

Green Welding – The Saviour

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Abstract

Though the welding technology has undergone a phenomenal change over the last five decades, the atmosphere or our environment is still under severe risk through the welding activities, including global warming. The main hazard due to welding activities are fumes and gases. In most of the welding operations, welding smoke is generated in large volume, which is a complex mixture of very fine particles (fumes) and airborne gases. To overcome the situation, green welding is the only way forward. Use of friction stir welding (FSW) is one of the ways towards green welding as well as to protect the environment somehow. Other less pollutant welding processes are also to be adopted as far as possible. Another way to protect our environment and to adopt green welding is to train the welders through virtual reality driven welding simulator.

Keywords: welding, green welding, environment, welding simulator, FSW

1.0 INTRODUCTION

Over the last 50 years, welding technology has undergone a phenomenal change because of the efforts made in global exchange of information and research. These changes have led to adoption of higher productivity processes with consistent quality, safety and improvements of work environment and have contributed to raising welding technology to a level where it is today.

However, the atmosphere or our environment is still under severe risk through the welding activities, including global warming. Let us have a look to the main hazards from the welding, which affects most to our environment.

2.0 WELDING HAZARDS

Hazard is an object that is imagined having the potential to harm.

One must understand, evaluate and mitigate dangers and hazards arising out of the process and associated tools, plant and equipment to save our health and as a whole our environment.

The main hazards due to welding activities are FUME AND GAS!



Fig. 1 [Picture courtesy: HSSE World]

2.1 HAZARD DUE TO FUMES AND GASES

In all the Welding operations, gases and fumes are generated in large volume. Generally, it is termed as "Welding Smoke." Welding smoke is a complex mixture of very fine particles (fumes) and airborne gases.

Fume hazards:

- ◆ Particulate fumes of $\approx 0.3 \mu\text{m}$ (sizes can range from 0.1 to 10 microns but mostly $< 1 \mu\text{m}$);
- ◆ Invisible gaseous fumes;
- ◆ Pollution from particulate matters and pollutant gases generated from various sources;
- ◆ Serious effects on welder's health over the time.

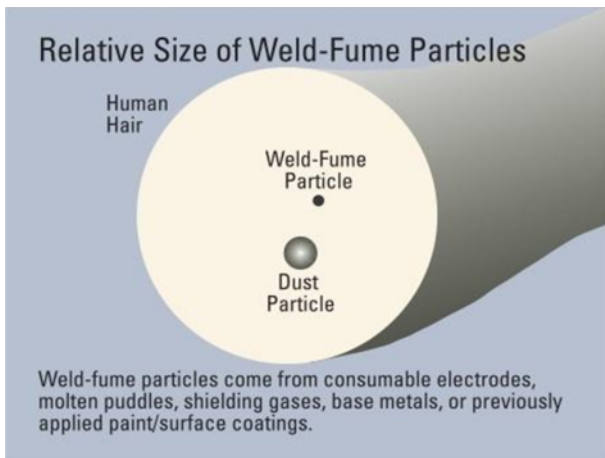


Fig. 2 [Picture courtesy: Construction Equipment]

2.1 SOURCES OF FUME AND GAS HAZARDS

Parent Metal:

- ◆ Metallic fumes generated by heating
- ◆ Oxides formed by heat from cutting

Surface Treatment:

- ◆ Chemical cleaning of surfaces
- ◆ Degreasing chemicals
- ◆ Anti-spatter sprays

Surface Coatings:

- ◆ Galvanizing and other metallic coatings
- ◆ Paints
- ◆ Plastic coatings

Surrounding Air:

- ◆ Formation of ozone
- ◆ Nitrogen oxides
- ◆ Carbon monoxides
- ◆ Other oxides depending upon the parent metals being welded and consumables being used



Fig. 3 [Picture courtesy: IIW-India]

Shielding gases:

- ◆ CO₂ splits into carbon monoxide
- ◆ Higher level exposure of inert gas-based mixture raises the level of ozone considerably higher
- ◆ Asphyxiation (lack of oxygen) due to both Co₂ & Argon
- ◆ Continuous leakage of these gases in a covered atmosphere can put welders' life at risk

Consumables:

- ◆ SMAW flux coatings
- ◆ Copper fumes from GMAW wires
- ◆ Welding fluxes

Fumes and gases can be dangerous



Fig. 4 [Picture courtesy: VIT University]

3.0 THE WAY FORWARD

Green Welding or Green Revolution is the Only Way!

3.1 GREEN WELDING

Welding through environment friendly processes is called Green Welding in general.

“Different welding techniques generate different amounts and kinds of pollutants, so selection of technique has an impact on environmental impact. Two solid-state welding techniques, friction stir welding (FSW) and magnetic pulse welding (MPW) create less pollution because they eliminate the need for fillers or flux and do not produce dangerous fumes. Another solid-state technique, diffusion welding, also eliminates outgassing, but it is impractical for large jobs.” [1]

While talking about arc welding, one should see the possibility to use submerged arc welding (SAW) to a great extent, through which production will be faster without any, or with negligible fume and gas, though positional constraints are there.



Fig. 6 [Picture courtesy: Government of S. R. Viet Nam]

2.3 HAZARD CONTROL CHART

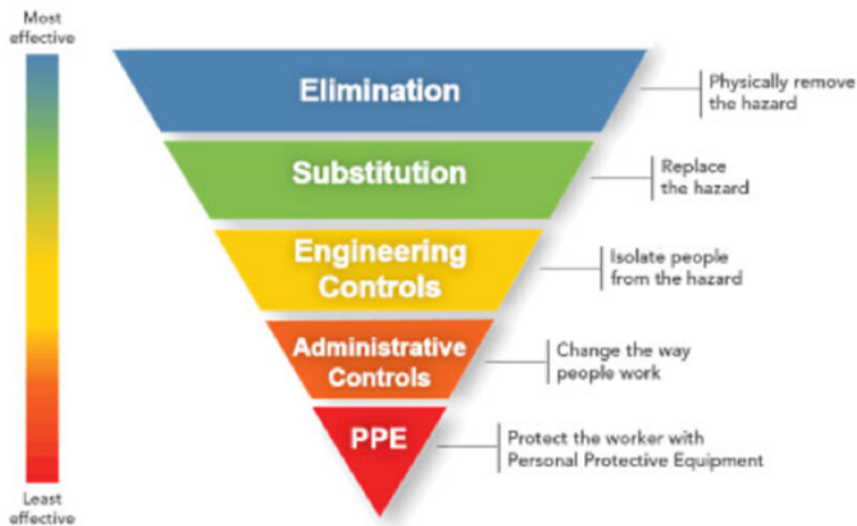


Fig. 5 [Picture courtesy: NIOSH]

3.2 FRICTION STIR WELDING

Friction stir welding is considered to be the most environment-friendly and is a "green" technology due to its energy efficiency with high performance welding.

"Indeed, it's a green process that does not emit smokes or other projections and does not produce any noise. As it does

not require any preparation of the surface to be welded, it does not involve any prior stripping."

"Moreover, the main advantage of FSW is that it's a 'cold' welding, more exactly in a pasty state. The weld is made only by mechanical deformation through friction." [2]

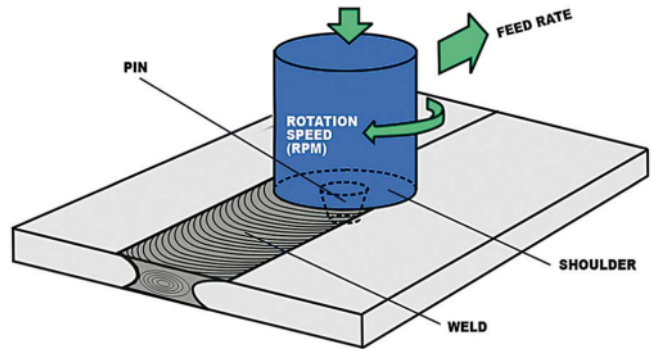
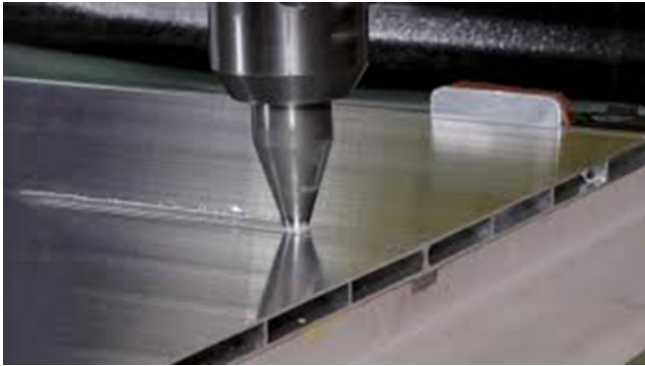


Fig. 7 [Picture courtesy: Belgian welding Institute]

3.3 COMPARISON OF FEW OTHER GAS EMITTING PROCESSES

"Among other techniques, researchers in Germany compared manual metal arc welding (MMAW or SMAW), laser arc hybrid welding (LAHW) and gas metal arc welding (GMAW) across several environmental factors and concluded that LAHW created the lowest direct environmental impact, with GMAW a close second. The lack of flux and electrode stubs and lower electricity use accounted for much of the difference." [1]

3.4 TRAINING THROUGH VIRTUAL WELDING SIMULATOR

"Greening the welding process starting by training welders using virtual reality. By providing virtual tools and materials, VR reduces training costs and eliminates the environmental impact of actual welding. And initial training is the right time to introduce new welders to new ways to start their careers knowing how to ply their trade in an environmentally responsible and sustainable way." [1][3]



Fig. 8 [Picture courtesy: IIW-India]



Fig. 9 [Picture courtesy: Lincoln Electric]

3.5 CONSTRUCTION PROJECTS

Construction projects are really challenging for green welding, where manual metal arc welding is used in most of the cases. There is a lot of scope for the research and development in low polluting electrodes or other welding processes with portability. Emphasis to be given for the shop floor fabrication, wherever possible, with less polluting welding processes. Also, tungsten inert gas or TIG welding to be used, wherever possible, because it is somehow less pollutant than SMAW or GMAW. However, challenge remains, and one really does not know how to overcome, at least at the present situation!



Fig. 10 [Picture courtesy: Dreamstime]

4.0 CONCLUSION

To make the Green Welding effective, the following steps have to be undertaken.

- To start training through Virtual Reality, i.e., through Welding Simulator;
- To use proper equipment to extract and neutralize fumes and gases as far as possible;
- To use Submerged Arc Welding to a great extent;
- To popularize the use of FSW or similar processes with less hazards wherever possible;
- To do more research to invent electrode, filler wire and gas mixtures which will emit less gas and fume;
- To be very conscious about unnecessary damaging the environment.

Note: Cost implications are not considered while drafting this paper.

ACKNOWLEDGEMENT

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