Health and Safety Executive

Fume facts - What is it and what does it do to you

This page expands on the basic ‘what you need to do’ guidance contained in the welders and managers pages. The information here is essentially background information but it may help you assess the level of risk at your workplace and hence decide if you need additional ventilation, fume extraction or RPE.

What is the fume and gases from welding and cutting

The fume given off by welding and hot cutting processes is a varying mixture of airborne gases and very fine particles which if inhaled can cause ill health.

Gases that may be present in welding and cutting fume are:

- nitrous oxide (NOx),
  (Nitric oxide (NO) and Nitrogen dioxide (NO2) are often referred to collectively, in this sector of work, as Nitrous oxides. (NOx).)
- carbon dioxide (CO2),
- carbon monoxide (CO)
- shielding gas (eg Argon, helium) and
- ozone (O3)

The visible part of the fume cloud is mainly particles of metal, metal oxide and flux (if used)
The exact level of risk from the fume will depend on 3 factors:

- How toxic the fume is
- How concentrated the fume is
- How long you are breathing the fume

How toxic is the fume?

For arc welding, the visible fume comes mostly from the filler wire when it’s exposed to the electric arc. The amount of hazardous substances in the filler wire should be included in the product information that is printed on the original packaging. Many of the common metals used in filler wires are harmful and several have Workplace Exposure Limits (WEL). Cadmium and Beryllium are rarely found, but are particularly toxic. Chromium, Nickel, Vanadium, Manganese and Iron all have WEL’s. see Table 1 of EH40 [1] for a complete list. Generally the smaller the number for the WEL the more

toxic the substance is. The toxic constituents of fume can be affected by the choice of welding process.

Example

Stainless steel MIG welding fume usually contains about 18% chromium but most of it is ‘trivalent’ Chromium (WEL= 0.5mg/m3). Stainless steel welding using MMA equipment tends to contains less chromium (up to 8%) but most of it is the more toxic ‘hexavalent’ Chromium (WEL = 0.05mg/m3). This means that although there is more Chromium in MIG fume, overall the fume tends to be less toxic. If all the other factors are the same and it is practical, it would be preferable to use MIG/MAG welding techniques for welding stainless steels.

It is generally accepted that stainless steel fume is more hazardous than mild (carbon) steel fume due to the higher chromium and nickel content.

TIG and flame welding techniques do not normally involve putting the consumable directly in to the arc, they generate much less visible fume particles. For these techniques and also resistance welding and flame/ plasma cutting, the health risk from the gases found in the fume cloud becomes as important as the risk from metal particles in the fume.

Flame cutting with an oxidising flame usually leads to increased levels of nitrous oxides. Using a reducing flame usually creates carbon monoxide. Both gases are toxic and have WELs associated. However they are not normally produced in large enough amounts to present a significant hazard provided there is good ventilation.

How concentrated is the fume?

The concentration of harmful substances will be highest in the plume of fume that rises from the weld point. As the plume rises it mixes with the surrounding air effectively diluting itself. Fans can be used to forcibly dilute it. In HSE guidance this is known as ‘forced ventilation’. The more air the fume can mix with – the lower the concentration of harmful substances. By reducing the concentration of harmful substances in the air, you reduce the level of risk. This is why it is important to try to work with your head out of the rising plume of fume.

Case study

MAG welding on mild steel inside an enclosed space (not a confined space[2])

The enclosed nature of the workplace means that there is a restricted amount of air to dilute the fume. Forced ventilation can be used to increase the dilution particularly if the welding process will take a significant amount of time (eg more than 10 minutes).

How long you spend breathing the fume

Some welders, particularly fabricators, spend a significant amount of time setting up a job before they pick up the welding torch to start welding. This means in an 8 hour working day the welder may only actually weld for an hour or 2. Conversely a production welder who is supplied with ready cut parts and a jig to hold them will spend much more time actually welding. If you are assessing risk it is important to consider how long a welder will actually be welding. This is sometimes referred to as ‘arcing time’ or ‘trigger time’. It equates to the period of time that fume is being created. Lower ‘arcing time’ means there is likely to be less fume exposure and hence less risk.

Aluminium fume

The predominant risk associated with aluminium welding is exposure to ozone. Exposure to ozone can result in streaming eyes and nose. A sore throat is often a symptom. In severe cases ozone can cause emphysema (water on the lung). Ozone exposure may make existing medical conditions like asthma, worse.
Ozone is an irritant gas and has WEL of 0.2 ppm (0.4 mg/m3). The exposure limit is likely to be exceeded at most aluminium welding operations (particularly TIG) unless there is effective LEV or the welder wears suitable RPE.

Case study

Optimise your shielding gas – compared to using pure Argon, using a gas containing 98% Argon 2%Hydrogen results in significantly less Ozone production when TIG welding aluminium. You will usually see production benefits (reduced arc time and weld quality) that can be used to justify any additional costs.

Link URLs in this page

1. Table 1 of EH40
   http://www.hse.gov.uk/pubns/books/eh40.htm
2. confined space
   http://www.hse.gov.uk/welding/confined-spaces.htm