POLLUTION IN WELDING INDUSTRY

S. S. DASGUPTA

Director, NORTECH Power Projects Ltd. Kolkata 700071

INTRODUCTION

The study of pollution in any industry cannot be taken up in isolation, as the type of pollutants are similar in all industries, viz.

- Gaseous Emissions
- Liquid Effluents
- Solid Wastes
- Noise

The composition and quantity of pollutants will vary from industry to industry. Thus it is prudent to first study in brief the above mentioned pollutants before coming to the subject proper.

GASEOUS EMISSIONS

This will consist of various gases and air as to take care of the gaseous pollutants, it is necessary to have a ventilation system with forced or induced draught.

This may involve the combination of following constituents:

1. *Sulphur Compounds*
   SO_2, SO_3, H_2S
2. *Nitrogen Compounds*
   NO, NO_2, NH_3
   This is also known as NO_x
3. *Oxygen Compounds*
   O_3 CO, CO_2
4. *Halogen Compounds*
   HF, HCl
5. *Organic Compounds*
   Aldehydes, hydrocarbons
6. *Radioactive Compounds*
   Radioactive gases
7. *Other Gases*
   Gases formed by reaction with some constituent of metals, chemicals etc.
8. *Dust*
   Popularly known as SPM or Solid Particulate Matters.

Pollution Control Board of each state has laid down certain norms and the factory owners have to see that the air going out of the plant should follow certain norms. The norms laid down by Central Pollution Control Board (CPCB) are presented in Table - I.

This is a general guideline, but for different industries it may have different norms, which is determined by various factors, viz.

- It is difficult or very expensive to bring down the levels further. Table- II indicates allowable norms in some industries.
- Smaller units which generate lesser total quantity of gaseous emissions ase allowed to have higher concentration of emissions e.g. in smaller cupola SPM level is 450 mg/Nm3 compared to I50 mg/Nm3 in larger cupola. Table - III gives examples of some such cases.

Table I
Norms for Emission (AIR)
CPCB

SPM	150 mg/Nm^3
SO_2	1200 mg/Nm^3
NO_x	950 mg/Nm^3
Cl and Compound	200 mg/Nm^3
F and compound	50 mg/Nm^3
CO	500 mg/Nm^3

TABLE–II
DEVIATION FROM THE TABLE–I CPCB

Industry	SPM mg/Nm³
Calcium Carbide, Kiln	250
Cement Plant	250
Steel making, during O_2 lancing	400
Coke Oven	50
Reheating furnace, except sensitive area	450
Stone crushing unit	600
Al plants, precipitation area, calcination	250
Ceramic Kiln, downdraft	1200
Ceramic Kiln, vertical	250
Brick Kilns	750

TABLE–III
ALLOWABLE SPM LEVELS IN SMALLER UNITS

Industry & Capacity	Allowable SPM in Emission (Larger Plants) mg/Nm³
Cupola, less than 3T/Hr	450 (150)
Brick kilns, small, i.e. less than 15,000 bricks per day	1200 (750)
Cement plants, less than 200 T/Day	400 (250)
Thermal Power plant, less than 210 MW	350 (150)
Boilers, Less than 2 T/Hr & 2T/Hr.to 15 T/Hr	1600 & 1200 (150)
Live kiln 5T/Day to 40 T/Day	500 (150)

- Some existing units will have to be closed down, if they are requested to follow such norms. This consideration however has gradually been removed.

In gaseous emissions, fixing of chimney's height also plays an important role and CPCB has given two formulas as mentioned below:

$$H_1 = 74\ (Q_1)^{0.27}$$

and $$H_2 = 14\ (Q_2)^{0.3}$$

Where

H_1 or H_2= Calculated height of chimney

Q_1 = Quantity of SPM in tonnes/hr

Q_2 = Quantity of SO_2 in kg/hr

CPCB also says that the height of the chimney should not be less than 33m and at least 5m above the tallest building structure within the plant or nearby colony.

Here also there are exceptions, particularly in the case of Thermal Power Plants. Some examples are given in Table - IV.

All state pollution control boards can have their own norms, which cannot be lenient to CPCB norms but are free to have stricter norms. I have considered CPCB norms in my paper.

LIQUID EFFLUENTS

This is a subject by itself as different types of industries will generate different types of effluents and has to be treated like in any chemical plant in an effluent treatment plant (ETP). ETP will consist af different equipment depending on the type of effluent, i.e. the composition and will be treated with different chemicals, again depending on the composition of the ETP.

Table V indicates the norms laid down by common ETP discharging treated effluents to inland surface water, or land for irrigation or into marine coastal area. In the case of liquid effluents also, CPCB has specified different norms for effluents from certain industries. It is not possible to mention the constituents for each of the industry, but Table VI lists some of the effluents from different plants, mentioning whether the norms are lenient or stricter to those mentioned in Table V.

SOLID WASTES

It is now a very important subject and the pollution control boards are very strict in the manner it is stored or dumped. Ministry of Environment & Forest (MOEF) has brought out which differentiates the different types of wastes including hazardous ones and the manner they are to be handled.

The concept of MOEF and pollution control boards are that as far as possible, the solid wastes should be recycled either within the plant or by other industries.

The solid wastes should not be stored intermittently or dumped on the ground as rain water passing through it may carry some undesirable elements in the subsoil. They have suggested some pits of special design, one of which is indicated in Fig.1.

TABLE–IV CHIMNEY HEIGHT

Industry	Requirement
Thermal Power Plant	
500 MW and above	275m
200 MW to 500 MW	220m
Boiler less than 2T/Hr	$2^{1/2}$ times the neighbouring housing building height but not less than 9 m
More than 2T/Hr. upto 30T/Hr	12m to 27m

NOISE

The noise can cause a lot of nuisance and also ill effect on the ears, which may even impair hearing. Certain norms have been laid down for level of noise, as given in Table - VII

The Fig. 2 gives an idea regarding the levels of sound for various applications.

SAFETY & HEALTH

Safety and health are very intimately connected with pollution and environment. Though pollution control boards have not laid down any guideline, like that in the case of pollutants, but the governments, both at the centre and states are quite concerned about the impact of pollution on safety and health.

So separately safety norms have been laid down for safety of operation at different plants and though no norms for health aspect have been fixed, but all new factories being set up, particularly in the large sector have to satisfy MOEF and/or state bodies that the process is not a health hazard, nor the emissions and wastes will create problems to health of workers and others.

A word has been coined internationally, *S H E*

where S stands for Safety
H stands for Health
and E stands for Environment

It is to be emphasized that the study of environment i.e. pollution and its control cannot be studied in isolation without studying its impact on safety and health.

POLLUTION IN WELDING INDUSTRY

In welding industry, safety and health hazard has to be studied while tackling the problems of pollution. Many welding processes do not generate much of pollution, but some involve problems in AIR due to gaseous emissions.

In some processes there is NOISE pollution, but liquid effluents and solid wastes do not create much of problems. .

SAFETY

This article deals with safety measures involved in welding industry first and then precautions for specific welding processes. Later some processes have been dealt with in details, where both Safety and Health hazard play important role involving pollution and endangering Environment.

Some abbreviations for welding process as mentioned in Table VIII have been used.

The utilisation of welding in manufacturing, construction, and maintenance activities involves many considerations. Of greatest importance, however, is the need to be attentive to safety. Factors involved in personal safety include protection against eye and ear damage, burns, radiation, respiratory damage, and crushed or broken limbs. Loss and damage to equipment and building are generally the result of fire or explosion.

Each welding process and its application determines the requirements

TABLE–V
GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS

Pollutant	Standards		
	Inland Surface Water	Public Sewer	Land for irrigation
pH	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0
Suspended Solids (mg/l)	100	600	200
Dissolved Solids (mg/l)	2100	-	2100
Oil and Grease (mg/l)	10	20	10
Residual Chlorine (mg/l)	1	-	-
Ammonical nitrogen (as N) (mg/l)	50	50	-
Total nitrogen (as NH3) (mg/l)	100	-	-
Free ammonia (as NH3) (mg/l)	5	-	-
BOD (mg/l)	30	350	100
COD (mg/l)	250	-	-
Arsenic (mg/l)	0.2	0.2	0.2
Mercury (mg/l)	0.01	0.01	-
Lead (mg/l)	0.1	1	-
Cadmium (mg/l)	2	1	-
Chromium (Gr+6) (mg/l)	0.1	2	-
Total Chromium (mg/l)	2	2	-
Copper (mg/l)	3	3	-
Zinc (mg/l)	5	15	-
Nickel (mg/l)	3	3	-
Phonolic Compound (mg/l)	1	5	-
Bio assay test	90% survival of fish after 96 hrs. in 100% effluent	90% survival of fish after 96 hrs. in 100% effluent	90% survival of fish after 96 hrs. in 100% effluent

for protection of personnel.

Eyes and Face : The eyes, face, and neck should be protected at all times through use of helmets, face shields, goggles, or hand-held shields. The shade of the glass lens used in helmets, goggles, or shield depends on the intensity of the arc.

For LBW and cutting, special safety glasses are available to filter out the infrared wavelengths that cause retinal damage. The lenses in goggles used for oxy-fuel processes are lighter shades than those used for arc welding.

Hearing : For some welding processes, such as EXW and metal spraying, precautionary measures are needed to protect the hearing of personnel. In such cases, the use of ear protection or properly fitted ear plugs should be worn to protect personnel from the high intensity sound. The type of protective device chosen should be capable of reducing the sound level below 75 decibels.

Clothing : 'To properly protect the arms, body, and legs, special protective clothing is available. In many cases, clothes made of high-grade denim provide sufficient protection against ultraviolet or infrared radiation and occasional spatter or sparks. However, where the work is performed in a very confined space or the application involves high temperatures, heavy spatter, and/or large molten weld pools, the use of flame- and temperature-resistant clothing material, such as leather, should be considered. In addition to shirt and pants, aprons, gauntlets, and leggings may be needed. High-top should be worn with cuffless pants that cover shoetops. Loose pocket flaps and open shirt collars present a potential hazard.

Respiratory : To prevent the inhalation of fumes, gases, and particulate matter, a positive ventilation system must be installed. Local codes and OSHA rules generally govern the requirements. The nature, type, and magnitude of fume and gas exposure will, for the most part, determine the type, location, and volume of air removal needed.

For certain welding processes, such as metal spraying, additional consideration must be given to the use of respiratory devices.

Toxic Materials : The vapours of some cleaning solvents break down in the presence of a welding arc or burning flame and can cause dizziness, nausea, or danger to life. Consequently, precautions should be taken to ensure the use and storage of these materials in a safe manner. Manufacturers of such materials should be consulted for needed precaution in their use. Protective clothing, such as rubber gloves, should be worn while using any materials, substances, or liquids that could cause irritation or allergic reaction.

Training : Personnel should be trained in the need and use of safe practices that are necessary for their protection. Safe practices should include:

TABLE–VI : SOME INDUSTRIES WHERE NORMS ARE DIFFERENT THAN IN TABLE VI

Industry	Stricter	Lenient
1. Oil Refining Industry	✔	
2. Sugar Industry	✔	
3. Thermal Power Plants	In some areas	In some areas
4. Cotton Textile and Woolen Industry		✔
5. Fertiliser Industry		Those commissioned prior to 1.1.1982
6. Petrochemicals	✔	✔
7. Pharmaceuticals	– Different norms laid –	
8. Pesticide	Cr & Ni	BOD
10. Dye & Intermediate	Cu & Ni	

TABLE VII - NOISE : STATUTORY OBLIGATIONS IN RESPECT OF NOISE LIMITS AMBIENT AIR QUALITY STANDARDS IN RESPECT OF NOISE

AREA CODE	CATEGORY OF AREA	LIMITS IN dB (A) Leq	
		DAY TIME 6 A.M.to 9 P.M.	NIGHT TIME 9 P.M.to 6 A.M.
A	INDUSTRIAL AREA	75	70
B	COMMERCIAL AREA	65	55
C	RESIDENTIAL AREA	55	45
D	SILENCE ZONE	50	40

Note :

1) Silence is defined as area upto 100 Mtrs around such premises as hospitals, educational institutions and courts. The Silence zones are to declared by the competent authority. Use of vehicular horns, loud speakers and bursting crackers shall be banned in these zones.

2) Mixed categories of areas should be declared as one of the four above mentioned categories by the competent authority and the corresponding standards shall apply.

TABLE–VIII
ABBREVIATIONS USED FOR SOME WELDING PROCESSES

Welding Process	Abbreviation Used
Shielded metal arc welding	SMAW
Gas tungsten arc welding	GTAW
Oxyfuel gas welding	OFW
Diffusion welding	DFW
Friction welding	FRW
Electron beam welding	EBW
Laser beam welding	LBW
Explosion welding	EXW
Ultrasonic welding	USW
Submerged arc welding	SAW
Gas metal arc welding	GMAW
Electron welding	EGW

- Anchoring of compressed gas cylinders .
- Insulation of electrical circuits
- Monitoring of molten metal (sparks or discharge) to prevent fire
- Protection from arc exposure to eyes and skin
- Elimination of fumes to prevent their inhalation
- Use of protective clothing to prevent skin burns

Fire Protection : All flammable materials such as solvents and cleaning agents, should be stored in tightly sealed drums and issued in suitably labelled safety containers to prevent fires during storage and use. Solvents and flammable liquids should not be used in poorly ventilated or confined areas. When solvents are used in trays, safety lids should be provided. Flames, sparking, or spark-producing equipment must not be permitted in the area where flammable articles are being used.

When welding or cutting operations produce heavy spatter or sparking, precautions must be taken to protect or remove combustible materials from the immediate vicinity to eliminate potential fire hazards or danger to personnel. Personnel should be trained properly in fire protection action, and fire-fighting devices, such as fire extinguishers, should be readily available.

Gas cylinders : Gas cylinders are pressurised and as such must be handled with care. They should be kept upright at all times and securely anchored by chain, rope, or cable to a wall or rack. The cylinder can be a hazard to personnel, equipment, or building if tipped or dropped. If a cylinder valve is broken while the cylinder is fully pressurised, it could become a missile, causing serious injury, loss of life, or damage to equipment and buildings.

Acetylene in contact with copper, mercury, or silver may form acetylides, especially if impurities are present. These compounds are violently explosive and can be detonated by the slightest shock or the application of heat. Alloys containing more than 67% Cu should not be used in acetylene systems unless such alloys have proven safe in a specific application by experimental testing.

Electrical installations : for equipment and controls should be manufactured and installed in accordance with the appropriate codes and standards. High-voltage parts must be insulated suitably and enclosed with access doors and panels that are locked to prevent access by unauthorised persons. All electrical equipment must be grounded suitably or provided with equivalent protection. External weld-initiating control circuits should operate at low voltage for portable equipment.

PRECAUTIONS FOR SPECIFIC JOINING PROCESS

Listed below are important safety precautions that should be followed during welding and related processes. No attempt has been made to list all required safety measures.

Shielded Metal Arc Weldirng : The welder should be properly protected

from the arc. This requires suitable spatter and spark resistant clothing, a welding helmet, and gloves.

Gas Tungsten Arc Welding : The same precautions apply to GTAW as for SMAW. A darker shade of welding lens may be necessary, because the gas tungsten arc is more intensive.

Submerged Arc Welding : No protective shield or helmet is necessary in SAW, but safety glasses and gloves should be used for routine protection. Safety glasses should be tinted for protection against flash when the arc is inadvertently exposed.

Oxyfuel Gas Welding : Protection is required in OFW from the glare of the flame and molten metal. Goggles or eye-shields and suitable gloves must be worn.

Plasma Arc Cutting : Operators and persons in the vicinity of plasma arc cutting (PAC) equipment must be fully protected from strong arc glare, spatter, fumes, and noise when the unit is in operation.

Resistant Welding : Operators should wear eye and face protection against the ejection of molten metal and sparks during welding. Equipment should be designed to prevent crushing of hands or other parts of the body.

Thermit Welding : Personnel should wear protective clothing to shield against hot metal particles or sparks. Full face shields and safety boots should also be worn.

S. S. DASGUPTA
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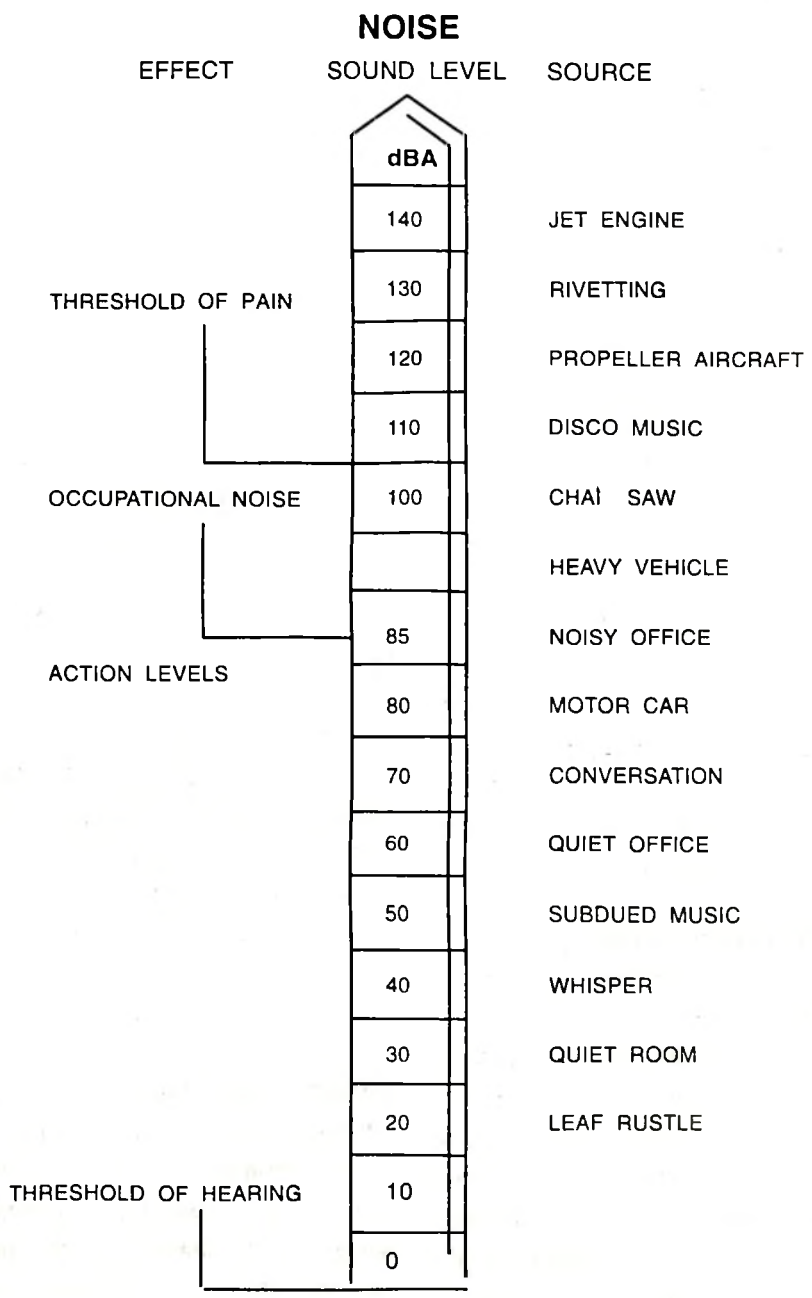

Fig. 2 : Typical Examples of Noise Levels

GIVES INDICATION OF NOISE LEVELS TO BE FOUND IN THE GENERAL ENVIRONMENT FOR COMPARISON

Brazing : Personnel and property should be adequately protected from hot materials, gases, and fumes.

Adequate ventilation is needed to prevent the inhalation of gases and fumes, as some metals and fluxes contain toxic materials. In furnace brazing, furnaces or retorts must be purged if the brazing atmosphere is flammable. Also, before personnel enter brazing furnaces or chambers for maintenance or cleaning, a complete air purge is needed.

Flash, Upset, and Percussion Welding : Some type of suitable fire-resistant shielding should be provided to protect the operator from molten metal particles. Eye protection with suitable shaded lenses also should be worn. Percussion welding (PEW) needs more safety precaution and pollution control as in this process noise level is high. As an example a 12 mm dia piece processed by PEW creates sound like firing a 12 gauge shotgun. Further it generates toxic vapour.

High Frequency Welding : No special protective clothing is needed in high frequency welding (HFW) applications. However, proper instruction and training of personnel is needed to ensure an understanding of safety precautions to prevent injuries from the high frequency power source. Electrical aspects of equipment installation are extremely important.

Electron Beam Welding : Operator protection from x-ray radiation, visible radiation, and electric shock is necessary in EBW applications. Although protection generally is designed into the equipment, a complete x-ray radiation survey should be made at installation and at regular intervals thereafter to ensure continued protection. In addition, high voltage involved in generating the electron beam and the beam itself call for safe operating practices.

Laser Beam Welding and Cutting : The primary hazards in LBW are eyes damage, skin burns, respiratory system damage, and electric shock. Proper eye shielding from beam exposure and fume elimination systems are also important factors to be considered.

Friction Welding : Welding personnel should wear appropriate eye protection and clothing commonly used with machine tool operations. Machines should be equipped with appropriate mechanical guards and shields and should be designed to prevent operation when the work area, rotating drive, or force system is accessible to the operator.

Ultrasonic welding : presents no unusual hazards to operating personnel. However, because of the high voltages involved, proper installation must be made to protect the operator. Proper controls must be incorporated into the installation to prevent operator injury from clamping fixtures.

This besides dealing with safety aspect mentions about gaseous and noise pollution in some cases.

SOME DETAILS REGARDING METALS

Specific precautions for some metals either being processed or being a constituent as filter material have to be taken as described here.

Beryllium - It is considered toxic, whether available as a fine powder or pure metal or an oxide. It can cause beryllosis, a respiratory disease. To minimise health hazards, welding should be done in glove box with a filtered exhaust system.

Copper - In resistance welding of copper alloys, a ventilation system is needed because of toxic elements.

Permissible limits for some common base and filler materials used in solder which release fumes on heating are given below:

Lead - The permissible exposure limit (PEL) in the developed countries is 0.05 mg/m3 compared to in other countries as 02 mg/m3.

Tin - No standard for this metal has been mentioned.

Cadmium - The PEL in Cd fumes is 0.1 mg/m3 and dust 0.2 mg/m3.

Zinc - The standard PEL is generally 0.5 mg/m3.

Arsenic - In the developed countries it has been reduced to 0.01 mg/m3 from earlier 0.5 mg/m3. Most countries follow a level of 0.2 to 0.5 mg/m^3.

Beryllium - It is now 0.002 mg/m^3 and may be reduced further.

Antimony - It is at present 0.5 mg/m^3.

BRAZING OF ALUMINIUM ALLOYS

The principal hazard in brazing aluminium alloys that is not present in brazing steel or copper alloys arises from the use of molten fluorine-containing fluxes in dip brazing. Toxic effects may be produced by the inhalation of fumes from the fluorine compounds; thus, exhaust facilities are required for dip brazing. Furnace brazing with fluorine bearing fluxes requires exhaust of the fumes generated to prevent attack on exposed metals; the air changes necessary for this reason are adequate from the standpoint of health protection.

MORE DETAILS IN SOME WELDING PROCESSES

High Frequency Welding

Serious consideration must be given to the health and safety of welding operators, maintenance personnel, and other personnel in the area of the welding operations. Good engineering practice must be followed in the design, construction, installation, operation, and maintenance of equipment, controls, power supplies, and tooling to conform to central, state, and local safety regulations, as well as those of the using company.

High frequency welding power sources are electrical devices and require all the usual precautions in handling and repairing such equipment. Voltages are in the range of 400 to 25,000 V and are lethal. These voltages may be low frequency or high frequency. To prevent injury, proper care and safety precautions should be taken while working on high frequency generators and their systems. Modern units are equipped with safety interlocks on access doors and automatic safety grounding devices that prevent operation of the equipment when the access doors are open. The equipment should not be operated with panels or high-voltage covers removed or with interlocks and grounding devices blocked.

The output high frequency primary leads should be encased in metal ducting and should not be operated in the open. The induction coils and contact systems should always be properly grounded for operator protection. High frequency currents are more difficult to ground than low frequency currents, and grounding lines should be kept extremely short and direct to minimize inductive resistance. Care should be taken that the magnetic field from the output system, particularly the output transformer, does not heat adjacent metallic sections by induction. Injuries from high frequency power, especially at the upper range of weld frequencies, tend to produce severe local surface tissue damage. Metal or flux fumes present little or no hazard to the welder, and although safety glasses are recommended for eye protection, arc burns pose no danger.

Gas metal Arc Welding

The major hazards of concern during GMAW are : the fumes and gases, which can harm health; the high-voltage electricity, which can injure and kill; the arc rays, which can injure eyes and burn skin; and the noise which may be present that can damage hearing.

The type and amount of fumes and gas present during welding depend on the electrode being used, the alloy being welded, and the presence of any coatings on the base metal. To guard against potential hazards, a welder should keep his head out of the fume plume and avoid breathing the fumes and gases caused by the arc. Ventilation is always required.

Electrode shock can result from exposure to the high open-circuit voltages associated with welding power supplies. All electrical equipment and the work-piece must be connected to an approved electrical ground. Cable should be of sufficient size to carry the maximum current required. Insulation should be protected from cuts and abrasion, and the cable should not come into contact with oils, paints, or other fluids which may cause deterioration. Work areas, equipment, and clothing

must be kept dry at all times. The welder should be well insulated, wearing dry gloves, rubber-soled shoes, and standing on a dry board or platforrm while welding.

Radiant energy, especially in the ultraviolet range, is intense during GMAW. To protect the eyes from injury, the proper filter shade for the welding-current level selected should be used. These greater intensities of ultraviolet radiation can cause rapid disintegration of cotton clothing. Leather, wool, and aluminium-coated cloth will better withstand exposure to arc radiation and better protect exposed skin surfaces.

When noise has been determined to be excessive in the work area, ear protection should be used. This can also be used to prevent spatter from entering the ear.

Conventional fire protection requirements, such as removal of combustibles from the work area, should be followed. Sparks, slag, and spatter can travel long distances, so care must be taken to minimise the start of a fire at locations removed from the welding operation.

Laser Beam Welding

Laser beam welding hazards differ substantively from hazards encountered in other welding techniques. The hazards are not readily apparent, and inexperienced personnel may suffer permanent injury before the existence of hazardous conditions is recognised. The individual should be familiar with laser safety and the officer should monitor the use of lasers to ensure adherence to safe laser practice. Because of the complexity of laser safety, this approach is strongly endorsed. The following brief review of laser safety by itself is not sufficient to ensure personnel safety.

Electrical Hazards : All lasers used for welding employ high voltages capable of lethal electric shocks. Therefore, maintenance should be performed by personnel familiar with high-voltage safety procedures.

Power supplies for high-power lasers contain capacitors capable of lethal shock even after initial discharge due to a phenomenon known as charge build-up. To facilitate safe maintenance access, the following provisions should be included:

- An automatic discharge and grounding circuit that is actuated when the laser is turned off
- Discharge and grounding interlocks on all access panels.
- Grounding rods for manual verification of complete discharge. Safety glasses should be used, because explosion-like discharges are possible on partly charged capacitors.
- Grounding straps to short out capacitors to prevent charge build-up.

In addition, all capacitors should be discharged and grounded before any work is performed on or near high voltage components.

Control of laser performance usually requires switching of capacitors. Insulated switches that do not expose personnel to electric conductors are preferred. If switching requires work on bus bars, the procedure listed above should be followed, and the use of insulated tools should be considered. Cooling water leaks are not acceptable, especially when electrical and cooling lines share the same umbilical.

Eye Hazards : Any laser beam capable of welding metals is also capable of causing serious eye damage. Personnel exposure to the beam and any specularly reflected beam must therefore be prevented at all times. Certain lasers, however, are also capable of producing diffuse reflections that can cause permanent eye damage. Hence viewing of the impact area of the laser beam or reflected beams also must be prevented. The preferred method for this is by complete enclosure.

Enclosures can range from a simple sleeve between the laser optic and the part to be welded to fully automatic operations in enclosed rooms. The following are general guidelines:

- The enclosure must be opaque to the laser wavelength. Metal enclosures are generally suitable, but plastics also are a

possible selection. Infrared lasers, for example, can be enclosed in clear polymethylmethacrylate.

- The enclosure must be interlocked to prevent firing of the laser beam when personnel could be exposed. When the piece to be welded is a part of the enclosure , the interlocks should also prevent firing, unless the piece is in place. In the case of pulse lasers, breaking of interlocks should also discharge the stored energy into a dummy load.

- Viewing of the weld area can be accomplished in several ways. Most common are viewing ports with filters and television monitors. For microwelding, microscopes should have filtered viewing optics or flip mirrors that permit either welding or viewing.

- Alignment of laser welding systems should be accomplished using low-power lasers.

BACKFIRE & FLASHBACK

Though it does not have any bearing with pollution control, but as it involves safety hazards, one may touch upon this aspect also.

Backfire occurs either when the gas exit velocity is too low or when the combustion velocity is too high. It is important to find out which factors influence these velocities. Common causes of too low gas exit velocity are :

- Wrong pressure is set on the torch or regulator
- Pressure drops depending on length and size of hoses
- Cylinder gas pressure is running low
- A hose has become constricted
- Dirt is blocking or constricting the flow in the torch or hoses
- Design faults in the equipment such as too large area of nozzle orifice(s).

The combustion velocity is dependent on the mixing proportions, temperature of gas mixture and any turbulence in the gas mix flow. Turbulence raises the combustion velocity, as the combustion becomes more effective, and can arise through :

- Spatter in the nozzle orifice (common in piercing).
- Damaged nozzle orifice.
- Uneven or scratched orifice walls (important to remember when manufacturing nozzles and tips).

The cause of **flashback** and hose explosions are that there is an explosive gas mixture **before** the mixing point due to the reverse flow, for example, oxygen into the fuel gas hose. If flashback occurs on ignition, and if there is a sufficient quantity of gas mix, there is such a violent explosion in the hose that it bursts.

Causes of reverse flow indicate the following :

a) Nozzle clogged by dirt, slag or damage. The gas with a higher pressure will then flow into the line with a lower pressure.

b) The oxygen pressure is dropping to less than the fuel gas pressure. Unless the oxygen valve on the torch is closed, fuel gas will flow over into the oxygen line.

c) If both the regulators are closed and the torch valves are left open when the operator leaves the job, the fuel gas with its lower pressure will be evacuated first. Oxygen can then flow into the fuel gas line.

d) Too high oxygen pressure when igniting the torch. If the operator opens both torch valves and tries to ignite with the oxygen flowing, oxygen can flow backwards into the fuel gas line.

e) A small nozzle in relation to the valve opening on the torch forces the gas at higher pressure over to the gas duct with lower pressure, as all the gas cannot escape through the nozzle.

A flashback arrestor will effectively prevent a flashback from entering the cylinder or supply system, which could cause a serious accident. Flashback arrestors are available in the form of torch-mounted and regulator-mounted arrestors.

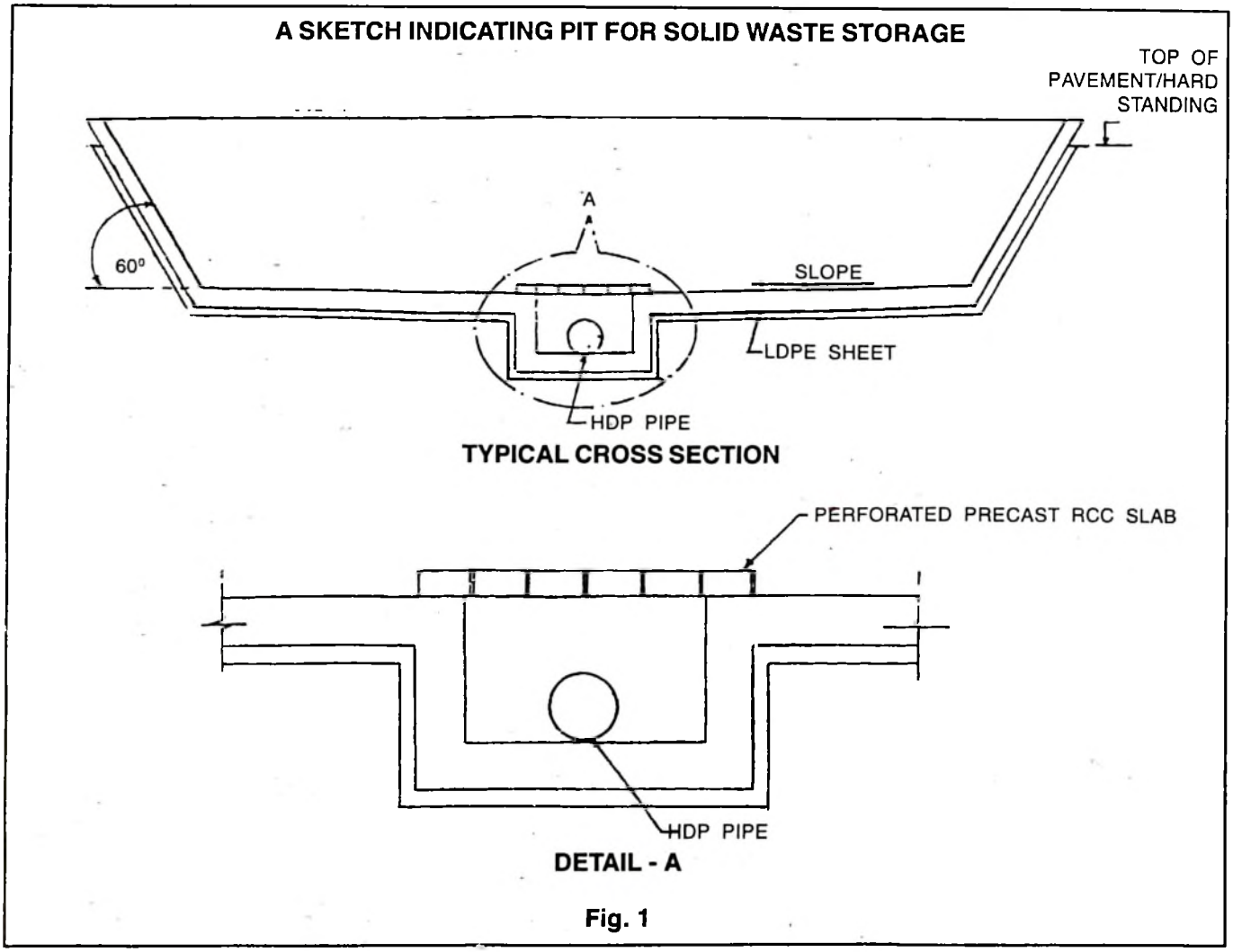

Fig. 1

LIQUID EFFLUENT & SOLID WASTE

Not much of liquid effluent is generated, which can be led to the effluent system of the plant. Otherwise can be treated in a pond with chemicals depending on the metal being welded.

Some solid waste is generated which can be collected and sold as scrap. If necessary, it can be stored in small containers awaiting disposal. However, if more metals are being handled, it is prudent to have different containers for different metals.

REFERENCES

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