Infrastructure Health & Safety Association™

*Work Safe for Life*

# HEALTH AND SAFETY ADVISORY

## Toxic Exposure to Manganese in Welding Fume

Welding is a method of joining metal parts together by heating them. The process of heating certain base metals and surface coatings can release toxic fumes into the air. Breathing in toxic welding fume, especially over time, can have serious health effects.

Welding fume may contain such chemicals as iron oxide, hexavalent chromium, nickel, cadmium, and manganese. Exposure to these chemicals is regulated under Ontario Regulation 833: Control of Exposure to Biological or Chemical Agents. These chemicals have been assigned specific time-weighted average (TWA) values. It is the responsibility of the employer to ensure that workers' exposure to these chemicals does not exceed the TWA.

### Manganese in Welding

Manganese is a naturally occurring element found everywhere on earth, including many of the foods we eat. In small amounts, it is an essential nutrient required for normal bodily functions. However, in excess amounts, it can cause serious harm.

Manganese is added to certain metals such as steel and aluminum to improve its strength, stiffness, and durability. Even more commonly, it is found in welding rods, welding wire, and the flux coating on electrodes. When inhaled, manganese in welding fume bypasses the body's normal defense mechanisms and can accumulate in the lungs, bloodstream, and brain.

Manganese exposure tends be higher in certain types of welding than others. Typically plasma cutting, metal inert gas (MIG), flux-cored arc welding (FCAW), and manual metal arc (MMA) have higher fume and manganese levels. Other factors that can increase manganese exposure include the work environment, work position, and welding process variables such as current, arc length, etc.

### Health Effects of Manganese

Toxicity from manganese exposure has been well documented and can include

- Metal fume fever at high concentrations
- Loss of energy
- Irritability
- Headaches
- Muscles weakness
- Speech impairment
- Balance problems
- Tremors
- Excessive salivation or sweating.

Some studies have found a connection between manganese exposure and Parkinson's disease in welders. However, these findings have been controversial and require further research. Regardless, many argue that measures should be put in place until conclusive evidence is established.

## Control Methods

**Exposure to welding fume can be controlled through a variety of methods.**

### Substitution

Exposure can be minimized by substituting variables such as the welding process or type of welding rod for another process that generates less fume or a lower level of contaminants. A Material Safety Data Sheet (MSDS) can be a valuable tool in identifying any hazardous components that may result in worker exposure.

### Isolation

Isolation controls can include planning the work so that welding is carried out far away from nearby workers. For instance, a welding booth can be installed in a shop to minimize the movement of fume to other areas.

### Ventilation

Ventilation is an effective way to remove the fume at the source of generation before it reaches the welder's breathing zone. Ventilation can take the form of natural dilution ventilation, mechanical dilution ventilation, or local exhaust ventilation. Each type of ventilation has its own benefits. For more information, see Chapter 41: Welding and Cutting in IHSA's *Construction Health and Safety Manual* (M029).

### Administrative Controls

Administrative controls can include procedures that are implemented to help minimize a worker's exposure to welding fume. For example, train welders to adopt safe work habits such as keeping their head out of the welding plume and make sure that welding equipment is maintained in accordance with the manufacturer's recommendations.

### Respiratory Protection

When ventilation is not adequate enough to minimize the worker's exposure to acceptable levels, respiratory protection may be required. The type of respirator required will depend on a variety of factors but predominantly the estimated exposure level and toxicity of materials. Before respirators are used, a respiratory protection program should be implemented and workers must be fit-tested and trained in the specific respirator provided. For more information, see Chapter 15: Respiratory Protection in IHSA's *Construction Health and Safety Manual* (M029).

## How Much Manganese Are Welders Commonly Exposed to?

There are many studies that document airborne exposures to manganese in welders that exceed the current TWA of 0.2mg/m$^3$. One study from the University of North Carolina and the Center for Construction Research and Training examined exposure data from several studies to characterize manganese exposures in welding operations. Exposure to manganese varied significantly based on the welding process, the type of enclosure, and the presence of local exhaust ventilation.

| Welding Process | Time in Minutes (N) = number of samples | Average (TWA) mg/m$^3$ |
|---|---|---|
| Plasma cutting | 132 (1) | 1.7 |
| MIG/MAG/MMA | 10,680 (17) | 0.13 |
| FCAW | 3,177 (9) | 0.20 |
| MIG/MAG | 30,701 (80) | 0.25 |
| MMA ("stick") | 4,772 (16) | 0.17 |
| OXY | 674 (3) | 0.005 |
| TIG | 726 (3) | 0.016 |

Source: Flynn, M.R. & Susi, P. (2010). "Manganese, iron, and total particulate exposures to welders." *Journal of Occupational and Environmental Hygiene* (7), 115-126.

Although many hazards are associated with welding, manganese exposure in welding fume is a potentially serious hazard that requires special consideration. Workplaces that want to assess the level of welding fume and manganese that workers may be exposed to can also enlist the help of an occupational hygienist.

For more information about this topic, contact IHSA:

**1-800-263-5024**