


INTERPLANT STANDARD - STEEL INDUSTRY		
 IPSS	CODE OF PRACTICE FOR OXYGEN GAS PIPELINE	IPSS:1-06-034-17 (First Revision)
	<i>NO CORRESPONDING INDIAN STANDARDS EXISTS</i>	Formerly-: IPSS:1-06-034-97

0 FOREWORD

0.1 This Inter Plant Standard prepared by the Standards Committee on Pipes, Fittings, Valves and Piping Layout, IPSS 1:6 with the active participation of the representatives of all the steel plants and associated organizations in the field was adopted on December, 1997 and first revision done in July 2017.

0.2 Oxygen is distributed to consumers from generation plant LOX storage and vaporization plant or a cylinder discharge manifold by means of pipelines oxygen is a highly oxidizing gas which under certain conditions combines with almost all the elements giving rise to a brisk exothermic reaction. In view of the possibility of spontaneous combustion in oxygen piping systems, special precautions need to be taken in design, fabrication, erection, testing and commissioning of oxygen pipelines.

1. SCOPE

- 1.1 This code of practice stipulates engineering requirements for safe design, construction and commissioning of oxygen gas pipelines made of carbon steels or non-ferrous metals and alloys for operation at pressures up to 42 kg/cm2(g) and temperature up to 55oC. The requirements are covered after pressure regulation system.
- 1.2 In this standard, wherever "oxygen pipeline" is mentioned, the same should be construed as referring to "oxygen gas pipeline" only.

2. CLASSIFICATION OF PIPELINES

2.1 Depending on the maximum operating pressures, oxygen gas pipelines shall be categorized as per the following table:

Pressure Range for Various Classes of Pipelines

Category of pipelines	I	II
Working pressure	up to 20 kg/cm2(g)	above 20 up to 42 kg/cm2 (g)

2.2 Pipe Sizing

2.2.1 Design Criteria

The three basic criteria that determine the design of pipes and components are:

- Gas velocity
- Pressure losses
- Mechanical strength of pipe (pressure, temperature and stress)

2.2.2 Design Procedure

For each section of the pipeline, the flow rate and required pressure being known the usual sequence of selection will be as follows:

- The diameter of the pipeline shall be finalized so that the required pressure is available at consumer point with the maximum flow in a given pipe run. It

should be selected by judging from economical velocity calculated separately for each pipeline.

- Verification of velocity and possible adjustment of the diameter so as to observe velocity limits.
- Selection of thickness of the pipeline based on the desired resistance to pressure.

2.2.3 Selection of Velocity

Selection of velocity in a particular section of a pipe depends on various factors like flow materials off the pipe dust and foreign matter content etc. Velocity means the gas velocity in a given cross section calculated under the conditions of pressure temperature and flow.

Velocity

=

$$(1.313 \times Q \times TZ) / (D^2 P)$$

V

=

Velocity of gas in m/s

Q

=

Flow in m3/h under NTP conditions

T

=

Gas temperature in K

P

=

Absolute gas pressure in bar

Z

=

Coefficient of compressibility under flow Condition

D

=

Internal diameter of pipe in mm

Maximum Recommended velocities for Carbon Steel in pipelines:

Category of pipeline	Velocity of oxygen m/ sec (max)
I	10
II	8

Although velocity of oxygen in the pipeline depends on the material of the pipe selected and the pressure range for which the pipeline system is designed. Although international standards and norms allow higher velocities of oxygen gas in pipeline, the velocities recommended by this code is limited to the values given above, considering prevailing qualities of workmanship and cleanliness achieved..

3 LAYOUT OF PIPELINES

- 3.1 Inter shop oxygen pipelines (outdoor)
- 3.1.1 Oxygen pipe work shall preferably be routed overhead. However, underground routing may also be permitted, if the requirements so demand.
- 3.1.2 While routing overhead oxygen pipelines depending on the route through which they pass minimum distances (surface to surface) shall be as per Table-1 and minimum height shall be as per Table-2.

Table-1

Minimum Clearance of Overhead Oxygen Pipelines (Surface to Surface)
Clause 3.1.2

S.No	Structures	Min Distance in mtr. (surface to surface)	Remarks
1	Explosion Hazardous Shops	3	-
2	Railway Tracks	3	To the nearest rail
3	Railway Bridges & Platform	3	-
4	Roads	1.5	1.5m up to the embankment
5	High voltage transmission lines a) parallel to pipeline b) crossing the pipelines Up to 20 Kv 35-150 Kv 150-220 Kv	10 3 4 5	-
6	To the place of hot metal tapping and source of open fire	10	-
7	(a) - for insulated LT cable (b) – for bare conductor LT	0.5 1	-

Table-2
Minimum Clearance of Overhead Oxygen Pipelines (In height)
(Clause 3.1.2)

S.No.	Route	Clearance (in Metre)	Remarks
1.	Roads	6.0	From the road surface to the bottom of pipe or to the bottom of pipe support structure whichever is lower
2.	Pavements	2.2	
3.	Railway Track		
3.1	Non-electrified	6.0	From the top surface of the rail to the bottom of the pipe or platform or heat shield whichever is lower
3.2	Electrified railway and tram track	7.1	
3.3	Hot metal track: Without heat shield With heat shield	10.0 6.0	

3.1.3 Pipeline should be laid on the platforms, pillars, columns and on the external walls of the building using the external bracket.

- 3.1.4
- a)

It is permitted to lay oxygen pipeline along with other pipelines on common supports, keeping a clear distance of 300 mm (both vertical and horizontal). For gaseous pipelines, refer IPSS: 1-06-014-17.
- b)

Oxygen piping shall have electrical continuity across all connections and shall be effectively earthed at suitable intervals (generally they are in the range of 100-150 m). The electrical resistance to earth of the overhead piping should not exceed 10 Ohms for lightning protection.

3.1.5 When gaseous oxygen pipeline crosses another pipeline (other than fuel gas pipelines) of 300 mm and more diameter, the distance between them should not be less than 150 mm and when the diameter is less than 300 mm, the distance should not be less than 100 mm.

3.1.6 The laying out of gaseous oxygen pipelines is not permitted in the following cases:

- Along the walls of explosion hazardous building
- Through the ware houses of inflammable materials
- With electrical wires and electrical cables.

3.2 Underground laying out of pipelines of gaseous oxygen

3.2.1 Underground pipelines should be laid in the trenches and then back-filled with soil unless specially permitted otherwise by the Engineer to protect against frost, casual surface construction, shifting due to unstable soil, back-fill damage to the external surface of the pip or the coating, and above ground loads such as vehicles or equipment moving over path of pipeline. All buried oxygen pipelines shall have a minimum horizontal distance of 3 m from buildings and 3.5 m from centre line of railway tracks. A vertical distance of 1

- m shall preferable be kept between buried oxygen lines and other underground piping cabling etc at crossings.
- 3.2.2 An earth cover of at least 1.2 m should be maintained from the top of the pipe to the ground level in areas subject to temporary load, and at least 1 m in areas not subject to temporary loads.
- 3.2.3 In case of laying oxygen pipelines in open trench a depth of 1 m should be maintained from the top of the pipe to the finished level of the road. In rocky soils, a clear distance of 0.1 m should be maintained between the bottom of the pipe and lowest level of the trench. Compacted sand should be provided on the top and bottom of the pipe to an extent of 0.2 m and 0.1 m respectively.
- 3.2.4 Piping should be all of welded construction applying a specification and inspection code such as API 1104 (7). No mechanical joints should be installed underground either buried or in pits because of possibility of leaks.
- 3.2.5 Cathodic protection of the underground sections of the pipeline shall be provided in addition to passive protection by coating and wrapping. This shall be as per APPENDIX-A.
- 3.2.6 Underground portions of the pipeline systems should be connected to the above ground portions through an electrically insulated joint to isolate the underground cathodic protection system. The insulation gasket shall be oxygen compatible.
- 3.2.7 Between buried oxygen lines and other underground piping, cabling etc at crossings, a vertical distance of 1 m shall preferably be kept.
- 3.2.8 Oxygen pipes passing through walls, ceilings, fences and other structures of the buildings or constructions shall be encased in a steel pipe having inside dia at least 50 mm more than that of oxygen lines. The lines shall have no joints in the sections at such crossings. The gap between the oxygen pipe and the outer pipe shall be filled with non-inflammable material, but allowing vertical and horizontal movements.
- 3.3 Inside shop gaseous oxygen pipelines
- 3.3.1 Oxygen pipelines serving to the technological equipment inside or outside are called the inside shop pipelines.
- 3.3.2 Inside the oxygen plants and the distribution compartments, the pipelines can be laid along the walls or columns of the buildings.
- 3.3.3 Oxygen pipelines in the consumer shops should be routed as far away as practical from other lines and process equipment containing fluids which are hazardous in an oxygen environment. If located in a multi-pipe rack the mechanical joints in the oxygen line should not be located close to mechanical joints in other fluid lines where hazardous mixtures could result if simultaneous leakage or failure occurred. In places of through walls, floorings, partition and other building structures oxygen pipelines shall be encased. The runs of pipelines within the casing shall be free of joints.
- 3.3.4 Each run of oxygen pipelines between the fixed supports shall be designed for compensation of thermal expansion. The compensation of thermal expansion can be achieved either by adopting a routing configuration which is self-flexible, or by using U-loops made from seamless pipes assumed either horizontally or vertically.
- 3.3.5 The gate valves on the oxygen lines, which are situated in the open should be at least 3 meter away from pump houses and other buildings and equipment.
- 3.3.6 Necessary provision shall be kept on oxygen lines for purging by Nitrogen for this purpose.
- 3.4 Other System design considerations

3.4.1 Fire break sections may be installed in the oxygen pipeline to limit the propagation of combustion in a steel pipeline. Fire break sections may be introduced immediately downstream of the main isolation and throttling valves where the velocities can be high. The fire break section will be either a length of copper pipe having the same inside diameter as the main pipe with flanges fitted at the two ends which is installed between the steel pipes. or copper insert tube made from copper sheet/ tube and inserted inside the steel pipe downstream of the valves. The copper insert tube is generally used in large diameter steel pipelines.

3.4.2 In steel pipelines care should be taken to install isolation valves on straight sections of the pipeline. Any pipeline component which is likely to cause a change in the flow pattern like reducer, bend, tee or "Y" connection, orifice plate etc should be at a distance of at least four diameters away from the valve.

4. MATERIALS FOR USE IN OXYGEN SERVICE

4.1 All materials used in oxygen piping systems must be compatible with oxygen at the temperatures and pressures used within the system and must be cleaned for oxygen service prior to their use. Violations of these requirements are extremely hazardous and can lead to a fire. Recommended specification for pipes and other pipe fittings shall be as per Table-5.

4.2 The metals most frequently used in oxygen service are carbon steel, copper and its alloys, stainless steel, nickel and its alloys are used for special applications.

- i) Carbon steels are used for delivery and distribution pipelines above or below ground and for the construction of pipe work fittings.
- ii) Copper and its alloys are used where resistance to oxidation and ignition are required. It is also used where the velocities in the pipe work are on the higher side.
- iii) Stainless steel is used in corrosive environments. It also facilitates ease of cleaning.

4.3 Valves in oxygen piping systems fit into three general categories; isolation, process control and pressure relief valves. Valves should be kept to a minimum since they have mechanical joints susceptible to leaks. Recommended specification of valves shall be as per Table-4.

4.4 Valves & accessories used in the oxygen gas pipeline should be designed to function without lubrication. However, if a lubricant is necessary to permit assembly operations or the functioning of a component, it shall be selected from lubricants like graphite. Molybdenum disulphate flourinated or non-flourinated silicones per-flourinated polyethers.

4.5 Lubricants used in actuators for valves on oxygen lines shall be suitable for oxygen service.

4.6 In case of a non-metallic being used for gaskets, valve seats etc, care should be taken to ensure that the material selected is dense, non porous and free from surface or other defects. Compacted fibers and powders shall be excluded. These parts shall be securely enclosed with the minimum of play in solid metallic supports which are conductors of heats. Suggested nonmetallic products and their uses are listed at Table-3.

4.7 Plastic or organic materials have a distinctly lower ignition temperature than metallic materials and on ignition they eventually heat particles and adjacent metal particles to the point of ignition. It is, therefore, good practice to use such materials in the smallest possible quantities and only in intimate contact with metallic parts of greater mass and good conductivity to dissipate the heat. The use of these materials in direct contact with oxygen gas shall be limited to the following:

- Seals and packings in components and assemblies
- Deformable elements (diaphragms) in regulating devices

hoses

Table-3

Suggested Nonmetallic Products and their uses

S. No.	Product	Properties	Uses
1	PTFE and FEP	Good antifriction Tendency to flow Tendency to sublime	Valve seats Antifriction bearings Antifriction coatings Thrust washers Thread seals Gland packings Flange gaskets
2	PTFCE	Harder than PTFE Greater mechanical strength than PTFE and FEP	Valve seats Bearings Insulating seals Gland packings
3	Flourinated Chloroflourinated elastomers (Viton)	Flexibility Elasticity	O-ring seals Diaphragms

Flourinated and chloroflourinated resins can be reinforced with oxides, asbestos, glass, ceramic, metals and alloys in order to improve some of their mechanical properties. Such reinforcement shall not affect resistance to ignition.

Table-4

Recommended Specification of valves

S.No	Item	Nominal dia	Pipeline category-I	Pipeline category-II
1.1	Isolation valve	40 and below	Class 600 Bronze/ stainless steel ball/globe valve, teflon packing and seats with bronze/ Monel/ SS trim, ends flanged	Class 800 Bronze/stainless steel ball/globe valve with teflon packing and Monel/ bronze/ stainless steel trim, flanged end
		50 and above	Class 300 ball valve bronze/ Monel/ stainless steel body and trim, teflon packing, flanged ends to ANSI B16.5	Class 600 ball valve, Monel/ bronze/ SS body and trim teflon packing, flanged ends to ANSI B16.5, size above DN 150 provided with gear reducer
1.2	Throttling	40 and below	Class 600 bronze/ Monel, globe valve, teflon packing and seats with bronze/ SS trim, ends flanged	Class 800 bronze/ Monel, globe valve, teflon packing and seats with bronze trim,
		50 and above	Class 300 bronze/ Monel, globe valve flanged ends to ANSI B16.5	Class 600 bronze/ Monel globe valve, bronze trim, teflon
1.3	Non Return	All Sizes	Class 300 Bronze/ Monel/ Stainless steel valves of swing/ lift cheek type with soft seat to suit	Class 600 Bronze/ Monel/ valves of swing/ lift cheek type with soft seat to suit installation,

			installation, flanged ends	flanged ends
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- Note:
- 1) Steel mating flanges for flanged copper valves/ appurtenances shall be flat faced with full face gaskets.
 - 2) Rating and drilling details of companion flanges for valves and fittings shall match with those of valves and fittings.

Table-5
Recommended Specification of Pipes and Pipe Fittings

S.No.	Item	Nominal dia mm	Specification
1	Pipe	6 to 10	Seamless tube, deoxidized non-arsenic copper or copper alloys for both category I & II.
		15 to 600	Carbon steel seamless to ASTM A 106-1992 Grade B/A53 Gr-B-1993, black with ends beveled for both category I & II.
2	Pipe Fitting	40 and below	Forged carbon steel socket as per class 300 weld fittings as per ASTM A 105-1994 to ANSI B 16.11 for both category I & II.
		50 and above	Forged carbon steel butt welded fittings as per ANSI B 16.9 to ASTM A 234-1990. Grade WBP for category I & II.
3	Bends	DN15 to DN 50	Cold bend (R= 5D)
		Above DN 50	Forged carbon steel alternatively hot bend (R = 5D)
4	Flanges	40 and below	Forged carbon steel, socket weld, raised face, class 300 for category I & class 300 for category II to ANSI B 16.5 and ASTM A 105-1994/carbon steel weld neck, raised face flanges to IS:6392-1971 made from plates to IS:2002-1992 Gr 2A with bore to suit pipe O.D.
		50 and above	Forged carbon steel, weld neck, raised face, class 300 for category I & class 600 for category II to ANSI B 16.5 and ASTM A 105-1994
5	Gaskets	All size	Teflon (LOX grade) / Klinger Oilit 3xA/ paronite (oil free)
6	Bolting	All size	IS:1367 for category I
	Studs Nuts		ASTM A 193-1994 Gr B7 ASTM A 194-1994 Gr 2H for category II.
7	Filters		Carbon Steel/ Copper alloy/ Stainless steel body, Sintered Bronze filtering element OR Monel strainer of =<150 micron..
8	Copper inserts		Made of copper tube/sheets, to be located inside steel pipes downstream of obstruction (valves, etc), length 600 mm or 5xDN (whichever is more) as per working drawings

5. PREREQUISITES FOR PIPELINE ERECTION

- 5.1 All general pipes, valves, fittings, instruments and appurtenances for oxygen service shall be permitted for erection only after physical inspection at installation site and verifying the supplier’s documents/certificates regarding satisfactory compliance with the requirements for oxygen services. The important aspects to be checked are listed below:
 - 5.1.1 All components of pipe work shall be checked for their standard of manufacture, dimensional and material suitability.

- 5.1.2 The accompanying documents and certificates showing results of tests at manufacturer's works should be verified. Without such certificates, the item shall not be used for oxygen service.
- 5.1.3 The packings should be checked to ensure that they are not damaged while in transport between place of manufacturer and site installation.
- 5.1.4 Presence of grease or oil should be checked in light on visible surfaces. Inside of pipes or fittings may be checked by passing a white lint free cloth. Alternatively the pipes and fittings can be subjected to inspection by ultra-violet lamp. Any presence of oil or grease on the surface will create fluorescence.
- 5.1.5 Presence of foreign matters such as fillings, scale flux, corrosion products, common dirt, wood and metal chips, threading compounds, sealers, tar, asphalt, moisture, paint, chalk, flushing compound etc should also be checked.
- 5.1.6 It should be ensured that all pipework are cleaned free of all foreign matter.
- 5.2 Cleaning by Manufacturers
 - 5.2.1 At the manufacturer's works, all pipes and fittings shall be pickled, neutralized and phosphated as per IS:3618 after completing shop tests. Then these shall be tightly sealed by plugs or blank flanges, packed with sachets of dry silica gel inside and tagged "pickled for oxygen services" before dispatch.
 - 5.2.2 Valves, regulators, filters etc shall be thoroughly cleaned and degreased, their ends sealed by plugs or blank flanges and packed in clean polythene bags and tagged "degreased for oxygen service" before dispatch with certificate of de-greasing.
- 5.3 Cleaning at Erection Site
 - 5.3.1 All pipes, valves, fittings, etc after visual examination verification of documents mentioned in clauses 5.1 and 5.2 above, shall also be cleaned at site as described herein.
 - 5.3.2 In case the oxygen pipes and fittings delivered to site by manufacturers/ stockists are found to contain scales, rust, etc, they shall be subjected to cleaning, degreasing pickling, neutralizing and phosphating as per procedure given in ANNEXURE-II. After this treatment they shall be dried by blowing dry air/Nitrogen. The ends shall then be kept sealed till erection commences.
 - 5.3.3 Degreasing of piping/ fittings during erection/ modification / maintenance
 - 5.3.3.1 Before erection, all piping components shall be degreased thoroughly, using solvents such as trichloroethylene suitable for oxygen service. Vapour degreasing or other suitable methods may also be adopted, subject to approval by Purchaser/Engineer.
 - 5.3.3.2 The degreasing solvent quality shall be checked before using the same for degreasing.
 - 5.3.3.3 Before degreasing, the pipe work shall be dried by blowing Nitrogen/ dry air. To the extent possible nitrogen shall be used for blowing/ drying.
 - 5.3.3.4 Inner surfaces of pipe shall be degreased by plugging one end, filling the pipe with solvent as per quantities given at Table 5 and then plugging the other end. The pipe shall then be kept horizontally and rotated on its axis at least once every minute, this process shall continue for 15 minutes. After draining the solvent the pipe shall be blown with dry, oil free air or nitrogen of at least 94.0 percent purity at 60 Deg C to 70 Deg C temperature for about 5 minutes, or till the smell of solvent is completely eliminated. Alternatively, the drying may be done in open air for a minimum period of 24 hours.

TABLE-5

Minimum Quantity of solvent to be used for degreasing							
Size of pipe in mm	32	50	100	150	200	250	300
Quantities ltr/ mtr	0.4	0.6	0.9	1.4	1.8	2.2	2.3

- 5.3.3.5 If considered necessary after site inspection, the valves, fittings and instruments shall also be degreased at site and dried by blowing with nitrogen. The valve and fittings shall be disassembled and kept in closed containers containing the degreasing solvent for 5 to 10 minutes. After removing the components the same shall be dried by blowing with nitrogen till the solvent smell is eliminated. Degreasing of gaskets and packing shall be done in a suitable solvent for 2 to 3 minutes and then dried.
- 5.4 All tools and appurtenances used for cleaning shall also be free of all oil, grease, dirt etc. These shall also be thoroughly cleaned, degreased in a suitable solvent and dried before use.
- 5.5 All personnel involved should follow a high standard of personal cleanliness. They shall also take adequate safety precautions to avoid inhaling solvent vapours arising during degreasing. They shall use clean gloves and gas masks.
- 5.6 Cleaned components of pipe work shall be well protected from recontamination by proper packing and storing. Pipes shall be sealed with plastics etc end-covers. It is recommended to place small sachets of dry silica gel inside the cleaned and degreased pipes by attaching the sachets by tape to the plastic end covers. Small items shall be kept sealed in polythene sheet. All items shall be kept in covered space till issue for erection. Sufficient quantities of descants shall be kept in places of storage to prevent condensation of moisture on ferrous materials.
- 5.7 Quality of the degreasing may be checked by the following methods:
- a) Determination of the oil content in the solvents removed from the components after controlled degreasing; degreasing quality may be considered satisfactory if oil content in the removed solvent does not exceed more by 20 mg/l of oil content in the solvent.
 - b) By wiping off the section of the cleaned surface by degreased napkin from lint free cloth soaked in the clean solvent and by subsequent determination of oil content on this napkin.
 - c) Visual inspection of the open cleaned surface with the help of luminescent devices such as Ultra-Violet lamp.
- 5.8 It is very important that the degreasing activity shall be carried out just before the erection activity and degreasing and erection schedules should be matched accordingly
6. **ERECTION & MAINTENANCE OF GASEOUS OXYGEN PIPELINES**
- 6.1 All erection work of Oxygen gas pipelines shall have to be closely supervised and rigorously followed up to prevent unforeseen holdup which may result in deterioration in cleanliness of the pipe work.
- 6.2 Parts, accessories, materials and pipes used for manufacture, erection and maintenance of the pipe lines, buildings and structures for pipelines should meet the specifications of the project. Any changes from design should be made only with the permission of design organization which worked out the project.

- 6.3 Materials, parts, units, accessories and other equipment used for manufacture, erection and maintenance should meet the required standard norms and technical conditions and should have certificates of manufacturing plant.
- 6.4 Accessories should have marking and distinguishing paint as per standards and norms, according to their use and materials. Steel slide valves, irrespective of their size should have tag number on housing.
- 6.5 Pipeline assemblies and parts during assembly and welding should be subjected to careful control, the welded joints should be controlled by physical methods like Ultrasonic Test and Radiographic Test..
- 6.6 While laying the pipe lines through the walls, roofs and other structures of buildings, the pipelines should be covered with sleeves.
- Portions of pipelines covered with sleeves should not have joints.
 - Gaps between pipeline and sleeve should be sealed with non-combustible materials
- 6.7 Welding of pipeline
- 6.7.1 Electric arc welding shall be used for erection of pipelines. Welding shall be done by qualified welders. Low Hydrogen electrodes shall be used.
- 6.7.2 Backing rings shall not be used for welding. Root run shall be made with Argon arc (TIG) welding. D P (Die- Penetration) test shall be carried out after root run.
- 6.7.3 Welding of each joint should be carried out without breaks up to the completion of welding qualifying tests for welding, welding procedures and quality control etc shall be generally as per IS:2825 'Code of Practice for Unfired Pressure Vessels'.
- 6.7.4 Radiographic examination of 100% welds for oxygen pipelines with working pressure over 10 kg/cm² shall be carried out. Interpretation of radiographs shall be done by a competent agency.
- 6.7.5 For pipelines having working pressure 10 kg/cm²(g) and below, 40% weld joints shall be tested by radiography. In case of failure of any welding joint found 100% radiography to be carried out.
- 6.7.6 For welding pipelines made of non-ferrous metals and its alloys, helium and argon should be used. Purity of Argon used for arc welding of copper pipelines should not be less than 99.8%.
- 6.7.7 All defective welds shall be removed and redone and then will be subjected to radiographic examination.
- 6.8 Sequence of Inspection of pipe work
- 6.8.1 Checking of quality of assembly for welding.
- 6.8.2 Control of technology of welding.
- 6.8.3 Checking of alignment.
- 6.9 Checking of welded joints on pipeline
- 6.9.1 During erection the systematic step by step procedure should be followed.
- 6.9.2 External inspection of welded joints.
- 6.9.3 Checking of the continuity of the joints.
- 6.10 All the joints should be subjected to the external inspection for the following defects:
- 6.10.1 Cracks on the external surface of the joint.

- 6.10.2 Uneven surface in the welded zone.
- 6.10.3 Through holes.
- 6.10.4 Depth and width of welded joints for evenness.
- 6.10.5 After erection, Pipelines shall be cleaned by either of the following three methods or Combination of them
 - 6.10.5.1 Blowing the piping with Nitrogen at minimum 40 m/s. During this period Valves, NRV, Filters, strainers, flow elements etc shall be replaced with a spool pieces.
 - 6.10.5.2 At the blowing outlet put a white screen at a distance of 0.5 to1 meter. Blowing is to be done till no particle spot is found on the screen. Screen may be changed as per requirement.
 - 6.10.5.3 Online Pickling
 - 6.10.5.4 Card board blasting: At the blowing outlet 2 to 4 layers of card board shall be fixed and pressure will be raised slowly with Nitrogen so that the card board bursts.

7. TESTING OF ERECTED OXYGEN PIPELINE

- 7.1 The tests of the pipelines should be carried out after blowing them with oil free and dry air or Nitrogen, which do not contain fatty materials or oil. Air can be considered oil free if the oil and grease content is less than 0.005 gm/Nm3 and is considered dry if its dew point is less than -40°C.
- 7.2 Pipelines of all categories should be tested for strength and tightness. The medium used for the pneumatic testing on strength and tightness should be Nitrogen, pure to the extent possible.
- 7.3 The tests should be carried out under the direct supervision of the person responsible for this job in strict accordance with the rules and the project data.
- 7.4 Strength-cum-leakage test
 - 7.4.1 Pneumatic leak tightness test of the pipelines should be carried out using oil free air or Nitrogen as follows:

Value of the testing pressure should be equal to 1.1 times the design pressure.
 - 7.4.2 The welded seams of steel pipelines during inspection may be tapped with wooden hammer/ Mallet of weight not more than 1.5 Kg. Pipeline from non-ferrous metals and alloys may be tapped with a wooden hammer of weight not more than 0.8 Kg. It is not allowed to tap by hammering the pipelines made of the other materials.
 - 7.4.3 Pneumatic test of the pipelines may be done for strength and tightness. Pneumatic test of the pipeline on tightness (including the test with detection of pressure fall) is to be performed only after the preliminary test of strength.
 - 7.4.4 Pressure shall be gradually raised to the test pressure and all joints checked by soap solution for leakage. The testing pressure should be held for 30 minutes during which joints shall be lightly tapped with a wooden hammer of 1.5 Kg weight. If any leakage is detected, line shall be de pressurized and defect rectified.

Leakage test for the pipeline system shall be done at maximum allowable working pressure for a period of 12 hours. During this period, pressure and temperature readings shall be taken at an interval of 1 hour. The gauges used should be tested for their accuracy and shall have minimum calibration of at least 0.1 Kg/cm2(g) and 0.5°C.

Leakage shall be determined by the formula:

A = 100 (1 - P2T1/P1T2)

- A = Quantity of air leakage in percent
- P1 = Pressure in pipeline at beginning of test (Kg/cm²a)
- P2 = Pressure in pipeline at the end of test (Kg/cm²a)
- T1 = Absolute temperature at beginning of test (oK)
- T2 = Absolute temperature at the end of test (oK)

The test results shall be considered satisfactory tested and acceptable if the leakage is less than 0.2% per hour.

After completing the testing, the line shall be kept under a pressure of at least 1.0 kg/cm² (g) using Nitrogen, till pipeline commissioning.

8. COMMISSIONING OF PIPELINE

- 8.4 After completion of blowing with dry air/ Nitrogen, strength and leakage testing and hooking up with the system, the line shall be filled with Nitrogen, then oxygen shall be gradually introduced into the line and Nitrogen slowly exhausted through the bleeder. The purity of the exhaust gas has to be checked until desired oxygen purity is reached. Then bleeder should be closed.
- 8.5 If there is any significant time gap between blowing with air/Nitrogen and commissioning then the line should be kept filled with Nitrogen at 1.0 Kg/cm²(g).

9. SAFETY PROCEDURES

Some of the important safety procedures to be followed are given below. For general/ specific requirements regarding safety procedure IPSS: 1-11-002-15, Safety Procedure for Oxygen, Nitrogen, Acetylene and fuel gases shall also be followed

- 9.1 The testing, cleaning and commissioning of Oxygen gas pipe work shall be carried out only in the presence of, and with the permission and guidance of senior Engineer and staff of contractor, engineer and purchaser.
- 9.2 All first aid and fire fighting facilities shall be readily available during cleaning, testing and commissioning of oxygen pipelines.
- 9.3 All arrangements for cleaning, testing and commissioning shall have the concurrence of the safety engineer. The fire fighting officer or his authorized representative shall be present during cleaning, testing and commissioning.
- 9.4 It is prohibited to put tools and materials on the pipeline.
- 9.5 During pneumatic testing and commissioning of pipelines for tightness and strength and Commissioning. Presence of unauthorized people in the guarded zone (not nearer than 25 meters) is prohibited.
- 9.6 On the container with trichloroethylene and other solvents there should be the distinct label poison and dangerous and shall be kept away from source of heat and fire.
- 9.7 Prolonged inhalation of vapours and contact of solvent with the skin should be avoided. People should avoid to be present near Oxygen deficient atmosphere during blowing with Nitrogen.

10. HANDING AND TAKING OVER OF OXYGEN PIPELINES TO OPERATION

- 10.1 A proper protocol should be drawn containing the compliance of the following points:
 - 10.1.1 Certificates for welding works.
 - 10.1.2 Reports of inspection of internal cleaning of the pipelines.
 - 10.1.3 Reports of tests of accessories.

10.1.4 Reports of tests of pipelines on strength and tightness.

10.1.5 Log book of welding works.

10.1.6 Lists of welders who took part in welding works pointing numbers of their certificates and marks.

10.1.7 Reports of cleaning, flushing and blowing of the pipelines (including accessories).

10.1.8 Drawings of the pipelines, sketches explanatory notes.

Note- General Comments: General safety rules for working at heights should be followed as per IPSS:1-11-005-14 & 1-11-008-14 ~ Safety Procedure for working at height by Contractors Worker & Safety Procedure for working at height by regular employees of Plants/ Mines Respectively

ANNEXURE-I
(Ref.CI.3.2.5)
(Based on IPSS:1-06-035)

CATHODIC PROTECTION

1. Cathodic protection systems reverse the electro-chemical corrosive force by creating an external circuit between the pipeline to be protected and an auxiliary anode (sacrificial metal) buried in the ground at a predetermined distance from the pipe. Direct current applied to the circuit is discharged from the anode surface and travels through the surrounding electrolyte to the pipe (cathode) surface.
2. Two (2) methods are available for generating a current of sufficient magnitude to guarantee protection. In the first method, sacrificial anode material such as magnesium or zinc is used to create a galvanic cell. The electrical potential generated by the cell causes current to flow from the anode to the pipe, returning to the anode through a simple connecting wire (refer Fig 1A). This system is generally used where it is desirable to apply small amounts of current at a number of locations, most often on coated pipelines in lightly or moderately corrosive soils.
3. The second method of current generation is to energize the circuit with an external DC power supply, such as a rectifier. This technique, commonly referred to as the impressed current method, uses relatively inert anodes (usually graphite or silicon cast iron) connected to the positive terminal of a DC power supply, with the pipe connected to the negative terminal (refer Fig 1B). This system is generally used where a large amount of current is required at relatively few locations, and in many cases it is more economical than sacrificial anodes.
4. For cathodic protection, a corrosion survey including chemical-physical analysis of the soil must be performed along the pipeline.

APPENDIX - B**PROCEDURE FOR PICKLING AND PHOSPHATING****1.0 GENERAL**

- 1.1 Pickling is a chemical process for removal of rust, scale and other coatings from pipes, fittings etc. This is normally done by subjecting the surface of the material to be treated in an aqueous solution of an acid. To prevent the acid from attacking the base metal an inhibitor may be added. Pickling bares the metal of the surface treated which become highly acceptable to corrosion. This operation is, therefore, followed by an anti corrosion treatment which retards the corrosion of surface that have been pickled. Phosphating is one such chemical process which deposits a thin protective layer on the surface.
- 1.2 The procedure given below is applicable for pickling and phosphate treatment of carbon steel pipes and components. The process requires the pipes to be immersed in vats/baths of adequate dimensions to take full lengths of pipes as supplied by the manufacturers/stockists. It also requires close supervision and availability of a chemical testing laboratory to assure that proper control is exercised during the process. Arrangements are also required for heating of the chemical solutions used for the treatment.

2.0 PROCEDURE**2.1 Pre-cleaning**

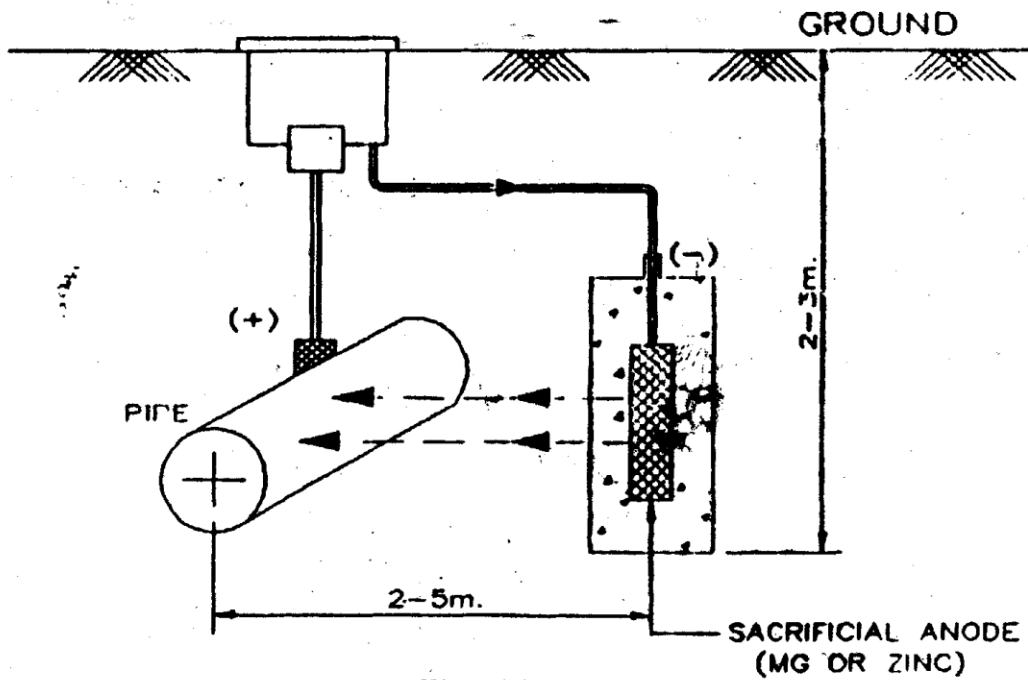
- 2.1.1 The pipes and fittings as supplied are cleaned to remove surface contamination. First a high pressure water wash is to be given on both the internal and external surfaces. If the pipes as supplied contain excessive oil, grease or lacquer the same has to be first removed by cleaning the surface with an approved chemical solvent to prepare the materials for pickling.

2.2 Pickling

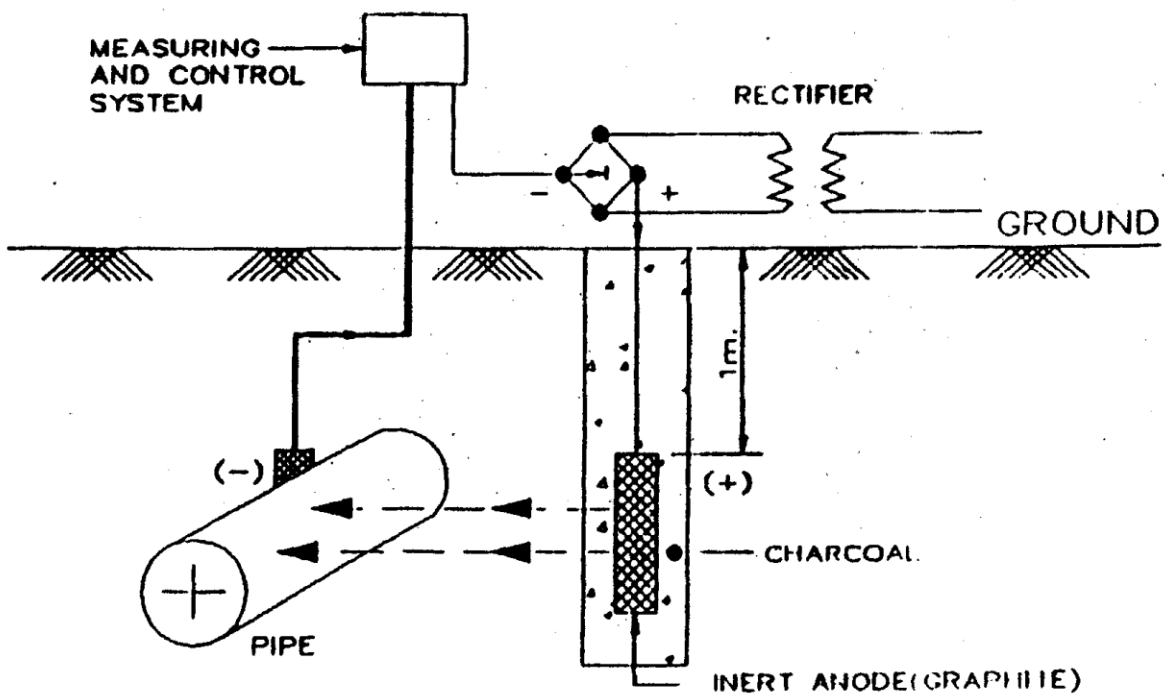
- 2.2.1 Immerse each length of pipe in a solution of 18 to 20%. Hydraulic acid by volume having a inhibitor of stannine low foam or equivalent for a duration of at least 10 minutes and not more than 20 minutes.
- 2.2.2 Drain and wash in hot clean water.

2.3 Phosphating

- 2.3.1 Immerse the pickled pipes in the phosphating bath having solution with the following parameters:
- i) Concentration of Pyroband 847 x 30-35 points.
 - ii) Bath temperature (phosphate) 60-75 Dec C.
The duration of the immersion shall be between 15 to 20 minutes.
- 2.3.2 Rinse the pipes in hot water bath maintained at 80 Deg C.
- 2.3.3 The phosphating procedure and coating weight per sq. metre shall generally conform to IS: 3618.
- 2.3.4 It is recommended that a production test coupon is used with each batch during the phosphating process to ensure coating weight as per IS: 3628.

**FIG.-1A****CATHODIC PROTECTION -- GALVANIC ANODE TYPE**

(Ref. Appendix 'A' CL A-2)

**FIG.-1B****CATHODIC PROTECTION -- RECTIFIER TYPE**

(Ref. Appendix 'A' CL A-3)