The Determination of Noxes Emissions in Case of Manual Arc Welding Process with Coated Electrode

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The occupational risk assessment of a machine building company must cover each activity and workstation, taking into account each component of the production system (work system), each workload, work equipment and the work environment. This assessment is an extremely complicated and complex issue since the production system of such an enterprise is particularly complex and complicated. Welding assembly is a highly polluting technology process, especially of the atmosphere and soil. The formation of gases in the welding process is the result of burning of the electrodes, powders, forming the molten metal bath and making the weld seam. Welding operators are exposed to smoke and toxic gases resulting from the welding process, which can in many cases be hazardous to health. Many acute intoxications that may be caused by excessive exposure to or short exposure to smoke and gas resulting from the welding process have been studied over time. In the paper are presented the elements of risk related to the welding process and the most widespread occupational diseases that can occur in the ranges of the welding operators. The following are presented the noxious emissions from welding and are determined by a practical method the emission of noxious at welding deposition of a welding sample, using the manual arc welding process with coated electrode.

Keywords: arc welding, chemical composition, noxious, electrode, toxic gases

The occupational risk assessment must cover each activity and workstation in a machine building enterprise, taking into account each component of the production system (work system), each workload, work equipment and the work environment. This assessment is a very complicated and complex problem because the production system of such an enterprise is particularly complex and complicated.

The risk assessment serves to continuously improve conditions in the workplace and to this goal, requires adequate and sustained documentation and training.

In the assessment of occupational risks it is mandatory to involve workers from each job and if it is appropriate, their representatives with specific responsibilities in the field of health and safety at work, namely occupational safety and health committees, because workers know the best the most dangerous situations and places from workstations, and the committees are informed about the specific dangers to the company's activities.

For the examination of the noxes emissions, were used specialized and certified appliances in the systems, with the necessary accessories and equipment.

The sampling and examination of particulates from smoke and gas released into the welding air, shall be carried out in accordance with the methods in the standards in force.

The noxes emitted by welding consist of two categories [1-6]:

-Particles of metals, non-metals and certain substances with harmful or dangerous, potential or concrete effects, contained in the welding smoke;

-Toxic or hazardous gases emitted by the welding process caused by the thermal effect and by some chemical reactions occurring in the welding process as a side effect of the welding process.

If the levels of the noxes exceed the limits admitted in the literature, measures will be taken to combat their effects on workers coming into contact with them [7].

Welding process risk elements

In order to detect the possible risks in the welding process it has done a detailed analysis of the welding activity in the main production units of such an enterprise where a technological welding process is carried out. For example, in the foundry section, the welder performs the following operations:

-making the fittings from the iron concrete, for the cores and shapes necessary for the casting, according to the documentation;

-cutting of masses, casting networks and the reshuffle of molded pieces with oxyacetylene torch;

-welding of cast and heat-treated parts: removal of defects detected by visual control, magnetic control, penetrating fluid control or ultrasonic control, arc-air gouging, filling of excavated areas by welding according to the procedures specific to each type of material;

In this activity, the possible risk-generating elements are:

-welding equipment and working environment: oxygen-acetylene mixture, welding generator and current transport cable; oxy-gas flame cutting burners, clamp electrode holder and accessories (wire brushes, welding hammer, protective equipment);

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-the pieces, the parts that they cut, make, reshape;
-the technical equipment in the area in which they operate (in particular, conveyor bridges);
-the environment in which it operates: its noxes wich are cumulative with those occurring during welding operations.

The welder performs specific work (oxy-gas and electric flame welding) at all workplaces according to the service tasks [8-10].

-organizes the workplace, checks the technical equipment used for welding;
-adjust the gas flows (oxyacetylene welding, welding in protective gas environment, etc.) or connect the welding transformer to the electrical outlet;
-strictly respects his obligations under the work procedure and the occupational safety notions with which it has been trained.

Occupational risk assessment must cover each activity and workstation in an enterprise, taking into account each component of the work system, respectively worker, worktask, work equipment and work environment [11].

The experimental results revealed the most common occupational diseases in the field of welding operators. This is shown in table 1.

Because in any technological process, the main pollutants emitted in the working environment or the natural environment are chemical substances, the greatest risk that occurs in these jobs is the chemical risk produced by a chemical agent.

Regarding chemical risk, the procedure for its evaluation is often difficult because of the many chemical agents and the preparations used, as well as the lack of knowledge of the dangers which it presents.

Chemical agent means any chemical element or compound, as such or in a mixture, in the natural state or manufactured, used or released, including as waste, from any activity, whether or not intentionally produced and whether or not it is placed on the market.

At work, welding operators may be exposed to hazardous chemical agents either accidentally (explosions, fires, damage to pipelines or tanks, etc.) either routinely during use, handling or transport. Dangerous chemical agents may cause one or several of the following effects: poisonings, burns, fires, irritations, injuries, explosions, etc. To assess the importance of exposure to chemical agents, it is sufficient to consider some of their features:

-are used on a very large scale, from domestic to industrial activities;
-are very varied;
-can migrate sometimes over very large distances from the source, depending on the air currents, the terrain configuration and the nature of the chemical agent, etc .;
-can accumulate:
-in space (especially in closed, non-ventilated areas);
-in the body (some substances accumulates in tissues and are eliminated very hard or can not removed)
-have a very wide range of effects:
-on health (toxicological effects);
-on the environment (ecotoxicological effects, etc);
-other effects (fire, explosions, corrosivity);
-present incompatibilities: substances whose simultaneous presence in the working environment, storage or transport should be avoided because the reactions between them result compounds very toxic / flammable / explosive;
-has a synergistic effect: the effect of several noxes on the same organ, it accumulates.

Experimental part

The examination of gas emissions to the manual arc welding process

To perform the examinations and measurements of smoke and gas emissions in the manual arc welding process with coated electrode, welded samples were performed in accordance with the requirements of the respective standards. This welding process has been chosen because it is a very widespread in industry, being used extensively in repair shops.

For the examination of the emissions of noxes, specialized and certified appliances were used in the systems, with the necessary accessories and equipment.

The sampling and examination of particulates from smoke and gas released into the welding air shall be carried out in accordance with the methods in the standards in force.

The welding noxes consist of two categories:

-Particles of metals, non-metals and certain substances with harmful or dangerous, potential or concrete effects, contained in the welding smoke;

-Toxic or hazardous gases emitted by the welding process caused by the thermal effect and by some chemical reactions occurring in the welding process as a side effect of the welding process.

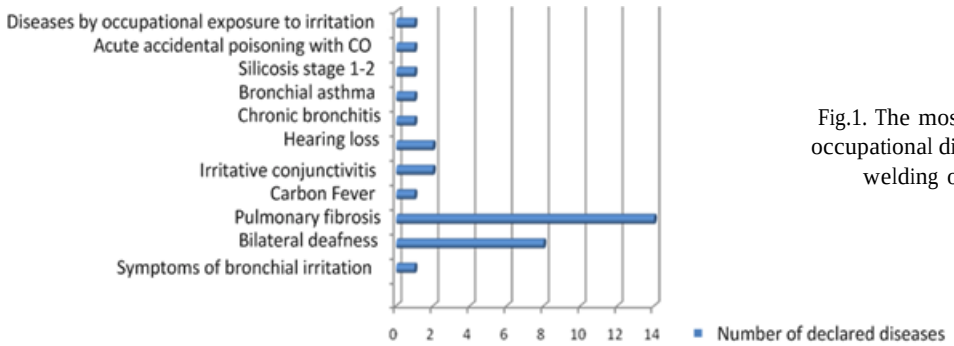

Fig.1. The most widespread occupational diseases among welding operators

Table 1

CHEMICAL COMPOSITION OF S235JR STEEL (ON THE SAMPLE OF LIQUID STEEL)

Name	Designation	Standard Number	Chemical composition					
			C [%]	Mn[%]	Si[%]	S[%]	P[%]	Other [%]
Steels for metals. boilers and pressure vessels	S235JR	NF EN 10028-2	max 0.17	1.40	max 0.30	max 0.045	max 0.045	N=0.09

The base material on which the welding seam was made is S235 JR, the chemical composition of which is shown in table 1.

The welding equipment used for the sample is intended for manual arc welding, BUFFALO 350I, having a maximum welding current of 350 A, is shown in figure 2.

Fig. 2. BUFFALO 3501 welding equipment

The filler material used for the welding the sample is the Superbaz electrode, with the symbol E 7018 according to AWS A5.1, with the diameter of the 3.25 mm electrode wire, having the chemical composition in the deposited metal shown in table 2.

Table 2

THE CHEMICAL COMPOSITION IN THE DEPOSITED METAL WELDED WITH E 7018

C %	Mn %	Si %	S %	P %
0.06-0.10	0.80-1.20	0.25-0.65	≤ 0.01	≤. 0.025

The dust sampling head is located on the exhaust system mouth to determine the emission rate in the welding smoke welding and smoke collection zone for analysis in accordance with ISO 15011-1. The location of the welding smoke sampling pump from the sweat breathing zone of the welder during the loawelding test was performed in accordance with ISO 10882-1. The gas detector measures and simultaneously displays 4 gases. It is equipped with an infrared sensor module for carbon dioxide. The other gases measured are: nitrogen dioxide, hydrogen and carbon monoxide.

Figure 3 shows an image of the positioning of the exhaust system during welding of the sample, which is the object of determining the noxes occurring during welding.

Fig. 3 The exhaust system used during welding of the sample.

Figure 4 shows the portable gas analyzer.

Fig. 4. Drager MSI EM200Gas Analyzer

The welded sample is shown in figure 5a and the particulate sample filter collected from the welding smoke during sample execution in figure 5b.

Results and discussions

The emissions analysis of the manual arc welding process was done on the basis of the particles emission measurements of the welding smoke, during the welding test execution, determining the particle emission rate, or the emission rate of them.

For the sample filter taken from the welded sample, the emission rate was 0.478 mg / m^3.

The emission rate was determined in the breathing zone when the welding test was performed. This emission rate in the breathing zone is 3-5 times lower than the emission rate measured in the welding area.

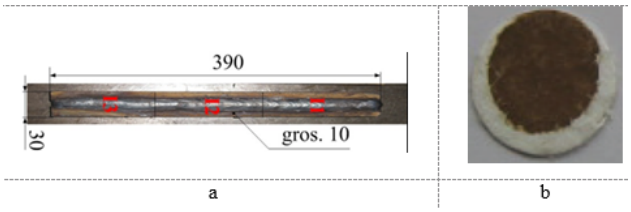

Fig. 5. The welded sample and the filter sample

Analyzing the results presented, it can be concluded that the emission of metallic and non-metallic particles to the electrode arc welding manually was below the exposure limit of 5 mg / m^3.

Physical and chemical analyzes revealed the following concentrations of chemical elements in samples of welding smoke particles: Mn, Fe, Cr and Ba in the range of 2.73-21.8 ppm; Zn, V, Cu and Ti in the range of 1.36-5.3 ppm; K and Ca in the 14.7-19.8 ppm range; Ni and Sn in the range of 0.4-1.8 ppm; Mo in the range of 4.12 ppm; Pb and Cd in the 0-5.4 ppm range. Correlated with emission rates, these concentrations are below the exposure limit. Concentrations depend on the contents of the chemical

Table 3

ANALYSIS OF THE PARTICLES IN WELDING SMOKE SAMPLES

Number	Chemical element	Sample filter no.1 The FRX method
1	Mo, ppm	4.12±6.34
2	Pb, ppm	0.00±15.15
3	Zn, ppm	1.47±100
4	Cu, ppm	1.36±100
5	Ni, ppm	0.4±15.5
6	Fe, ppm	21.8±500
7	Mn, ppm	16.3±700
8	Cr, ppm	2.73±500
9	V, ppm	5.3±100
10	Ti, ppm	1.5±200
11	Ca, ppm	147.300±1.100
12	K, ppm	19.8±200
13	Cd, ppm	5.400±21.92
14	Ba, ppm	2.8±100
15	Sn, ppm	1.8±100

composition of the electrode used in the welding process, but are not directly proportional to them. The results of X-ray fluorescence analysis are shown in table 3.

The examination of toxic gas emissions was carried out by the direct method during the welding test. The concentration of the gases emitted in the welding zone was determined. The multiple gas detector was placed on the welding table at a distance of about 300 mm from the electric arc welding. The measurements are relevant for the concentration of the gases emitted in the breathing air at the workplace in the breathing zone of the welder in accordance with the standards in force.

In the stabilized phases of the welding process, the emission levels of the gases emitted are: 0.13-0.14% CO_2; 0.15-0.17 ppm NO_2; 0-11 ppm H_2; 0-4 ppm CO. These values are below the exposure limit (8 h per day, 5 days a week): 5% CO_2; 1.0 ppm NO_2; 30 ppm CO. Emissions of toxic gases to welding with the manually welded electrode process do not pose a health risk to the welder. Hoyidrogen concentration is higher due to atmospheric humidity, which is absorbed by the electrode coating. However, hydrogen emissions does not represent a fire danger.

Several measurements were made to determine the concentration of toxic gases in the vicinity of the workplace, at a distance of about 3 meters from the electric arc, during the welding tests. The concentration levels of the gases emitted are as follows: 0.12% CO_2; 0.10 ppm NO_2; 0 ppm H_2 and 1 ppm CO. The determinations made here show that levels of harmful or toxic gas concentrations near the welding station have values close to those at the welding station. However, the determined concentrations are below the warning limits mentioned in the literature.

Conclusions

In order to determine the welding noxes, it was chosen as a method of welding, the manual arc welding with coated electrode, considering that this process is still very widespread in the industrial environment, especially in the repair workshops;

During the welding test, a practical method of determining the particules emissions was used by placing the sampling head in the sweat area of the welder as compared to the head position in the welding area. The method is a covert for the welding protection because the welder can accidentally be exposed to the noxes emissions from the welding area in the event of a malfunctioning of the exhaust system, the inappropriate placement of the welding mask, or the presence of unfavorable air streams;

According to the physicochemical analyzes performed on the samples of welding smoke particles in case of the electrode arc welding process, performed with high technical equipment, the concentrations of the chemical elements in the smoke particles are below the exposure limits.

The concentration values of toxic and dangerous gases emitted during welding with the manual arc welding process with the coated electrode, are below the exposure limits.

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Manuscript received: 13.11.2017