HAZARDS IN WELDING OPERATIONS

Welding consists of a group of processes by which metals (or other hard materials) are joined together, cut apart or provided with desired surface coatings with the help of intense heat, generally from a suitable gas flame or an electrical arc.

"Welding", Flame or Arc cutting", "Brazing" etc., comprise quite a number of processes are basically similar. They differ in intensity and nature of the different processes, work situation, the materials being worked upon etc.,

In heavy engineering industry, besides oxyacetylene and electric arc, other means used are automatic submerged welding, Argon arc welding, plasma cutting and also cutting and gouging welding.

They are carried out in open and covered bays confined in booths, pressure vessels, tanks, cabins etc.,

WELDING ELECTRODES

The base metal for welding is mainly mild steel, but cast iron, cast steel, stainless steel are also welded. The composition of electrode coating is a trade secret and may contain five or more of the following components, sodium silicate, magnesium silicate, tin oxide, ferro-manganese, magnesium zirconium oxide, silicon oxide, iron oxide etc.,

The various hazards in Welding operations

A. THOSE ARISING IN THE PREPARATORY PHASE OF THE WELDING OPERATIONS:

1. The surfaces to be welded and their immediate surroundings generally require special treatment to remove scales, dirt, grease and other coatings. This may be done mechanically by grinding or grit blasting as also by manual filing, or brushing with wire brush or steel wool with or without the concomitant use of chemical substances to help these operations. Injuries to different parts of the body (eye, skin) may result from the mechanical operations and inhalation of the dusts may give rise to pulmonary damage.

2. Inorganic materials including metal and metal compounds may be removed by pickling in mineral acids, while grease and oil require removal with the help of organic solvents and alkalies. In either case skin is likely to be damaged. Some of these organic solvents may be absorbed through intact skin and may give rise to systemic manifestations like hepatoxic, nephrotoxic and toxic to central nervous systems. Some are suspected of carcinogenicity on the basis of animal experiments.

B. THOSE ARISING DIRECTLY OUT OF WELDING PROCESSES:

1. Radiation hazards, which are essentially visual effects, including eye injuries.
2. Exposure to metal oxide fumes and other fumes generated as a result of high intensity arc - Respiratory hazards.
3. Burn injuries due to molten motel
4. Electric burns and explosive injuries.
5. Digestive disturbances
6. Postural fatigue
7. Thermal stress

1) RADIATION HAZARDS:

The harmful radiations comprise invisible light rays - the ultra - violet and infra red rays. The ultraviolet spectrum as been classified into three different wave length bands:

315 - 400 mm - Near u.v. spectrum
200 - 315 mm - Mid range u.v.spectrum
below 200 mm - Far u.v.spectrum of little biological significance.

Oxyacetylene arc welding emits radiant energy which, if not absorbed by suitable means, affects the eyes adversely.

a.ULTRA-VIOLET RAYS:

The short u.v.rays cause biochemical changes in the conjuctiva and cornea which manifest themselves after many hours as "conjunctivitis" and are responsible for "arc-eye". Arc eye is an acute, self-limited irritation and inflammation of the superficial structures of the eye resulting from cumulative unprotected exposure to the u.v.radiation from the arc. There will be acute pain, photophobia, inflammation and swelling of conjunctiva, increased lachrymation which lasts for 12-18 hours.

b.INFRA-RED RAYS:

The long rays are absorbed by cornea, while the short ones get transmitted through the cornea and are absorbed by the lens - a small part reaching the retina (causing burns in the retina). The lens gets overheated through absorption of these and undergoes changes giving rise to cataract, which sets in the posterior cortex of the lens.

2)FUME ASPECTS:

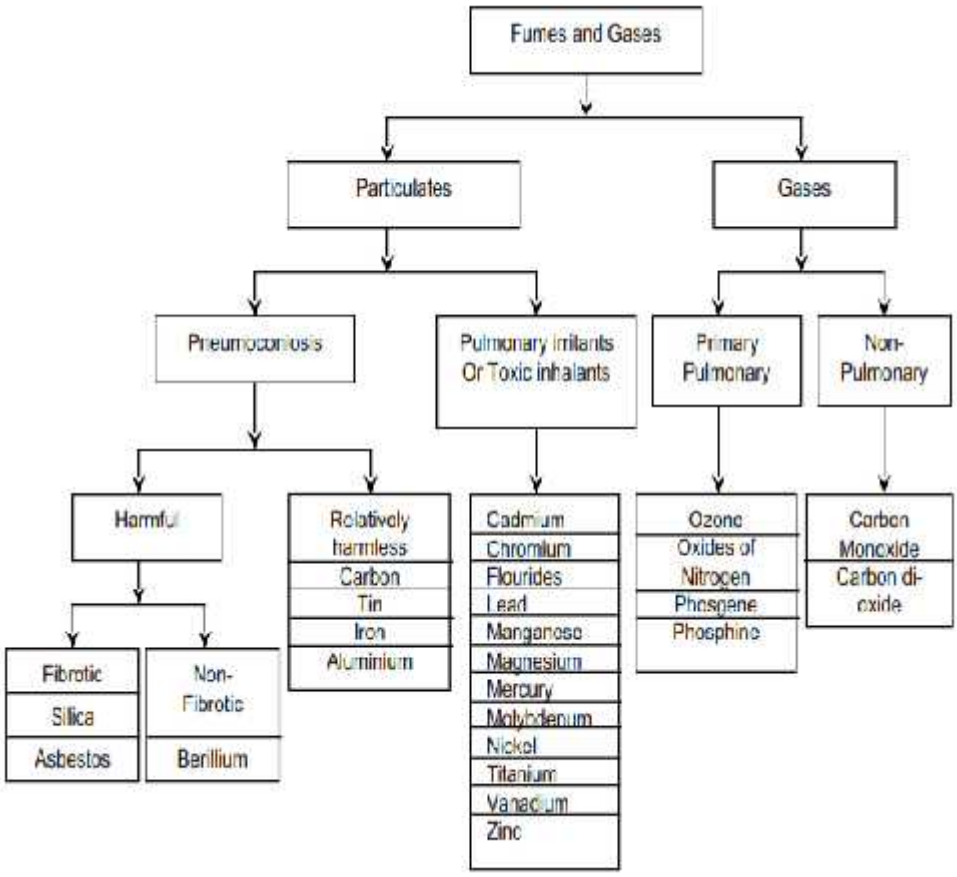
A very varied and complex atmosphere presents itself to the welder.
The contents of the fume may have their origin in:

a) Metals being welded
b) Gaseous fume generated in welding process
c) Coating of metals, including electrode flux
d) Inert gas shielding
e) Impurities of the metal
f) Atmospheric pollution

Once the fume has entered the respiratory tract it may

1. be exhaled
2. go either via the sputum or into the gastrointestinal tract.
3. be absorbed into the body .
4. Pass without absorption, into the faeces.
5. be excreted from the body into the urinary tract.

CONSTITUENTS OF WELDING FUMES AND GASES



Both particulate and gases can be generated during the welding process. The particulate fraction can be divided into two groups .

1) produce pneumoconiosis,
2) Producing pulmonary irritants.

The following is the physiological classification of constituents of welding fumes. Classified by effect

CLASS A	CLASS B	CLASS C	CLASS D	CLASS E	CLASS F
Acute respiratory	Chronic Respiratory	Acutic Systemic	Chronic systemic	Irritant to skin & eyes	Relatively inert
Chromium Copper Nickel Manganese Nitrogen dioxide Ozone Cadmium Vanadium Zinc Fluorides Cobalt Cldehydes	Asbestos (all forms) Quartz Tridymite Cristobalite Nickel	Copper Lead Manganese Zinc Nickel	Lead Manganese Cadmium Fluorides	Chromium Nickel Vanadium Aldehydes	Iron Aluminium Tin

EFFECTS OF PARTICULATE MATTER:

The major part of the particulate fume in welding, is able to reach all parts of respiratory system including the smallest tubes (terminal bronchioles) and the membrane tissue at the end of these tubes (alveoli) . The deposition of particulate matter in the lung is termed pneumoconiosis.

HARMFUL PNEUMOCONIOSIS:

Silicosis: Silicates constitute a significant portion of many coatings and cores, releasing silica or silicates or both into fumes when these electrodes are burned. Another source of silica is in the oxidation of alloying elemental silicon.

Asbestosis: Asbestosis is the pneumoconiosis resulting from the deposition of asbestos in the lung concomitant exposure to asbestos.

Beryllium: The hazards associated with the handling and joining of Beryllium and its alloys are well known in the welding industry. Beryllium enters the body almost entirely by inhalation.

Though it may be absorbed from the lung as a particulate, the toxic reaction to its body- wide rather than in the lung alone. The acute pulmonary form may be severe chemical pneumonia follows with pulmonary oedema. Chronic beryllium poisoning in most cases affects the respiratory tract.

INTERT OR BENIGN PNEUMOCONIOSIS

Some of the main types of benign pneumoconiosis associated with welding are:

a)Siderosis: resulting from the deposition of iron oxide dust in the lung. However, the welding fume contains many other metallic particles as well as iron oxide and the term "Welders" siderosis" is more accurate as the condition is a mixed dust pneumoconiosis.

b) Stannosis: resulting from inhalation of tin oxide dust

c) Aluminiosis: resulting from inhalation of aluminium oxide.

A varying degree of opacity can be detected on the X-ray chest of welders.

PULMONARY IRRITANTS AND TOXIC INHALANTS

The majority of metal components contained in welding fumes do not produce radiographic changes in the lungs and depending on the definition of pneumoconiosis, they can be classified in a separate category of pulmonary irritants of toxic inhalants. These materials include cadmium, chromium, lead, manganese, mercury, magnesium, molybdenum, nickel, titanium, vanadium, zinc and the fluorides.

LEAD POISONING

Lead poisoning occurs in shipyards where vessels were salvaged or repaired. Lead fumes are given off when lead paint comes in contact with the electric torch.

FLUORIDES

For welding aluminum and certain stainless steel alloys, a flux containing fluorides may be used. In such instances, inhalation of fumes produced gives rise to acute respiratory irritation when work is carried out in a confined space. Exposure to fluoride fumes for prolonged periods may give rise to skeletal or dental fluorisis.

OXIDES OF NITROGEN

Oxides of nitrogen are formed by the union of nitrogen and oxygen of the air brought about by heat of an electric arc; fatal cases have occurred due to acute pulmonary oedema caused by inhalation of these fumes during welding in ship's holds.

OZONE

The concentration of ozone in the environment being above the TLV 0.1 ppm, it is likely that the symptoms of throat irritation, chest pain, dry cough in Aluminium welder were due to this high concentration of ozone. The adverse health effects of ozone are mainly pulmonary congestion and even pulmonary oedema.

Ozone tends to cause discomfort to exposed individuals in the form of headache; dryness of throat and mucus membranes of nose and eye irritations. Exposure to these gases may reduce the ability of the lungs to clear itself of pathogenic organisms and make the lung susceptible to secondary infections.

BURNS

Radiant energy from the electric arc can cause burns of the skins of the face.

Contact with hot metal or handling hot objects also cause burns. Metal spatter burns were more liable to occur with certain types of welding, for example on the galvanised metal

EXPLOSION

Since acetylene forms an explosive mixture with air when the concentration of acetylene reaches about 2.5% there may be explosion hazard. Careful attention must be paid to prevent escape of acetylene gas into the air.

ELECTRIC SHOCK

Precautions should be taken against the possibility of electric shock from the electric welding apparatus. All parts should be carefully checked to make sure that there is no leakage of electric current.

POSTURAL FATIGUE

If a welder or flame cutter is observed at work , the body posture leads to strain and fatigue. This stress can be mitigated by a proper work-rest-scheduling.

THERMAL STRESS

High temperatures generated in “Welding” tend to produce environmental thermal stresses. The protective clothing etc., that the welders wear, makes the welding operation tremendously stressful thermally. The materials and design of the gloves, sleeves and the shoes should allow permeation of air or water vapour through them.

SKIN DISEASES IN WELDERS

1. Injury as a result of mechanical operation
2. Primary irritant dermatitis due to alkalies which dissolve the protein and organic solvents which cause defatting of skin.
3. Allergic contact dermatitis, due to exposure to Benzene or other Chlorinated hydrocarbons.
4. Skin-burn as a result of exposure to ultra violet radiation.
5. Diseases like acne, tineapedis, heat-rash may occour.
6. Repeated U.V.exposure over unprotected skin results in basophilic degeneration and carcinogenesis.

ENVIRONMENTAL CONTROL

PREPERATION

Before commencing the work , the welding and cutting equipment must be checked for mechanical and electrical soundness. Engineering and administrative controls for the contaminants produced by welding and cutting should be assessed.

VENTILATION

Ventilation is necessary whenever welding or cutting is done in a work space of less than 10,000 cubic feet per welder or in a room less than 16 feet high or in confined spaces or where the welding space contains partitions, balconies, or other structural barriers that obstruct cross ventilation. Otherwise, natural ventilation should be sufficient for most welding and cutting activities.

LOCAL EXHAUST VENTILATION

Local exhaust ventilation is the most effective means of control for airborne contaminants produced by welding or cutting. Local exhaust ventilation can be provided by several types of equipment; freely movable hoods, fixed enclosures (booths), down-draft benches, and extractor nozzles.

ADMINISTRATIVE CONTROL

If engineering controls cannot be installed, or while they are being put into effect, administrative controls may be necessary to limit exposure. Work can be scheduled so that no individual worker is exposed to airborne contaminants above the acceptable concentration or time limit.

PERSONAL PROTECTIVE EQUIPMENT

After environmental controls have been analyzed , personal protective equipment should be considered. Most welders recognize the need for personal protective equipment, particularly for the eyes and skin.

1. EYE AND FACE PROTECTION

Protection of the eyes, face, and neck against flying sparks and radiant energy is one of the primary concerns in welding and cutting. Ultraviolet, invisible and infrared radiation from the arc can harm the eyes.

To properly protect the eyes and face, helmets, must be used for all arc welding and cutting.

Helmets that protect the face, forehead, neck, and ears from direct exposure to radiation from the arc should be used.

Goggles or other suitable eye protection must be used for gas welding or oxygen cutting.
Spectacles with suitable filter lenses, and without side shields are permitted during gas welding.
Goggles should have vents near the lenses to prevent fogging.
Cover lenses or plates should be provided to protect the filter lens and helmet.
All glass used for lenses should be ground properly so that front and rear surfaces are smooth.
Filter lenses must be marked so that the shade number can be readily identified.

FILTER LENS SHADE NUMBERS FOR VARIOUS WELDING AND CUTTING OPERATIONS

Type of operation	Recommended shade number
Resistance welding and for protection against stray light from nearby welding and cutting	Clear or filter upto
Torch brazing or soldering	3 or 4
Light oxygen cutting and gas welding (to 1/8")	4 or 5
Oxygen cutting, medium gas welding (1/8 to 1/2") and arc welding upto	5 0r 6
Heavy gas welding (over 1/2") and arc welding and cutting from 30 to	6 to 8
Arc welding and cutting from 75 to 200 amps	10
Arc welding and cutting from 200 to 400 amps	12
Arc welding and cutting exceeding 400 amps	14

2. SKIN PROTECTION

Protective clothing for the skin will be required for nearly all welding. Protective gloves, preferably the gauntlet type, should be worn regardless of the degree of welding performed.
For light arc welding and cutting (low current densities,) durable, flame-resistant cotton gloves may be used.
For heavier work (higher current densities), gloves of leather or some other suitable flame-resistant material should be used.

Flame proof of aprons made of asbestos or other suitable materials should be used when additional protection against sparks and heat is needed.
For heavy work, fire-resistant leggings should be used. A sheet metal screen placed in front of welder's legs can provide further protection against sparks and molten metal.
Cape sleeves or shoulder covers with bibs made of leather or other flame- resistant materials should be worn during overhead welding or cutting.
Skull-caps made from flame-resistant materials should be worn under helmets to prevent head burns.
Sparks may lodge in rolledup sleeves, pockets, or cuffs. Therefore, sleeves and collars must be kept buttoned and pockets should be removed from the front of clothing. The legs of trousers or coveralls

should not be rolled up on the outside.

3. HEARING PROTECTION

Noise problems are not normally associated with arc welding or cutting. plasma arc welding, produce relatively high noise levels. For These type of welding special equipments are to be provided.

4. RESPIRATORY PROTECTION

The welding process may produce an extremely toxic substance (cadmium or chromium, for example) is considerable quantities. In this case, it may be necessary to use respirators.

Common respirators are not suitable for welding. The welder's helmet and welding position interfere with the fit of the respirator. However, a "modified" welding helmet with a built-in respirator, or one which allows a respirator to fit underneath may be provided.

5.PROTECTIVE EQUIPMENT-OTHER CONSIDERATIONS

- ☐ Non-combustible or flame-proof screens or shields must enclose the welding area to prevent exposure of nearby workers to ultraviolet and infrared radiation.
- ☐ Individual booths, painted with a substance such as zinc oxide or lampblack, are also recommended. The substance on the inside of the booth should absorb UV radiation.
- ☐ The screens and booths must not block circulation of air at floor levels.

6. CONFINED SPACES

Welding within each confined space, ventilation must be provided to prevent the accumulation of toxic or combustible materials and to supply oxygen.

- ☐ All replacement air must be fit to breathe or an approved air line or hose mask respirator must be worn. Oxygen must not be used for ventilation.
- ☐ Workers exposed to substances immediately hazardous to life must wear wither hose masks with blowers or self-contained breathing equipment.
- ☐ Gas cylinders and welding machines must be left outside the space. Heavy equipment mounted on wheels must be securely blocked to prevent accidental movement.
- ☐ If the entry to the space is through a small opening or manhole or the atmosphere is immediately hazardous to life, means must be provided for quick removal incase of emergency. If safety belts and lifelines are use, they must be attached so that the worker may be easily removed. An attendant trained in rescue procedures must be continuously present outside to observe and assist if needed.

7. LABELS

Information on symptoms of overexposure, first aid procedures, and control of employee exposure is usually provided for substances such as filler metals, fusible granular materials, and welding fluxes. This information is frequently printed on tags or on boxes or other containers. Become familiar with these directions and follow them.

8. GENERAL WORK PRACTICES.

Welders or their helpers working on platforms, scaffolds, or runways must be protected by railings, safety belts, lifelines, or other equally effective safeguards. Welding cables or other equipment must be placed so that they are clear of passageways, ladders, and stairways.

Each welder is responsible for marking the hot metal or providing some means of warning for others to keep away. Hard hats or other head protection may be required where sharp or heavy falling objects or bumping in confined spaces are a hazard.