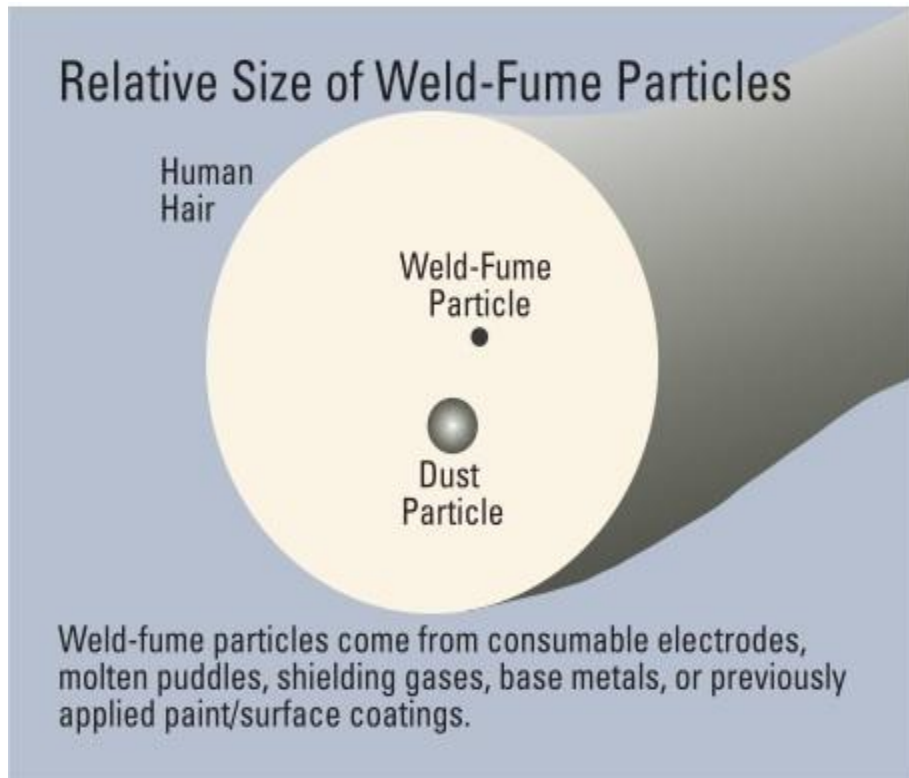


Welding Generated Gases

Welding and soldering joins pieces of metal by the use of heat, pressure or both. There are more than 80 different types of welding and associated processes. Welding “smoke” is a mixture of very fine particles (fumes) and gases. Many of the substances in welding smoke, such as chromium, nickel, arsenic, asbestos, manganese, silica, phosgene, and carbon monoxide, can be extremely toxic.



Welding fumes and gases can originate from the following sources: the base material being welded or the filler material that is used; coating and paints on the metal being welded, or coatings covering the electrode; shielding gases supplied from cylinder; chemical reactions which result by the action of ultraviolet light from the arc and heat; process and consumables used; and contaminants in the air, such as vapors from cleaners and degreasers.

Gases

All welding processes produce hazardous gases. Gases are invisible to the eye, and may or may not have an odor. The heat in both the flame and the arc, and the ultraviolet radiation from the arc, produce gases. Gases include:

- Shielding gases—Argon, Helium, Nitrogen, and Carbon Dioxide.
- Process gases —Nitric Oxide, Nitrogen Dioxide, Carbon Monoxide, Ozone, Phosgene, Hydrogen Fluoride, Carbon Dioxide.

Fumes

Welding also produces fumes. Fumes are formed when hot metal vapors cool and condense into very small particles that stay suspended in the vapor or the gas. The particles may be metal or metal compounds, and are often smaller than one micrometer (one-fiftieths) the width of a human hair). Metals that may be included in fumes include Aluminum, Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Silver, Tin, Titanium, Vanadium, and Zinc.

Fumes may be visible or not. Welding “smoke” is an example of a visible fume. But even if the fume can’t be seen, its particles are still present.

Vapors

If the metal is painted or coated, or has a residual solvent on its surface, welding may generate toxic organic vapors. Research shows that welding polyurethane-coated steels may expose welders up to 25 times the PELs for di-isocyanates. It only takes small amounts of chlorinated solvents, such as trichloroethylene or carbon tetrachloride, used for degreasing, to produce dangerous amounts of phosgene gas. Binders and solvents on metal can expose welders to formaldehyde at twice the permitted level. Thus it is essential to allow metals cleaned with chlorinated solvents to dry in a well-ventilated place removed from the welding area. Containers of these fluids must not be stored in the welding area, as welding radiation can react with the vapors.

Health Effects of Breathing Welding Fume

- Acute exposure to welding fume and gases can result in eye, nose and throat irritation, dizziness and nausea. Workers in the area who experience these symptoms should leave the area immediately, seek fresh air and obtain medical attention.
- Prolonged exposure to welding fume may cause lung damage and various types of cancer, including lung, larynx and urinary tract.
- Health effects from certain fumes may include metal fume fever, stomach ulcers, kidney damage and nervous system damage. Prolonged exposure to manganese fume can cause Parkinson’s–like symptoms.
- Gases such as helium, argon, and carbon dioxide displace oxygen in the air and can lead to suffocation, particularly when welding in confined or enclosed spaces. Carbon monoxide gas can form, posing a serious asphyxiation hazard.

Welding and Hexavalent Chromium

Chromium (Cr) is a component in stainless steel, nonferrous alloys, chromate coatings and some welding consumables. Chromium is converted to its hexavalent state, Cr (VI), during the welding process. Cr (VI) fume is highly toxic and can damage the eyes, skin, nose, throat, and lungs and cause cancer.

ILLNESS CAUSED BY WELDING FUME AND GASES

There will be people who don’t get ill but some welders do get ill from breathing welding fume. Some may be ill for only a short time; others may get permanent illnesses like asthma. There is no easy way to know if it will be you. A few welders get so ill they have to stop welding and find a new career.

Pneumonia

Welders are particularly prone to a lung infection that can lead to severe and sometimes fatal pneumonia. Antibiotics usually stop the infection however in severe cases you could end up in hospital. It can affect young

welders as well as older people. Exposure to welding fume in the past does not increase the chances of you getting pneumonia now.

Occupational asthma

Welders need to protect themselves and follow the safe way of working. Welding metal coated with zinc (galvanized metal) releases zinc oxide which can cause work-related asthma. Stainless steel fumes have chromium oxide (CrO3) and Nickel Oxide in it. Both these chemicals can cause asthma. For this reason, stainless steel welding fume is considered more harmful than mild steel fume.

Cancer

Welding fume is internationally classified as possibly carcinogenic to humans (IARC classification group 2B). Although primarily associated with stainless steel welding, this classification is not limited to stainless steel fume. It covers all welding fume.

Metal fume fever

Many welders report flu like symptoms after welding. The effects are often worse at the start of the working week. Metal fume fever is usually linked to welding or hot work on galvanized metals. High exposures to mild steel weld fume can also cause this illness. Metal fume fever does not usually have any lasting ill effects. Don't believe the stories about drinking milk before welding. It does not prevent you getting metal fume fever.

Irritation of throat and lungs

Gases and fine particles in welding fume can cause dryness of the throat, tickling, coughing or a tight chest. The effects tend to be short lived. Ozone is a particular cause of this when TIG welding stainless steels and aluminum. High exposures to nitrous oxides (generated during most arc welding operations) can also cause this health effect. Extreme exposure to ozone can cause pulmonary edema (fluid on the lungs).

Temporary reduced lung function

Overall lung capacity and the ease at which you can breathe out (peak flow) are affected by prolonged exposure to welding fume. The effects tend to get worse through the working week but gradually improve when not exposed (e.g. over the weekend).

Table 1 Health Effects of Fumes Produced During Welding

FUMES	Source	Effects and Symptoms
Aluminum	Aluminum component of some alloys, e.g., Inconel's, copper, zinc, steel, magnesium, brass and filler materials.	Respiratory irritant.

Beryllium	Hardening agent found in copper, magnesium, aluminum alloys and electrical contacts.	“Metal Fume Fever.” A carcinogen. Other chronic effects include damage to the respiratory tract.
Cadmium Oxides	Stainless steel containing cadmium or plated materials, zinc alloy.	Irritation of respiratory system, sore and dry throat, chest pain and breathing difficulty. Chronic effects include kidney damage and emphysema. Suspected carcinogen.
Chromium	Most stainless-steel and high-alloy materials, welding rods. Also used as plating material.	Increased risk of lung cancer. Some individuals may develop skin irritation. Some forms are carcinogens (hexavalent chromium).
Copper	Alloys such as Monel, brass, bronze. Also some welding rods.	Acute effects include irritation of the eyes, nose and throat, nausea and “Metal Fume Fever.”
Fluorides	Common electrode coating and flux material for both low- and high-alloy steels.	Acute effect is irritation of the eyes, nose and throat. Long-term exposures may result in bone and joint problems. Chronic effects also include excess fluid in the lungs.
Iron Oxide	The major contaminant in all iron or steel welding processes.	Siderosis – a benign form of lung disease caused by particles deposited in the lungs. Acute symptoms include irritation of the
Lead	Solder, brass and bronze alloys, primer/coating on steels.	Chronic effects to nervous system, kidneys, digestive system and mental capacity. Can cause lead poisoning.
Manganese	Most welding processes, especially high-tensile steels.	“Metal Fume Fever.” Chronic effects may include central nervous system problems.
Molybdenum	Steel alloys, iron, stainless steel, nickel alloys.	Acute effects are eye, nose and throat irritation, and shortness of breath.
Nickel	Stainless steel, Inconel, Monel, Hastelloy and other high-alloy materials, welding rods and plated steel.	Acute effect is irritation of the eyes, nose and throat. Increased cancer risk has been noted in occupations other than welding. Also associated with dermatitis and lung problems.
Vanadium	Some steel alloys, iron, stainless steel, nickel alloys.	Acute effect is irritation of the eyes, skin and respiratory tract. Chronic effects include bronchitis, retinitis, fluid in the lungs and pneumonia.
Zinc Oxides	Galvanized and painted metal.	“Metal Fume Fever.”

Table 2 Health Effects of Gases Produced During Welding

Gases	Source	Effects and Symptoms
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Carbon Monoxide	Formed in the arc.	Absorbed readily into the bloodstream, causing headaches, dizziness or muscular weakness. High concentrations may result in unconsciousness and death.
Hydrogen Fluoride	Decomposition of rod coatings.	Irritating to the eyes and respiratory tract. Overexposure can cause lung, kidney, bone and liver damage. Chronic exposure can result in chronic irritation of the nose, throat and bronchi.
Nitrogen Oxide	Formed in the arc.	Eye, nose and throat irritation in low concentrations. Abnormal fluid in the lung and other serious effects at higher concentrations. Chronic effects include lung problems such as emphysema.
Ozone	Formed in the welding arc, especially during plasma-arc, MIG and TIG processes.	Acute effects include fluid in the lungs and hemorrhaging. Very low concentrations (e.g., one part per million) cause headaches and dryness of the eyes. Chronic effects include significant changes in lung function.

Table 3 Health Effects of Organic Vapors Produced During Welding

Organic Vapors	Source	Effects and Symptoms
Aldehydes (such as formaldehyde)	Metal coating with binders and pigments. Degreasing solvents.	Irritant to eyes and respiratory tract.
Di-isocyanates	Metal with polyurethane paint.	Eye, nose and throat irritation. High possibility of sensitization, producing asthmatic or other allergic symptoms, even at very low exposures.
Phosgene	Metal with residual degreasing solvents. (Phosgene is formed by reaction of the solvent and welding radiation.)	Severe irritant to eyes, nose and respiratory system. Symptoms may be delayed.
Phosphine	Metal coated with rust inhibitors. (Phosphine is formed by reaction of the rust inhibitor with welding radiation.)	Irritant to eyes and respiratory system, can damage kidneys and other organs.

Table 4 Other Health Effects that can occur During Welding

Other Issues	Source	Effects and Symptoms
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Oxygen Deficiency	Welding in confined spaces, and air displacement by shielding gas.	Dizziness, mental confusion, asphyxiation and death.
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Table 1-4 from Workplace Health and Safety Bulletin: Work Safe Alberta; Welder’s Guide to the Hazards of Welding Gases and Fumes.

REDUCING EXPOSURE TO WELDING FUME

- Welders should understand the hazards of the materials they are working with. OSHA’s/WISHA’s Hazard Communication standard requires employers to provide information and training for workers on hazardous materials in the workplace.
- Welding surfaces should be cleaned of any coating that could potentially create toxic exposure, such as solvent residue and paint.
- Workers should position themselves to avoid breathing welding fume and gases. For example, workers should stay upwind when welding in open or outdoor environments.
- General ventilation, the natural or forced movement of fresh air, can reduce fume and gas levels in the work area. Welding outdoors or in open work spaces does not guarantee adequate ventilation. In work areas without ventilation and exhaust systems, welders should use natural drafts along with proper positioning to keep fume and gases away from themselves and other workers.
- Local exhaust ventilation systems can be used to remove fume and gases from the welder’s breathing zone. Keep fume hoods, fume extractor guns and vacuum nozzles close to the plume source to remove the maximum amount of fume and gases. Portable or flexible exhaust systems can be positioned so that fume and gases are drawn away from the welder. Keep exhaust ports away from other workers.



Portable Exhaust System



Fixed Exhaust System

- Consider substituting a lower fume-generating or less toxic welding type or consumable.
- Do not weld in confined spaces without ventilation.
- Respiratory protection may be required if work practices and ventilation do not reduce exposures to safe levels.

If You Weld In A Confined Space

Welding or soldering in a confined space will require the welder to have confined space training, hot work permit, a reevaluation of the confined space and a fire extinguisher. Fire extinguishers are required whenever any welding or open flame soldering is conducted.