IMPACTS OF WELDING ON ENVIRONMENTAL PROBLEMS AND HEALTH AND SOLUTIONS TO OVERCOME THESE PROBLEMS

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Abstract— According to scientific progress and industrialization, engineering sciences and processes have significant progress in all the areas. There are important problems because of this progress in addition to the advantages such as life simplicity, life quality improvement and many other advantages. Environmental problems are one of the main problems due to the rapid development of engineering technologies. Therefore, nowadays environment should enter on different the field of engineering, and it should control, guide and develop these processes according to the specific principles and effects of these processes on environment and health. According to the nature and used equipment, welding is a job with the major impact on environment and human health. Released fume in welding, is a combination of various and fine particles such as carbon monoxide, silicates and so on. Welding fume analysis showed this fume is rich in toxic and hazardous compounds. On the other hand, medical investigations proved, welders are in serious danger of acute and chronic respiratory diseases. The problems are not limited to the respiratory diseases only. In this regard, it can be noted some problems such as suffocation, skin diseases, visual disturbances, many long-term negative effects and environmental problems due to the welding fume. It is very painful that many welders don't know anything about these problems, and the suffered from irrecoverable effects because this lack of awareness. The goal of this paper is creating awareness about welding effects on the health and environment; furthermore, it proposed some solutions to overcome these dangers.

Keywords— Welding, Fume, Environmental problems, Health dangers.

I. INTRODUCTION

Welding and its operation created a massive transformation in industry, so that any industry cannot be fined without welding requirements. If metal industry be applicable in a place, then welding plays a significant role in that place, such as automotive, electronic, construction, oil and many other industries. In other words, engineering sciences and advanced industries of countries will be paralyzed without welding operations. Welding refers to the operations, which two separated metals connect to each other due to the heat, pressure or combination of these factors; in this operation, the in touch part of each metal combined to each other, completely. Basically, welding is more important in an industry with complex structures and building goals. For example, consider shipbuilding industry, giant structures need to be afloat on the seas and oceans, but without welding operations, this goal is elusive. In another case, consider metal and steel structures, construction of any large and small buildings is impossible without welding operations. Nowadays, various methods are available for welding, and suitable method can be chosen according to the conditions; some of the most famous methods are arc welding, shielding gas and electrode welding, and plasma arc welding. In all of these methods, a part of metal and welding electrodes sublimated due to the extreme heat on arc or flame. According to the nature, these metal vapors condense quickly and produced welding fume; these fumes are nanoparticles and inhaled easily, and they enter to the human respiratory tract. As mentioned, various welding methods are available, and all of these methods produce fume. Amount of produced fume is different in any method. Investigations proved, the most amount of produced fume belongs to arc welding method. Required time in welding is another effective factor in the amount of produced fumes. There is extreme heat in welding processes. As mentioned, fumes are metal nanoparticles. These metal particles connect to each other due to the extreme heat and make up a chain that is dangerous for human respiratory tract. At the beginning of the production, fumes are nanoparticles with 0.2 – 0.3 micron in diameter. Over time, the particles connected to each other and make up a metal particle chain due to the fume feature and their trend to aggregation.

According to the mentioned notes and importance of the issue and its impacts on environment and health, environmental experts should be careful, and they should control, guide and develop mentioned processes. The importance of this issue doesn't limit to a special country, because any country cannot be found without welding processes. Workers are responsible to welding after acquire expertise and necessary skills. Each industry with the construction goal, use from these skilled workers. Therefore, welders can be considered as the arm of industries. The role of these workers is very important, but they faced with serious dangers. Fume inhalations have many short-term and long-term effects on welders, because it includes toxic and hazardous substances. As the name implies, short-term effects appear immediately, a few hours and days after inhalation, but long-term effects make a problem after several years. Many features can change the amount of produced fumes. Therefore, different factors are

effective in vulnerability of welding processes, such as voltage (by increasing voltage, more amounts of fume produce, so the probability of vulnerability increased, obviously), arc length (increased arc length leads to increased vulnerability too), electricity flow (more fume produced by increasing electricity flow), electrode polarity (AC or DC polarity of the electrode, produce a different amount of fume), welder experience, ambient humidity and type of welding operations are effective factors on produced fume and vulnerability of welding processes.

II. ENVIRONMENTAL CONSEQUENCES CAUSED BY WELDING

In these years, companies' managers compete with their competitors in order to gain more profit; so, gaining more profit is the first priority of the most companies. To achieve this goal, workers should perform difficult, onerous and dangerous tasks, in this is an unfortunate fact that the first priority of the companies belongs to more profit instead of human health. According to the working environment and conditions, serious dangers and diseases threat workers. For example, welders are working in construction, mine, metallurgy industry, petrochemical and metal industry, faced with respiratory diseases more than others due to the contaminated workplace and significant height difference relative to sea level. There are different methods for welding, which all of these methods produce toxic and hazardous gases. Produced and dangerous gases in welding processes include carbon dioxides, nitrogen dioxides and ozone. The most important feature of these gases is toxic and suffocating effects, and officials are extremely concerned about this feature. Breathing and lung problems and severe headaches are other symptoms of these gases inhalation. Of course, other gases produced in welding processes too. Use of inappropriate raw materials or impurities on the metal surface leads to produce other gases like phosgene.

Ozone produced in all the welding methods. In welding operation UV radiation forms because of welding arc, this radiation leads to oxygen ionization; thus, ozone gas produces finally. In welding operation, bluish color belongs to produced ozone, and the inhaling smell in the electric sparks is the ozone smell. As mentioned, produced gases in welding are toxic and hazardous, and ozone is not the exception too. This gas is very strong and creates problems in trace amounts such as cough, nausea, bronchitis and drowsiness, and in large quantities lead to death. Produced ozone in welding can make breathing problems because of its nature (low solubility in water).

Nitrogen oxides include nitrogen monoxide and nitrogen dioxide is other produced gases with dangerous effects. These oxides produced in the presence of UV radiation and nitrogen of atmosphere warming. Nitrogen dioxide produced during the welding process, without a doubt; the amount of this gas is more than other gases. This gas has different colors at different temperatures. These kinds of oxides have very dangerous effects upon human life. These gases create problems even in trace amounts such as headache, cough, shortness of breath, eye irritation and insomnia. The important note about these oxides is exposed time. For example, very short exposed time with 50 ppm nitrogen monoxide leads to acute respiratory problems. According to the mentioned notes, this issue is a serious challenge. In this regard, some protocol should be ratified in all the countries, which determine the allowed exposed time and the allowable amount of these compounds in order to minimize the risks.

Carbon monoxide is another toxic and hazardous gas, which produces in the welding process. This gas is the result of UV radiation on carbon dioxide, and leads to chemical suffocation and interferes in natural absorption of oxygen by blood. Therefore, the released gases in welding operation are toxic and hazardous gases, and lack of knowledge and safety tips leads to irreparable effects.

III. DAMAGING EFFECTS OF WELDING ON THE HEALTH

On welding operation, metals converted to the molten state, and they evaporated due to the very high temperature, and this produced vapor is called fume. The production of this metal vapor is with oxidation reactions; therefore, metal oxides such as aluminum, chromium, copper and cadmium produced according to the metal nature of fumes. Medical investigations proved constituent compounds of fume have negative effects upon the health. However, the influence of fume on the health is depended upon several factors such as the amount of produced fume, special metal and gas presence near the electrode tip, type of metal in welding operation and constituent compounds of the electrode. Each company or factory managed by different sectors and workers. Workers group are more vulnerable, because they are more evolved with toxic and hazardous substances; unfortunately, workers don't have appropriate and adequate training to deal with the risks in many countries and developing country, especially. As mentioned, fume threat the health, and its impacts categorized into short-term and long-term effects. As the name implies, short-term effects appear immediately, a few hours and days after inhalation; these impacts include problem such as metal fume fever. On the other hand, long-term effects make a problem after several years, and lead to chronic disease, normally. Of course, workers can be safe at short-term effects by attention to the simple and basic rules. While, these simple and basic rules don't guarantee the safety of long-term effects of these toxic fumes and gases.

Another important note is effectiveness of various fumes. A fume with special compound may create irreparable problems with very low concentration; while, another fume may have fewer impacts in high concentration. Therefore, awareness from different compounds is very important. For example, operation threshold and effectiveness of aluminum is 1 milligram per cubic meter in every 8 hours of work, while this amount is 0.00005 milligram per cubic meter in every 8 hours of work for beryllium. Therefore, if a fume with beryllium compound produce in welding is more dangerous from a fume with aluminum compound. This amount called threshold limit value in safety standards. Threshold limit value determines the allowable concentration of a compound for application and inhalation, and it is specified with exact investigations and analysis by experts. Therefore, exceed this amount associated with damaging effects.

Produced fume in the welding process, composed of fine and man-sized particles. These particles diameter is about 0.2 – 0.3 micron; therefore, they can effect on the human respiratory tract easily. According to the investigations, effective diameter of fume particles and welding ash is in the range of 0.0005 – 5000 micrometers. Therefore, tiny particles of pollutants increased their destructive power. It is concluded, pollutant inhalation in welders is 4 times more than other people according to the analysis and comparison between welders and others.

Disadvantages of fine metal particles in fume consideration required several researches, because this is a very detailed topic. Briefly, some of the disadvantages can be noted; for example, aluminum compound in fumes leads to respiratory tract irritation, copper compound leads to acute problems such as irritation to the eyes, nose and throat, nausea and metal fume fever, manganese compound can cause problems such as metal fume fever and chronic problems in central nervous system and zinc oxides may lead to metal fume fever too. Many other problems can occur due to inhaling these pollutants.

IV. SOLUTIONS TO DEAL WITH THE DANGERS OF WELDING OPERATION

Create awareness is the first step to be safe in the welding process. Welders should be trained in the type of welding methods, welding metals and produced gases and fumes in welding operation as well, because sometime very low concentration of a compound like cadmium is fatal. If awareness of these compounds is adequate, then welders can use considered alternatives. For example, alternative alloys like cadmium free silver alloy can be used. The best way to minimize dangers of fume and gases is the use of a proper ventilation system. According to the operation type, ventilation systems classified into local and general ventilation. Local ventilation, transfer fumes and gases to the out of workplace after production directly, and general ventilation refers to outputs such as doors, windows and installed fans. Although, transfer of gases and fumes decrease welder problems, but it increased environmental problems. To solve this problem, experts proposed use of filtration technology; this equipment can filter out detrimental compounds and prevent them to enter the atmosphere. Electronic precipitators, bag filters and cartridge filters are some of the filtration process in welding. Other safety tips include guard, sanitary actions, personal protective equipment, eye protection, protective clothing, ear protection, respiratory equipment and periodic exams. All of these actions are necessary for safety and deal with possible dangers.

CONCLUSION

This papers attempts to investigate different methods of welding consequences on environment and health, and proposed some solution to deal with these dangers. Different gases like ozone, nitrogen oxides and carbon oxides produced in the various welding methods, and all of these gases are among the pollutants, which can cause environmental problems as released into the atmosphere. Furthermore, as these gases inhaled, mentioned person is faced with serious threats. Fumes are other productions of welding operation, and composed from fine particles. As produced gases, fumes are a pollutant too, and it leads to acute and chronic disease according to the short-term and long-term exposed time. These are severe problems and cannot be ignored; so, practical and definitive solutions should be proposed to prevent these effects. Create awareness is the most important way to achieve this goal. Many arose problems is the result of lack of awareness, and adequate knowledge is the only solution in this regard. Necessary and vital points should be taught to welders by holding training classes, because they should have suitable reactions in different conditions. Use of proper ventilation systems is important too. These systems transfer dangerous gases and fumes outside the workplace, and suitable filters prevent them to enter into the atmosphere.

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