Health and Safety Information

Welding Fume
Welding fume consists of various airborne substances (fine particles and gases) which may increase hazards to health when they are inhaled or swallowed. The degree of hazard to the welder depends upon the composition of the fume, the concentration in the air that he is breathing and the time for which he is exposed to it.

No fumes or gases are evolved by MMA, MIG or TIG, SAW or gas welding consumables at normal ambient temperatures, but in use (welding), fumes can be evolved. The tables in this section give the chemical composition of the particulate fume evolved during the use of the range of welding consumables, analysis being of fume generated in an enclosed Swedish box type apparatus and using a compatible base plate.

The chemical composition of the fume is expressed as weight percent of elements, as is conventional, rather than as oxides and silicates and the other complex forms they actually exist in, in the fume. The analysis is not a complete analysis, the balance of the fume from the MMA process, for example, consisting of complex oxides and silicates of some or all the slag-forming constituents of the electrode coating such as sodium, potassium, calcium, magnesium, aluminium, titanium, which are usually treated together as a residual fraction of inert inorganic fume.

The gases nitric oxide, nitrogen dioxide and ozone may sometimes be produced by the action of the electric arc or the radiation from it on the surrounding air. These gases do not arise from the welding consumable and are not usually a problem in MMA welding under conditions of normal ventilation. MIG welding is more likely to give rise to these gases, particularly at high current levels, and ozone generation may be increased by the presence of argon in the atmosphere around the arc. Carbon monoxide may be produced by the decomposition of carbon dioxide in the shielding gas or of carbonates in flux cored wires.

Occupational Exposure Limits
The recommended limit on the concentration of welding fume (or any other atmospheric contaminant) in the air breathed by any person is defined by the Health & Safety Executive in a list of Occupational Exposure Limits (guidance note EH40). This guidance note is revised annually and reference should always be the most recent edition. A long term exposure limit (8 hr TWA value) of 5 mg/m^3 for particulate welding fume is included in the current list.

It is the responsibility of the user/employer under the Health & Safety at Work Act and the Control of Substances Hazardous to Health (COSHH) regulations that limits are not exceeded. The fume analysis cannot be used to assess the concentration of total welding fume to which a welder is exposed. Assessment of the possible exposure of the welder must be carried out by a competent person.

The analysis of fume from electrodes and wires for welding mild and some low alloy steels and aluminium alloys indicates that at a total particulate fume concentration of $5mg/m^3$ no individual constituent of the fume will exceed its own recommended limit.

These consumables can be found in table 1. There are, however, consumables which give fume containing elements such as chromium, nickel, manganese and copper in sufficient quantities that even at 5mg/m^3 their own limits would be exceeded. In these cases a greater degree of fume control or protection is required to ensure that welders and others are not exposed to excessive amounts of these elements. Consumables giving fume of this nature are listed in table 2, which also include guidance on the maximum concentration of total particulate fume allowable in order to protect workers from the main constituent (e.g. chromium) present in the fume.

The figures quoted in these tables are theoretical maximum concentrations, but at very low values, for accuracy with gravimetric determinations, sampling would have to be carried out for long periods, perhaps even over a complete working day. In these instances it is suggested that chemical analysis for the main constituent elements of concern might be a more practical approach.

Hazards of Excessive Exposure
Effects from excessive exposure to fume arising from inadequate ventilation may become apparent at the time of welding or shortly afterwards or at some later date. Some of the effects are summarised below, and here it is important to note that workers other than welders may also come into contact with the products of welding fume:-

(a) Irritation of the Respiratory Tract
This is the effect of dust or fume on the lining of the respiratory tract and can cause dryness of the throat, tickling, coughing, chest tightness, wheezing and difficulty in breathing. In its most acute form it can cause the lungs to become full of fluid. The effects will vary with exposure, concentration and type of irritant.

(b) Metal Fume Fever
The inhalation of freshly formed metallic oxides such as those of zinc, chromium, nickel, copper, manganese may lead to an acute influenza like illness termed metal fume fever.

(c) Systemic Poisoning
This can result from the inhalation or swallowing of substances such as fluorides, hexavalent chromium, lead and barium.

(d) Long Term Effects
It is possible that certain constituents of welding fume such as hexavalent chromium and nickel may be carcinogenic and until there is definite information about this it is wise to treat them as such.

(e) Fibrosis
This is the formation of fibrous or scar tissue in the lungs. It is the result of a reaction between dust or fume with the lung tissue. There are various types depending on the nature of the substance involved and duration of exposure.

In all cases of doubt concerning physiological response to welding pollutants, medical advice should be sought promptly.

Composition

(a) Manual Metal Arc Consumables
Manual Metal Arc welding electrodes consist of a metal core wire coated with a flux covering. The coating of rutile mild steel electrodes contains approximately 50% rutile sand; ferro-manganese; carbonates in the form of magnesite or chalk;the coating may contain mineral aluminium silicates, such as china clay, talc, felspar or mica.

About 10-15% (wet weight) of a silicate binder (water glass) is used to produce a paste which is extruded onto a mild steel core wire and dried.

Iron powder rutile types contain similar materials and approximately 50% iron powder with a corresponding reduction in the other constituents.

In basic mild steel electrodes the mineral silicates and rutile sand are replaced wholly or in part by calcium fluoride and calcium carbonate or similar materials.

Rutile and basic electrodes for the deposition of alloyed weld metal are formulated similarly to the above with the addition of appropriate alloying elements to the coating and/or core wire.

In cellulosic electrodes the rutile sand is replaced wholly or in part by cellulose material and an increased quantity of water glass, similar carbonates, mineral silicates and ferro-manganese form the balance.

Handling and Storage
With regard to storage and handling we do not consider that any special safety precautions are required, although obviously electrode coatings should not be ingested or allowed to come into contact with food. Hands should be washed thoroughly before all meal breaks.

Skin contact does not normally present a hazard, though it is always possible that occasional individuals may be found who are allergic to substances normally regarded as inert (e.g. cases of allergy to nickel have been reported arising from the wearing of nickel bracelets). However we do not know of any such cases in which welding consumables have been identified as the cause of an allergic response.

Consumables are dense materials and even small packets are relatively heavy. They should not be left in positions where physical injury or accidents could result.

Fire/Explosion Hazard
Welding consumables are non inflammable under ordinary conditions and do not present a fire or explosion risk. Welding consumables should not be allowed to come into contact with acids or other corrosive substances or with oxidising agents, nor with any other chemical substance with which a reaction may occur.

Personal Protection/Ventilation
Welders should wear the normal protective clothing and eye protection appropriate to electric arc welding. Under certain circumstances particularly with some high alloyed electrodes, the slag formed on the weld bead can detach and fly off in pieces,presenting a burn hazard to eyes and skin. Those in close proximity to welds should protect themselves from the danger of flying slag.

Ventilation and/or fume extraction must be adequate to keep fume concentration within safe limits.

Note on Other Atmospheric Pollutants
In any welding operation other possible sources of atmospheric contamination may be present, for example, coatings, paint or traces of oil or of degreasing agents on work being welded, or substances arising from other operations in the vicinity, in addition to any fume arising from the welding consumables. Advice regarding the nature and extent of any possible hazard which might arise directly or indirectly from such substances or sources should always be obtained from the manufacturer of each product. Occupational exposure limits for a large number of substances are listed in “Guidance Note EH40”.

Further Information
Additional information and technical advice on products included in this book may be obtained from:

Murex Welding Products
Hanover House,
Queensgate,
Britannia Road,
Waltham Cross,
Herts EN8 7TF

Tel: 01992 710000
Email: info@murexwelding.co.uk
www.murexwelding.co.uk

Welding Manufacturers Association leaflet 236 “Hazards from Welding Fume”, which gives some more general information about welding fume, is also available on request.

Guidance Note EH40 (Occupational Exposure Limits), EH54 (Assessment of exposure to fume from welding and allied processes) and EH55 (Control of exposure to fume from welding, brazing and similar processes) are available from HMSO bookshops.