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IS 10221 (2008): Coating and wrapping of underground mild steel pipelines - Code of practice [MTD 7: Light Metals and their Alloys]



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भारतीय मानक
भूमिगत मृदु इस्पात पाईपों के लिये विलेपन
और संवेष्टन — रीति संहिता
(पहला पुनरीक्षण)

Indian Standard

COATING AND WRAPPING OF UNDERGROUND
MILD STEEL PIPELINES — CODE OF PRACTICE

(First Revision)

ICS 25.220.01, 77.140.75

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BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Corrosion Protection and Finishes Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1982. While reviewing this standard in the light of experience gained during these years the Committee felt to revise this standard

This Code was formulated to serve as a guide for corrosion protection of underground mild steel pipelines by using coating and wrapping materials, with the reasoning and proven performance that if the metal could be isolated from contact with the surrounding earth, corrosion could be controlled.

Underground pipelines may be protected against corrosion by various methods like a concrete sheathing, coating and wrapping and cathodic protection. This Code provides for protective exterior coating with a coating of primer followed by the application of enamel, one multiple wrap of fibre glass tissue and a layer/layers of impregnated fibre glass tissue and/or a coat of water resistant white wash.

In this revision, following modifications have been made:

- a) Requirements of various coating, wrapping materials and coal tar based anti-corrosive tape have been withdrawn since they are covered in IS 9912 : 1981 'Specification for coal tar based coating materials and suitable primers for protecting iron or steel pipelines'; IS 14695 : 1999 'Glass fibre base coal tar pitch outer wrap — Specification'; and IS 15337 : 2003 'Coal tar based anti-corrosion tape for protection of underground mild steel pipelines — Specification' respectively.
- b) Asphalt and asbestos materials have been withdrawn as they are not being used at present.
- c) A new clause on measurement has been incorporated.

In the formulation of this standard, assistance has been derived from the following publications:

AWWA C203-2002 'Coal tar protective coatings and linings for steel water pipelines — Enamel & tape — Hot applied', issued by the American Water Works Association of America.

BS 4164 : 2002 'Specification for Coal tar based hot applied coating materials for protecting iron & steel including a suitable primer'; issued by the British Standards Institution of UK.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

COATING AND WRAPPING OF UNDERGROUND MILD STEEL PIPELINES — CODE OF PRACTICE

(First Revision)

1 SCOPE

This standard covers the application requirements for a hot melt protective coating system for steel pipelines to be installed under normal or average construction conditions in soil.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of the publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
8062 (Part 2) : 2006	Code of practice for cathodic protection of steel structure: Part 2 Buried pipeline/structures for transportation of natural gas, oil and liquids
9912 : 1981	Specification for coal tar based coating materials and suitable primers for protecting iron or steel pipelines
14164 : 1994	Industrial application and finishing of thermal insulation materials at temperature above -80°C up to 700°C — Code of practice
14695 : 1999	Glass fibre base coal tar pitch outer wrap — Specification

3 GENERAL REQUIREMENTS

3.1 Minimum requirements of a suitable coating for underground steel pipelines should comprise of a relatively high melting point thermoplastic coal tar coating of known permanent low water absorption, resistant to product spillage and high electrical resistivity.

3.2 Approval of Materials

3.2.1 Prior to use, samples of all materials proposed to be used under these specifications shall be submitted to the inspector for test and analysis and no material shall be used until it has been approved by the inspector.

4 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

4.1 Blasting — Blasting with suitable abrasives.

4.2 Centrifugal Lining — The process of applying coal tar enamel to the inside surface of pipe, whereby molten coal tar enamel introduced into the pipe is spread on the surface of the pipe and held thereon by the centrifugal force developed by rotating the pipe about its longitudinal axis until the enamel has cooled and solidified and become bonded to the pipe.

4.3 Contractor — The person, firm or corporation executing the contract or agreement with the purchaser to furnish any material or to perform any work under this standard.

4.4 Inspector — The inspector or engineer employed by the purchaser and acting as his representative, their respective assistants properly authorized and limited to the particular duties assigned to them, or the purchaser himself acting as his own inspector.

4.5 Purchaser — The person, firm, corporation or government sub-division entering into a contract or agreement for the purchase of any material or of any work to be performed or both under this standard.

5 MATERIAL

The materials, commonly used for coating and wrapping of underground pipelines are as follows:

- a) Coating primer,
- b) Coating enamel, and
- c) Wrapping materials.

5.1 Primer

There are two types of primers, namely, coal tar primer, Type A and synthetic primer, Type B. The choice of primer to be used in connection with hot applied coating is highly important and the first requirement is compatibility with the type of enamel being used.

5.1.1 Coal Tar Primer, Type A

Coal Tar Primer shall consist only of processed coal tar pitch and refined coal tar oils, suitably blended to produce a liquid that may be applied cold by brushing

or spraying and that shall produce an effective bond between the metal and a subsequent coating of coal tar enamel. The primer shall contain no benzol or other toxic or highly volatile solvent or other substances. This prohibition shall extend to added pigments and inert fillers. The primer shall show no tendency to settle out in the container and shall have the characteristics as specified in IS 9912.

5.1.2 Synthetic Primer, Type B

Fast drying synthetic primer shall consist of chlorinated rubber, synthetic plasticizer and solvents. They shall be suitably compounded to produce a liquid coating that may be readily applied cold by brushing or spraying and that shall produce a suitable and effective bond between the metal and subsequent coating of coal tar enamel. The primer used with coal tar enamel shall have the characteristics as given in IS 9912.

5.2 Enamel

5.2.1 Coal Tar Enamel

The coal tar enamel should also be immune to attack of calcium, magnesium and other salts normally encountered in the route of the pipeline. A gist of the saline content and other chemical salts present in every 10 km of the soil along the route should be provided to the coal tar enamel supplier to ensure guarantee of immunity of the enamel to these salts.

The enamel should be impermeable to water and immune to attack by sea water, thereby making it useful to protect submarine pipelines. The enamel should not be attacked by any micro-organisms found in the ground.

The enamel shall consist of specially processed tar pitch, blended with inert and non-hygroscopic mineral fillers, properly graded, clean, dust free and without asphalt, to be applied at the recommended temperature.

5.2.1.1 The quality of coal tar enamel is liable to be affected by the quality of coal carbonized and the temperature of carbonization as well as by the subsequent methods of pitch processing and particulars of formulation. To rectify this defect, coal tar should be produced from coal that has a minimum heating value of 320 kJ/g on a moisture and mineral-matter-free basis and that has been carbonized in a slot-type coke oven at a temperature of not less than 900°C. The enamel shall have the characteristics as specified in IS 9912.

5.3 Wrapping Materials

5.3.1 Inner Wrap

Inner wrap shall be of glass fibre tissue. The glass fibre tissue is a thin, flexible, uniform mat, composed of glass fibres in an open porous structure, may be bonded with a suitable inert material, compatible with coal tar enamel. The glass fibre tissue shall have the characteristics as specified in IS 14695.

5.3.2 Outer Wrap

5.3.2.1 Glass fibre outer wrapping

The outer wrap shall conform to glass fibre tissue as specified in IS 14695. It shall consist of glass fibre, tissue, as specified in IS 14695, saturated with coal tar enamel, as specified in IS 9912. The resultant outer wrap shall be uniform, flexible and of uniform porosity to facilitate the release of hot gases and achieve better finishing. The outer surface of outer wrap shall be lightly dusted with talc, fine sand, or other approved mineral powder sufficient to prevent sticking in the rolls under conditions likely to be met at site. The inside surface shall receive minimum dusting, as excessive amount may impair the bond between outer wrap and enamel. The finished outer wrap shall have the characteristics as specified in IS 14695.

5.3.2.2 White wash

All white wash to be used shall be formulated from water, boiled linseed oil, processed quick lime and salt.

5.3.2.3 Water emulsion paint

All water emulsion latex paints to be used must be stabilized, pigmented dispersion of water — insoluble film-forming, high molecular-weight synthetic polymeric materials in water. After application and drying, the paint must be able to produce a film that adheres to the coal tar enamel is white in colour, water resistant and able to withstand exterior exposure without degradation for a minimum of 90 days.

6 APPLICATIONS TO EXTERIOR SURFACES

6.1 Types of Application

The external coating job shall be done as per the following steps:

a) Single Coat/Double Wrap

- i) Cleaning of external pipe surface;
- ii) Priming with suitable Type A or Type B primer;
- iii) First coat of coal tar enamel with 2 mm, *Min* thickness;
- iv) First layer of inner wrapping with glass fibre tissue of 0.3 mm, *Min* thickness;
- v) Outer wrap coal tar impregnated glass fibre with 0.70 mm, *Min* thickness; and
- vi) White colour latex emulsion paint or white wash.

The total thickness of coal tar enamel and wrapping shall be of 3.00 mm, *Min*.

b) Double Coat/Double Wrap

- i) Cleaning of external pipe surface;
- ii) Priming with suitable Type A or Type B primer;

- iii) First coat of coal tar enamel with 2 mm, *Min* thickness;
- iv) First layer of inner wrapping with glass fibre tissue of 0.3 mm, *Min* thickness;
- v) Final coat of (2nd coat) of coal tar enamel with 1 mm, *Min* thickness;
- vi) Outer wrap coal tar impregnated glass fibre with 0.70 mm, *Min* thickness; and
- vii) White colour latex emulsion paint or white wash.

The total thickness of coal tar enamel and wrapping shall be of 4.0 mm, *Min*.

6.2 Method of Application

There are three methods of application of wrapping materials, namely:

- a) Mill/yard wrapping,
- b) Site wrapping, and
- c) Line wrapping.

6.2.1 The inner wrap shall be mechanically applied by continuous end feed machine or by a lathe-type machine or by other approved application equipment. Application shall be simultaneous with the first coat of coal tar enamel. The roll of inner wrap shall be under tension sufficient to embed the fibreglass mat in the enamel before the latter sets or cools. The wrapper shall not be pulled through the hot enamel to the metal surface.

6.3 Choice of Method of Application

The choice between the three methods of application of pipe wrapping shall depend on a detailed assessment of site conditions and the technical aspects, including corrosion engineering and economic factors involved in the construction work.

6.3.1 The conditions, which decide the selection of wrapping method, are as follows:

- a) *Weather conditions* — Under variable weather conditions the mill/yard wrapping shall be resorted to for carrying out uninterrupted coating/wrapping of pipes with controlled and trained labour.
- b) *Site conditions* — Undulated ground does not permit the line wrapping. Special surfacing of sides of trenches shall be needed for easy movement of machines and medium.
- c) *Size of pipeline* — Small diameter pipe permits the use of line wrapping. Yard wrapping may be adopted for medium and large diameter pipes.
- d) *Location of site* — Mill wrapping suitable and economical when the pipes are transported over small distances. When the coating and wrapping is likely to be damaged in transit due to transportation over long distances, yard wrapping shall be preferred.

6.4 General Procedure of Application

6.4.1 Material and Workmanship

All materials furnished by the supplier shall be of specified quality as per the requirements laid down in this standard. All work shall be done in a thorough workmanlike manner. The entire operation of priming the pipe, heating and applying the coating shall be performed under the supervision of experienced men skilled in the application of protective coating.

6.4.2 Equipment

The equipment of cleaning, priming, coating and wrapping shall be in such condition as to permit the applicator to follow the procedure and obtain results prescribed in this standard.

6.4.3 Cleaning

6.4.3.1 Pipe surfaces shall be thoroughly cleaned and dried before the primer is applied, and shall be free of dirt, grease, oil rust, scale or other foreign matter. The pipe shall be cleaned by any one of the following, mutually agreed, methods:

- a) Blasting with suitable abrasives, and
- b) Manual/Mechanical cleaning.

6.4.3.2 Before grit or shot blasting, all oil and grease, if present on the metal surface, should be removed by using suitable solvent and clean rags. The use of dirty, oily rags should not be permitted. All other foreign matter, which cannot be removed by blast cleaning, should be removed by suitable means. The surfaces then should be thoroughly cleaned by blast cleaning and the operation should remove mill scale, rust or any other superficial impurities from the surfaces exposing base metal presenting a greyish metal appearance except that slight shadows, streaks or discoloration caused by rust stains or mill scale oxides need not be removed. Blasted surfaces which rust before the priming coat has been applied should be cleaned of this superficial rust by wire brushing or emery papering at the discretion of the Engineer. If the rust formation is heavy, that is, if the pipes have been exposed overnight without priming, the same can be reblasted once again at the discretion of the Engineer.

6.4.3.3 Adequate moisture separators should be used so as to remove effectively oil and moisture from the air supply of the blasting unit.

6.4.3.4 After cleaning the pipes shall be protected from and maintained free from all oil, grease and dust that may fall on the pipes from outside sources till the pipe has received its final coat of enamel.

6.4.3.5 Any pipe, that shows deep pitting after blasting has been done, should be set aside pending examination by the Engineer for approval for reconditioning or rejection.

6.4.4 Priming

6.4.4.1 One uniform coat of primer, compatible with the type of enamel to be used and free from floods or runs, shall be applied immediately after pipe has been cleaned and dried. The primer shall be applied in such a way that the surface profile shall be covered on the blast cleaned metal surface. The dry film thickness of primer shall be at least between 25 and 50 μ .

6.4.4.2 Primer coverage shall be such as to ensure maximum bond between the steel surface and the enamel coating.

6.4.4.3 Atmospheric conditions, type and coverage of primer determine the drying time. If the primer coat is found to be unsatisfactory due to rain and excessive humidity, the pipe shall be reprimed.

6.4.5 Coating

6.4.5.1 The primed pipe surface shall be free from moisture or any foreign matter immediately prior to the application of the hot coating.

6.4.5.2 All enamel coating shall be broken into lumps suitable for the heating equipment employed and shall be free of any foreign material.

6.4.5.3 The loaded heating kettle shall be brought to application temperature in a manner to prevent damage to the coating material.

6.4.5.4 The kettles shall be equipped with mechanically operated agitators so as to supply uniform hot material to the coating and/or wrapping machines. Kettles shall not be used as a continuous coating supply source by adding unmelted coating material after application temperature has been reached. Kettles shall be completely emptied of one charge and cleaned when necessary before recharging.

6.4.5.5 Application temperature of enamel is normally 230°-250°C. In low ambient temperatures one would expect to operate at 250°C while in warm weather it should be 230°C. Any enamel which has been held in the melting kettle at application temperature for four hours or more, without being circulated, should be rejected. The maximum temperature in the melting kettle should never exceed 270°C at any time. Enamel which has been heated above this temperature should be rejected.

6.4.5.6 While the enamel may be kept in a kettle up to a maximum temperature of 257°C the manufacturer should guarantee proper flow for application by standard machines even at the lowest enamel application temperature of 230°C at an ambient temperature of 7°C.

6.4.5.7 When the enamel has reached application temperature it should be applied to the primed pipe

through a standard flood box. Simultaneously with the flood, the glass fibre inner wrap and outer wrap should be applied under tension, the wrapping having a minimum overlap of 12 mm. There should be approximately 0.8 mm of enamel between the pipe surface and the inner wrap.

6.4.5.8 Enamel should not be applied to the primed pipe when the pipe metal temperature is below 7°C.

6.4.5.8.1 Glass fibre tissue for inner wrapping. The glass fibre tissue shall be as per 5.3.1 with a minimum thickness of 0.3 mm.

6.4.5.8.2 Final coat of coal tar enamel shall be applied with 2 mm thickness as per the procedure given in 6.4.5.

6.4.5.8.3 Outer wrap coal tar impregnated glass fibre. The outer wrapping shall conform to as per 5.3.2. The thickness shall be 0.75 mm, *Min*.

6.4.6 Handling

6.4.6.1 The coated pipe shall be handled at all times with equipment, such as wide belt slings and wide padded skids, designed to prevent damage to the coating. Bare cables, chains, hooks, etc, shall not be permitted to come in contact with the coating.

6.4.6.2 When transported by rail, all coated pipe shall be carefully loaded on properly padded saddles. Pipes shall be separated so that they do not wear against each other and securely fastened to prevent movement in transit.

6.4.6.3 In truck shipment; the coated pipe shall be supported in wide cradle of suitably padded timbers, hollowed out on the supporting surface to fit the curvature of pipe and securely fastened to prevent movement in transit.

6.4.6.4 Along the trench side, coated pipe should be suitably supported off the ground to avoid damage to the coating.

6.4.7 Lowering and Backfilling

6.4.7.1 While lowering, the coated pipe shall neither be hoisted from the trench side to the trench by means of wide belt slings. Chains, cables, tongs, or other equipment likely to cause damage to the coating shall not be permitted nor moved by dragging or skidding of the pipe. The underside of the pipe should be inspected while lowering and any damage shall be repaired before the coated pipe is lowered into the trench.

6.4.7.2 Where the trench traverse rocky ground or hard objects that could penetrate the protective coating, a layer of soft earth or sand, not less than 75 mm thick, shall be placed at the bottom of the trench prior to lowering. After lowering, backfilling should be done in such a manner that the protective coating is not damaged in any way.

7 INTERNAL COATING

7.1 The pipe surface should be cleaned and primed in accordance with the procedure given in 6.4.3 and 6.4.4.

7.2 The primed steel surface to be enamelled shall be dry and clean at the time the enamel is applied. The enamel shall be coal tar conforming to the requirement of IS 9912.

7.3 The application of enamel, to the inside surface of all pipes shall be by centrifugal lining by either trough method or retracting weir or feeline method. The temperature of the enamel on application shall be as recommended in 6.4.5.5. Care shall be taken to ensure that it is at no time heated above the maximum temperature recommended.

7.4 During application of enamel, the pipes shall be revolved at a speed best suited to produce a smooth glossy lining of uniform thickness. Finished enamel lining shall be free from wrinkles, sags, blisters or blow holes.

7.5 The thickness of the lining shall be 2.4 mm and the variation in thickness shall not exceed ± 0.8 mm with glass fibre tissue.

7.6 All pieces of line pipe in which excessive rough areas appear or other irregularities exist shall be stripped off the entire lining and recoated.

8 DESIGN CONSIDERATIONS

8.1 The following factors should be considered before taking up the work of pipe coating/wrapping:

- Nature of soil* — The pipe coating system shall depend upon the type of soil (see 8.2),
- Past history of corrosion condition of the same pipeline or other pipelines running in that area,
- Environment,
- Pipe dimensions and material,
- Transport facilities, and
- Feasibility of providing cathodic protection.

8.2 Thickness of coating shall be decided upon considering the degree of corrosivity of the soil. The coating system based upon the soil resistivity may be selected on the following basis:

Soil Resistivity $\Omega\text{-cm}$	Corrosivity	Coating System
Below 1 000	Extremely corrosive	3 coats and 3 wraps (7.0 mm, <i>Min</i>)
From 1 000 - 5 000	Corrosive	2 coats and 2 wraps (4.0 mm, <i>Min</i>)
Above 5 000	Non-corrosive	1 coat and 1 wrap (3.0 mm, <i>Min</i>)

9 ELECTRICAL INSPECTION

9.1 All coated and wrapped pipes shall be tested with an approved high voltage holiday detector equipped with a positive signalling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

9.2 The applied output voltage of the holiday detector shall have a spark discharge at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness.

9.3 When selecting test voltages, consideration should be given to the tolerance of coating thickness and the voltage should be selected on the basis of maximum coating thickness likely to be encountered.

The testing voltage shall be calculated by using following formula:

$$\text{Testing voltage } V = 7\,900 \sqrt{T} \pm 10 \text{ percent}$$

where T is average coating thickness, in mm.

9.4 The test shall be carried out in co-ordination with the coating/wrapping manufacturers.

10 MEASUREMENT

10.1 All measurements for piping shall be taken over the finished surface in meters, corrected to nearest centimeter along the center line of piping, through all fittings, coated and wrapped, or otherwise, such as valves, flanges, elbows, bends, tees and reducers (see also IS 14164).

10.2 Coating and wrapping of valves, flanges or other fittings shall be measured through such valves, flanges or other fittings as per 10.1 and in addition extra measurements shall be allowed as follows:

- For each coated and wrapped valve and venturi including flanges and body 1.5 linear metres of piping of connected line size up to 300 mm line size and 2.00 linear metres for larger sizes.
- For each pair of coated and wrapped flanges including orifice plate and flanges, 0.80 linear meters of piping of connected lines, etc.
- For all coated and wrapped bends and elbows twice the actual length of such fittings, of concerned connected line sizes, as measured along their centre lines.
- For all coated and wrapped reducers, actual length of longer size (along the centre line of piping).
- For all coated and wrapped tees, the formula $2(D_1 + D_2)$ shall apply where D_1 and D_2 are

coated and wrapped diameters of the two pipelines forming the tees.

- f) Any other special fittings not covered under above shall be specified and measured separately on number basis.

11 CATHODIC PROTECTION

Since not even a reinforced coating can be guaranteed to provide satisfactory protection along its whole length, a cathodic protection system conforming to IS 8062 (Part 2) shall be used in conjunction with the

appropriate coating and wrapping system, where the soil-resistivity is less than 5 000 Ω -cm. For soil resistivity above 5 000 Ω -cm, cathodic protection may be used in consultation with corrosion engineers.

12 MATERIAL PACKAGING

All coating, primers and wrappers purchased or used under the specifications laid down in this standard shall be packed in suitable and approved containers. The containers shall be legibly marked with the name of the manufacturer, type of material, batch or lot number and date of manufacture.

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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