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Indian Standard

PAINTING OF STRUCTURES IN AGGRESSIVE CHEMICAL ENVIRONMENT — GUIDELINES

ICS 87.040

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Painting, Varnishing and Allied Finishes Sectional Committee had been approved by the Civil Engineering Division Council.

This standard is based on the survey conducted on the current practices being followed and is designed to serve as a guide for the selection of protective coating and application methods. Several type of coatings and application methods may be recommended for various cases, but each type of environment should be considered as a separate case and the final choice should depend upon the economics involved.

The main function of painting in chemical plants is to control corrosion in the capital investments of equipment, structures, vessels, piping and buildings.

Atmospheric corrosion is that environment which is generated by the presence of the elements of nature, the air pollution of the general industrial area and the traces of chemicals within the plant itself. Chemical spillages present unusual problems and are not considered as a part of a corrosive atmosphere. An industrial maintenance painting programme is the administration, specification, application, inspection and evaluation of protective coating systems. These guidlines, based upon current industrial practices and experiencs, present an outline of an industrial maintenenace painting programme. The outline includes all phases of a programme deemed necessary, though emphasis on each phase and manner of accomplishment of individal portions will vary with the following:

a) Size of industrial plants,

b) Type of industrial plants,

c) Corrosive atmosphere,

d) Geographical location,

e) Economy, and

f) Desires of management.

Because of instances of inadequate hand tool cleaning, owner in certain areas have resorted to specifying blast cleaning on all new structures regardless of its feasibility, its environment and type of paint. To avoid unnecessary failures or unnecessarily stringent specification in mild environments, it is important to follow the good practices outlined in this standard.

The composition of the Committee responsible for the preparation of this standard is given at Annex A.

Indian Standard

PAINTING OF STRUCTURES IN AGGRESSIVE CHEMICAL ENVIRONMENT — GUIDELINES

1 SCOPE

1.1 This standard povides guidelines in the selection of protective coating for painting of metallic, concrete and other types of surface of structures subjected to different chemical environment. It also briefly describes various types of coatings and the processes of surface preparation for painting.

2 TYPES OF ENVIRONMENT

2.1 A normal rural atmosphere is comparatively mild because the only deteriorating influence is the weather. Strong sunshine may lead to rapid degradation of some materials. The rural environment may be dry or wet and damp.

2.2 An industrial atmosphere generally is thought of as that found in urban regions near industrial plants or industrialized areas. The characteristic of an industrial atmosphere is the high concentration of sulfur dioxide. This factor increases corrosion rates and attack on the protective systems.

2.3 Environments near some types of industrial or chemical plants may be classed as chemical because of the presence of strong corrosive agents such as acid fumes, atomized solutions of alkali dust, mist, solvent vapours or any of the host of deteriorating substances.

2.4 The severiety of a chemical environment may vary from mild exposures, remote from the source of chemical contamination to extremely corrosive situations such as produced by immersion in strong chemicals.

2.5 The environments described in **2.3** and **2.4** are considered as chemically aggresive which are referred hereafter.

3 SELECTION OF COATINGS

3.0 The selection of materials involves the evaluation of the generic type of coatings, the brand or manufacturer and the application characteristics. Also the evaluation of expendable materials such as sandblasting abrasives are also to be considered.

3.1 An evaluation programme may vary widely depending upon the size of plant, funds available and the end result desired. The evaluation method may consist of one a combination of the following:

a) *Literature description* — Manufacturer's literature and recommendation, oganizational publications, information from neighbouring plants, etc.

b) *Laboratory test* — Determination of physical characteristics with laboratory apparatus.

c) *Field panels* — Exposure of small panels in the corrosive atmosphere of the plant or area to evaluate the performance.

d) *Larger area test* — Application of various materials on steel over an area of more than 2 square metre in the corrosive atomosphere. This allows simultaneous evaluation of application characteristics as well as performance data.

e) *Limited field tests* — Field application of materials to the steel to be protected over an area over 2 square metre.

f) *Actual performances* — Information from records and by observation of actual coatings, applications and performance over a long period of time.

3.2 The most important phase of any evaluation programme is the proper and accurate correlation of derived data to actual performance.

3.3 The types of material used for protection will vary with the service exposure and the life expectancy required, or other economic justifications.

3.4 Final evaluation of the performance of the desired systems as mentioned under **3.1** (d) be arrived by working the life of each paint system in sqm/mil (25 micron/year).

4 TYPES OF COATINGS AND THEIR CHARACTERISTICS

4.0 General

The descriptions of various types of coatings most commonly used in the field are given in order to familiarise the field man with their nomenclature and give him an idea about their performance characteristics. This at standard cover only those types of coatings which have been used successfully over a period of time. It does not cover some of the newer coatings which are still considered to be in the experimental stage as far as their in the field is concerned.

4.0.1 Organic coatings are composed of pigments and vehicles as binders for anticorrosive primers. These coatings change from the liquid to a solid film by several mechanisms such as:

a) Evaporation of solvent,
b) Oxidation, and
c) Polymerization, either by internal reaction or reaction with an added catalyst or activator.

4.1 Oil Base or Oleoresinous

These consist of an oil (usually linseed, tung, soy bean, or castor), which is capable of being converted to a solid by reaction with oxygen of the air. Metallic driers are added to accelerate this reaction. The film formed has very little resistance to chemicals and has higher permeability to water vapour and other gases than other types of films. This permeability makes it a good binder for use in house paints, which if not somewhat permeable would blister and peel. An outstanding property of the drying oils is their ability to wet and adhere to steel, which accounts for their widespread use in primers. This property is particularly important in instances where it is not possible to remove all rust before painting.

4.2 Alkyd

These synthetic resins are made by cooking certain acids and alcohols along with varying quantities of drying oils. These drying oils impart flexibility to the resin ; more the oil in the resin, the more flexible the coating will be. However it also follows that the more the oil length or content, the more coating will resemble the oleoresinous type. Alkyds are used in environments mentioned in **2.1** and very mild acidic environments. The outstanding properties of alkyds are their gloss retention and stability to sunlight.

4.3 Phenolic

Phenolics are formed by reacting phenol with formaldehyde. Air-drying phenolics have better chemical resistance and more water resistant than alkyds, but they are less resistant to the effect of ultraviolet light, tending to yellow with age and to chalk more rapidly. The phenolic based coatings are suitable for areas which are subjected to sunlight and mild chemical environment.

4.4 Chlorinated Rubber

Chlorinated rubber resins are made by reacting chlorine with natural rubber. Coatings made from chlorinated rubber have very good resistance to alkalis, weak acids, and salt water, but should be modified and stabilized to make them resistant to sunlight. Their major use is in the coating of offshore platforms, fertilizer plants and barges. It is essential that only chemically inert plasticizers are incorporated in the formulation.

4.5 Catalyzed Epoxy Coatings

A small amount of amine or polyamide catalyst or activator is added to the epoxy coating just prior to application. This causes a cross-linking of the molecules and curing of the coatings. While these coatings set to touch in a few hours, several days are required for them to cure completely and develop their ultimate chemical resistance. Catalyzed epoxy coatings have good acid resistance and very good alkali resistance, however, their outstanding property is their excellent resistance to solvents. They are widely used for coating the interior of products, storage tanks. In sunlight, they tend to develop rapidly (within months) a surface chalk.

The catalyzed coating shall be applied within a few hours after the addition of catalyst, otherwise it will set up in the can. Brushes and spray equipment used to apply these coatings shall be cleaned thoroughly after use. After the epoxy has cured there is no known way to remove it from the equipment.

The coating manufacturer should always be consulted before using an epoxy system for an equipment which is to be immersed in either fresh or salt water.

4.6 Coal Tar Epoxy

These catalyzed materials combine the excellent adhesion and water resistance of coal tar with the thermal stability of catalyzed epoxy coatings. They have high solids content by volume (65-85 percent) and good stayput, allowing thick coatings to be applied in a minimum number of coats. Two coats of 8/10 mils each are recommended for most uses. The main uses of coal tar-epoxy coatings are for offshore equipment, mud tanks, equipment to be exposed to immersion in salt water (particularly boat bottoms), the exterior of pipe which is to be used underground and the interior of crude tanks. The high degree of impermeability of gases, particularly hydrogen sulphide, makes them well adapted to protecting the vapour zones of sour crude tanks.

4.7 Bituminous

These coatings are made from coal tar or asphalt. They may be hot-applied cut-back (dissolved in a solvent), or emulsions (particles dispersed in a non-solvent). Their widest use lies in protection of buried pipe. The coal tar coating have much better resistance to moisture penetration, to attack by soil organisms, and to hydrocarbons than do most of the asphalts.

4.8 Vinyl

Vinyl coatings have very good resistance to acids, alkalites, oils and salt water. Their adherence is poor unless special vinyl primers are used. For a vinyl system a bright metal sand blast is necessary for perfect performance. Vinyl coatings have the lowest solid content(and highest chemical resistance) of any of the commonly used coatings, therefore multiple coats are necessary to built up adequate film thickness.

4.9 Silicone

Silicone resins, because of their thermal stability are used to make heat-resistant paints. These resins are quite expensive, therefore silicone coatings should be used only if other types of coatings are unsatifactory. Aluminium-pigmented silicone perform well up to about 427°C. They are widely used on mufflers, heater stacks, and hot surfaces of that type. A white-metal sand blast is necessary for the silicones to perform properly.

4.10 Polyurethane

Polyurethane coatings are based on the reaction of a group of chemicals, the disocyanates, with resins or a chemicals containing alcohol or amine substituents in their structures. The diisocyantes have a high order of toxicity and therefore chemically modified to permit their use in protective coatings.

There are total five types of polyurethane coatings, namely:

Type 1 Single component urethane—Modified oil based system

Type 2 Single component moisture—Cured urethane system

Type 3 Single component—Block isocyanate system

Type 4 Two component catalyst—Cured polyurethane system

Type 5 Two component polyol type polyurethane system

However, Type 5 is the most practical and widely systems for structural painting. There are two general types of two component urethanes; aliphatic and aromatic. The aliphatic type has excellent resistance to weathering and most commonly used where colour and gloss retention are important. The aromatic type polyurethanes are sometimes used as tank linings. When properly formulated, applied and cured, two component polyurethane coatings have outstanding hardness, abrasion resistance with chemical properties similar to epoxies.

4.11 Organic Zinc Primers

Organic zinc primers usually contains a high loading of zinc dust with organic film formers such as epoxy, phenolics or chlorinated rubber. This type of primers have no critical application requirements and are commonly applied to blast-cleaned steel at 50-75 microns dry film thickness without problems of cracking or flaking.

4.12 Inorganic Zinc Primers

Inorganic zinc primers are usually referred to as inorganic zinc silicates. All silicate coatings are essentially based on a combination of zinc and a complex silicate solution. Such coatings can provide outstanding resistance to corrosion in a single coat. These coatings are extremely hard and abrasion resistant and the adhesion to metal is of a chemical nature which is one of the strongest bonds that can be obtained between two materials. This types of primers have excellent weathering properties and solvent resistance and extensively used for preventing corrosion of tank exteriors, structural steel, piping off shore platforms, bridges, marine, etc.

5 GENERAL INSTRUCTIONS

5.1 Protective coatings are measures which can be used in the control of corrosion of producing equipment. If used intelligently and properly, they should do a satisfactory job of protecting a metal from a corrosive environment. No coatings last forever, and there are no cure-alls. No coating will work just as well over rust as it will over properly prepared surface.

The following points should be taken care of:

a) The surface should be prepared properly;

b) The correct type of coating for the intended service should be chosen, and applied according to the manufacturer's recommendations;

c) If the job is contracted out:

   1) Adequate and firm specifications, particularly as to film thickness should be mentioned.

   2) Competent inspection of the job should be arranged.

d) Schedule shall be so arranged as to prevent coating damage. When welding above a painted surface, the surface should be covered with sand, dirt, sacks or anything that will prevent the weld spatter from dropping down and burning holes through the coating;

e) The paint should not be overthin. Requisite quantity of thinner shall be added as per the manufacturers recommendations to get proper film thickness and flow of paint;

f) As paints have limited shelf life, procurement instalments should be planned as per requirements; and

g) If difficulties are encountered with application, or if a coating does not perform as expected, the paint manufacturer may be consulted. Manufacturers should send a competent technical field representative to the job to help out difficulties.

6 SURFACE PREPARATION

6.0 For surface preparation for painting, one should visualize what constitutes the most ideal surface condition for a good paint anchor. For general work, this anchor would constitute a metal surface free of soil and chemical products. It would be a relatively smooth surface free of scale or oxidation products but with a mechanical surface anchor of a height known to be suitable for the coating system employed. Mill scale itself is a satisfactory surface to paint. If kept intact, it will result in long paint life in mild or only moderately severe environments. If intact mill scale is painted, long paint life may be expected, in fact almost as long as for descaled steel.

6.1 While it appears desirable to produce the best surface condition before a coating is applied, the cost of the finished job should be born in mind. Some service conditions do not require the removal of all of the mill scale, rust, and contaminants. As long as the prepared surface is compatible with the coating applied, it will serve for a period of time dertemined by the environment.

6.2 If the deterioration of a paint film is sufficiently slow and the underline metal is not seriously affected by the eventual loss of the coating, there is little reason to concentrate on anything but the more economical surface preparation methods.

6.3 Hand tool cleaning is an acceptable method of surface preparation for normal exposures in the atmosphere, interiors, for much of the maintenance painting, including paints of good wetting ability. Hand cleaning will not remove all residue or rust nor will it remove intact, firmly adhered mill scale. For small limited areas such as spot cleaning for maintenance priming hand cleaning will suffice, even for paints requiring very clean surfaces.

6.3.1 Hand tool cleaning shall consist of the following sequence of operations:

a) Oil grease, soluble welding flux residues and salts shall first be removed by solvent cleaning. Other detrimental foreign matter shall be removed by the following operations.

b) Stratified rust (rust-scale) shall be removed by hand hammering, hand chipping, other hand impact tools, or a combination of them.

c) All loose mill scale, and all loose or non-adherent rust shall be removed by hand wire brushing, hand sanding, hand scraping, or by a combination or these methods.

6.3.2 Painting should proceed as soon as possible after the hand cleaning operations. It is not as critical, however, as in the case of blast cleaning or pickling where virgin metal is exposed.

6.4 Blast cleaning is preferable where areas are very large to achieve lowest coats (because of difficulties in the reclamation of abrasives). The following factors influence blast cleaning operations:

a) Type of metal to be cleaned and cleaning rate (speed).

b) Shape of the part.

c) Kind of materials to be removed.

d) The surface finish desired and the thickness of the coating that is anticipated.

e) Loss of abrasive and breakdown rate.

f) Hazards to equipment and working conditions associated with abrasive.

g) Time requirements.

During the initial set up of the plant all the above can be controlled in addition to protecting adjacent property, particularly machinery, electrical equipment, etc.

7 SAFETY AND HANDLING

Aspects of safety and handling during the application of all types of paints mentioned in this specification, especially epoxies, polyurethanes, zinc silicates, etc assume great importance. Diverse chemical ingredients used in the formulations as curing agents, hardners, additives, bases could be agressive, toxic or hazardous in nature. It is therefore mandatory to have full details with complete procedures and precautions for safety and handling of coatings from the suppliers and/or manufacturers.

ANNEX A

COMMITTEE COMPOSITION

PAINTING, VARNISHING AND ALLIED FINISHES SECTIONAL COMMITTEE, CED 34

Chairman	*Representing*
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SHRI R. S. JUNEJA
Joint Director (Civ Engg), BIS

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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 Handbook' and 'Standards Monthly Additions'.

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