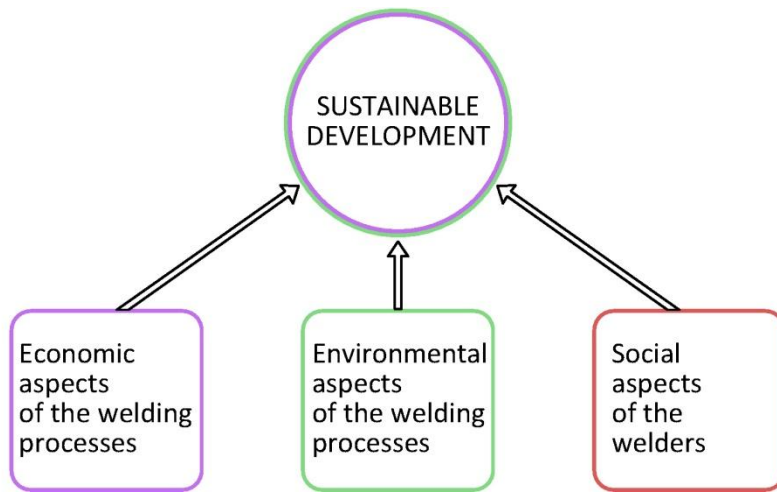


Figure 3. The scheme of the sustainable development- factors

In the companies that produce welded constructions the following 3 rules can be applied:

- The technical-economic activity respects the requirements of the quality management system, according to ISO 9001 standard;
- Welding processes are environmentally friendly and comply with the requirements of ISO 14001, in order to reduce the negative impact on the environment;
- Welding processes are weld-friendly and comply with the requirements imposed by ISO 45001: 2018 (OHSAS 18001) standard, for the prevention of occupational diseases.

Based on the above mentioned ones, the schematic representation was made in the form of an equation, given in figure 4.

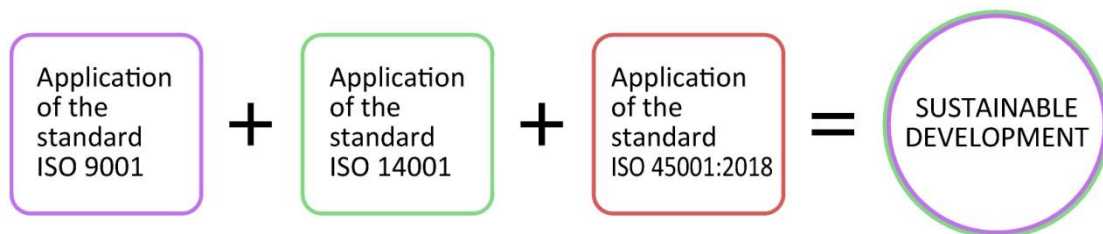


Figure 4. The scheme of the equation – sustainable development

### 3. CONCLUSIONS

Economic development has many positive effects, but it also has negative effects that directly affect the environment and endanger human health and even the existence of humanity. It can be observed that most of the specialized literature focused on the technical and economic aspects of the welding process, and less on the environmental and social aspects. In the last period there is a concern of researchers in the field of welding in 3 directions: technical and economic aspects, environmental and social aspects. Greater attention should be paid to the smoke generated during the welding operation because it has a major negative impact on both the environment and the health of the welder. The paper also deals with the connection between sustainable development and the application of ISO 9001, ISO 14001 and ISO 45001 standards.

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