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Hazards of welding fume

What is welding fume?

Welding is a process that joins selected work pieces together by melting them to form a strong joint. As part of this process, there is an amount of metal fume produced – basically microscopic particles of hot metal and gases that are small and buoyant enough to be released from the welding arc and rise in a cloud of metal fume into the workplace air. This fume is then able to be inhaled by the welder or others close to the source. There can be significant exposures to workers if effective controls are not in place, potentially leading to significant short and long-term health effects.

Welding fume can contain a mixture of airborne gases that may include oxides of nitrogen (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), ozone (O_3) and shield gases e.g. argon, helium.

The visible part of the fume cloud is mainly particles of metal, metal oxides and flux (if used). The exact level of risk from the fume will depend on what metals are involved in the work e.g. iron, aluminium, copper, lead, manganese, chromium, nickel, and others. Each of these can have a different toxic effect on the body so exposure needs to be effectively controlled. The airborne concentrations and total exposure time to these fumes are also significant factors in determining the overall exposure of the welder.

Known health effects from welding exposures

Inadequate respiratory protection is the 4th most frequently cited workplace violation in the United States[1]. There are a number of known health effects that can occur welding exposures:

- Short term exposures to significant levels of welding fume and gases can result in eye, nose and throat irritation, dizziness, headache and nausea. Ozone is a particular cause of this when TIG welding stainless steels and aluminium.
- Long term significant exposure to welding fume can cause lung function abnormalities, including bronchial asthma, chronic obstructive pulmonary disease (COPD), pneumoconiosis and other pulmonary fibrosis (chronic beryllium disease, cobalt lung). Various types of cancer, including lung[2], larynx and urinary tract cancer[3]. Chromium (VI), a specific chemical form of chromium, can be created during welding of many stainless steels and non-ferrous alloys, and is highly toxic and can cause cancer. Certain fumes (zinc is one) may induce metal fume fever, stomach ulcers, kidney damage and nervous system damage[3]. Prolonged exposure to manganese fume can cause Parkinson's–like symptoms.
- Pneumonia – welders are particularly prone to a lung infection that can lead to severe and sometimes fatal pneumonia. Modern antibiotics usually stop the infection, however in severe cases you could end up in hospital. 40-50 welders in the UK are hospitalised every year with pneumonia caused by welding fume. Two of these welders die every year[4]. It can affect young welders as well as older people.
- Asthma – this is a common complaint for welders, with components of stainless steel fume containing chromium oxide (CrO_3) and nickel oxide which cause asthma. For this reason, stainless steel welding fume is considered more harmful than mild steel fume.

Some strategies that may help reduce exposure to welding fume:

Welding creates a mixture of respirable gases and/or fumes (particles). To address these hazards and risks, it is best practice to use a hierarchy of controls. The idea is that the highest priority items on the hierarchy not only do the most to reduce fumes and worker exposure, but that they also put the least burden of responsibility on the welder.

1

Modify or substitute your welding process to other processes that generate less fumes and/or reduce the most toxic contaminants.

Control limitations: substitutions may not be possible. For example, when the end product requires stainless steel (chromium).

2

Engineering controls include modifying enclosures around the welder, or the general ventilation of the workshop, or local exhaust controls.

Control limitations: ventilation can be difficult to achieve due to conflicting needs, for instance heating/cooling or shielding gases.

3

Work practices include having the welder keep their head out of the plume.

Control limitations: space-restricted workpieces or the welding situation may not allow alternative placement of the welder's head.

4

Personal respiratory equipment. If steps 1 through 3 do not eliminate the respiratory hazards, respiratory protection for the welder can provide protection and comfort.

Control limitations: companies should establish a respiratory protection program that includes a selection of respirators and their filters, training and maintenance.

By evaluating every risk, you can prioritise their prevention. Welders should understand the hazards of the materials they are working with and have access to relevant safety data sheets and identification of size and scale of exposures to welding fume.

- Investigate consumable options to see if there are less toxic alternatives or a welding type that produces less fume.
- Welding surfaces should be as clean as practicable of any coating or oil/grease etc. that could potentially increase the overall exposure to airborne concentrations of hazardous particles or vapours.
- Local exhaust ventilation systems can be used to remove fume and gases from the welder's breathing zone. Any air extraction system inlet should be located as close to the plume source as possible to remove the maximum amount of fume and gases. Keep any exhaust points away from other workers.
- Workers should position themselves in respect of the fume source as efficiently as possible to avoid or reduce exposure to the welding fume and gases e.g. welders can try to position themselves to be upwind when welding in open or outdoor environments. When working inside, welders should take advantage of any natural drafts by positioning themselves to keep fume and gases away from themselves and other workers.
- Use of appropriate respiratory protection equipment.

References

[1] *Top 10 Most Frequently Cited Standards*, OSHA, U.S. Department of Labor, for 2015

[2] "*Welding-Related Respiratory Diseases*" article, (translated from) Medycyna Pracy (Occupational Medicine), Wittczak T., Walusiak J., Pałczyński C., 2009;60(3):201-8.

[3] "*Controlling Hazardous Fumes and Gases during Welding*", OSHA Fact Sheet, U.S. Department of Labor, DSG FS-3647, March, 2013.

[4] Health and Safety Executive (www.hse.gov.uk/welding/illness.htm)

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