Metal Fume

It is no coincidence that many workers within the metals industries seem to suffer from flu, with symptoms of runny noses, sore throats, fevers, chills, nausea and headaches. As surprising as it may seem, these flu like symptoms may not relate to flu at all - they can be caused by the inhalation of metal fumes generated from welding and related processes.

Often invisible to the naked eye, metal fumes are generated as the filler rod or base metals are vaporised through the various welding processes, which then condenses out as very fine particles. Once inhaled the flu-like symptoms can begin within 24 hours of exposure, and although the symptoms are usually short lived with full recovery, repeated exposure can lead to longer term illnesses such as bronchitis, pulmonary oedema and even bone damage.

For years, different industries have been aware of the existence of metal fume fever and a wide variety of synonyms have been adopted to describe the resultant industry-related ailments. Usually caused by exposure to copper, magnesium, zinc, lead and Ozone, these occupational illnesses include Brassfounders’ ague, Smelter shakes, Zinc chills, Galvanizers’ poisoning, Copper fever, Foundry fever, Monday fever and Smothers.

Wider implications

Metal fume fever is, however, not the only potential health hazard for those working within the metals industries.

Metal fumes are by-products of the material being used. As a result they can, depending on the materials being used, contain a wide variety of potential respiratory hazards. For example, welding fume from stainless steel and some hard facing electrodes may contain chromium and nickel which could lead to the development of nasal cancer. Extreme care should be taken when working with painted, plated or coated steels because some finishes, such as chlorinated rubber paints, can breakdown to form harmful gases when welded or cut.

Cleaning applications can also be potentially hazardous to the respiratory system. Unless allowed to evaporate fully, vapours from chlorinated solvents can decompose under the intense heat of the welding arc and, as a result can produce a wide range of nasal and lung irritant gases and vapours.

Each of these substances can have a different effect on the respiratory system. For this reason it is important that metal workers and welders are aware of the range of potential hazards as well as their cause and effect. It is also vital that those involved in welding processes are properly trained in the correct use and maintenance of control measures, for example Local Exhaust Ventilation (LEV) and Respiratory Protective Equipment (RPE). This is a legal requirement under the Control of Substances Hazardous to Health (COSHH) Regulations 1999. This is also a requirement of the British Standard BS4275: 1997 - Guide to implementing a respiratory protective device programme.

Common Hazards and Effects

Whilst far from exhaustive, the following list highlights some of the most commonly found substances found in metal working and welding applications.

In addition to Chromium plating, Chromium is also present in stainless steel and is frequently used in the production of alloys with Nickel and Molybdenum. Whilst initial exposure may cause respiratory irritation and ulceration of the nasal mucosa, it is believed that repeated exposure to hexavalent Chromium compounds and Nickel compounds may be associated with the development of nasal cancer in the long term.
- Irritation to the nose and throat as well as nausea may follow exposure to fume that contains Copper or Fluoride. Found in some electrode fluxes and coatings, high concentrations of fume containing Fluoride over long periods can result in pulmonary oedema and bone damage.
- **Iron Oxide**, the major fume to which welders are exposed, is another respiratory irritant. Affecting the nose, throat and lungs, long-term exposure can cause Siderosis, a fibrosis of the lungs, which is commonly known as Iron Oxide Lung.
- **Lead** is often found in pipes, sheet metal and foil. Symptoms of acute exposure include loss of appetite, a metallic taste in the mouth, constipation, anxiety, nausea, tiredness, pallor, weakness muscle joint pains and colic. Whilst low exposures over a long period of time can damage the nervous, urinary, reproductive and blood forming systems, severe Lead poisoning may damage the central nervous system, e.g., wrist drop (peripheral motor neuropathy), and kidneys possibly causing anaemia and muscular paralysis.
- **Manganese** is mostly used as an additive in the manufacture of steel alloys, which greatly enhances its hardness and tensile strength. Manganese exposure can cause nervous system disorders or, where large doses are concerned, can produce pneumonia-like symptoms.
- Allergic contact dermatitis and respiratory irritation can follow exposure to Nickel, which is often found in the production of special steels including ‘silver’ coins.
- MIG and TIG welding, as well as the welding of Aluminium, stainless steel or Copper, can lead to the creation of Ozone gas which is formed by the reaction of oxygen and ultra-violet light, that is usually present during welding applications of this type. Inhalation of Ozone can irritate the eyes, and respiratory tract, and also result in headaches and even lead to pulmonary oedema.
- Finally, **Vanadium** is widely used in the production of steel alloys and can cause severe pneumonitis, bronchitis, pulmonary oedema, and may also cause green discoloration of the tongue and fine tremors of the extremities.

**Respiratory Protection**

When this list of substances is combined with the vast array of cleaning solutions and surface coatings commonly associated with the metal working industries, it is not surprising that a wide variety of respiratory hazards can exist.

For this reason reputable companies such as 3M offer a range of disposable and powered air respirators which are suitable for use against the effects of dusts, metal fume and Ozone, as well as the nuisance odours generated in welding processes. Before an appropriate respirator is selected, it is a legal requirement that a risk assessment be undertaken (COSHH Regulations). The assessment needs to identify a number of things, the nature of the hazard(s), how individuals are being exposed and the level of personal exposure, and to determine whether the existing control measures do adequately control personal exposure. If it concludes that exposure is not adequately controlled, employers must introduce further preventative or control measures to reduce exposure. If the control of exposure is still deemed inadequate, then in addition to the control measures, Personal Protective Equipment (PPE) such as RPE should then be used.
The respirator most appropriate should be selected by:

- Relating the hazard(s) to the right RPE.
- Relating the level of exposure to the maximum usage concentration offered by the respirator (the Assigned Protection Factor) in order to reduce exposure in the breathing zone to below the Occupational Exposure Limits (OEL).
- Taking into account wearer and environmental factors such as: face size and shape; facial hair; work rate; wear time; spectacles; medical conditions (cardiovascular problems); and work environment (extreme temperature and humidity).
- Compatibility with other forms of PPE, e.g., welding shields, goggles etc.

Specialist Maintenance-Free Welding Respirators

Because Ozone gas may be present in arc and MIG/TIG welding applications or where aluminium, stainless or polished steels and copper are used, a respirator which includes a layer of activated charcoal such as the 3M™ 9925 Welding Fume Respirator or the 3M™ 9928 Premium Welding Fume Respirator should be considered. This type of respirator works by filtering out dust, metal fume and Ozone from contaminated air as 'lung-power' draws the air in through the filter material.

Specifically designed for use in welding processes, the 3M 9925 and 3M 9928 respirators meet the requirements of the European Standard EN 149:2001 FFP2 and have an Assigned Protection Factor (APF) of 10. They have been independently tested against particulate welding fume and have also been tested for use against Ozone. Featuring an exhalation valve to reduce moisture and heat build-up, they are designed to fit under the welding hood and can be worn with face shields and goggles without restricting vision or interfering with other protective devices.

3M™ Adflo™ Powered Air Respirator – specially designed for welders

The Adflo powered air respirator is specially designed for welders using the award-winning Speedglas™ 9000 Series Welding Shields. Its smart, compact design is made to suit welders and their specific working conditions.

With the right type of filter the Adflo respirator effectively protects against both particles and gases – all in one system. And you can selectively replace either the particle or the gas filter as needed: you don’t need to change both filters at the same time.

3M™ Modular Range Powered air Respirators

Powered Air Respirators from 3M include the Airstream™ Powered Air Respirators plus the Dustmaster™ and Jupiter™ Turbo Units that can be used with a broad range of 3M Headtops. These powered air turbo units provide a constant supply of filtered air to the wearer's headtop and are suitable for many welding and metalworking applications. The full range of 3M Headtops includes soft headtops, impact resistant headtops, full face masks and welding headtops. They are available with a choice of either passive or electronic welding shields.
**Airstream™ Respirator**
The Airstream Respirator offers integrated head, eye and respiratory protection. The helmets are in the form of a lightweight, strong and tough injection-moulded shell with a visor to protect the face and battery powered motor at the back of the head providing a flow of clean air to the wearer. The Airstream system may either be airfed or powered air with the battery worn round the waist.

**Dustmaster™ Respirator**
The Dustmaster respirator features a belt mounted turbo unit which powers clean air into the headtop after filtering out the harmful dust particles, metal fume and nuisance odours.

**Jupiter™ Respirator**
The Jupiter respirator also incorporates a belt mounted turbo unit designed for use with the range of 3M Headtops. The slim, compact design features lighter, stronger materials to make it one of the safest, comfortable and most versatile powered air unit ever developed.