भारतीय मानक
Indian Standard

IS 13643 : 2022

जल गठित जमा को हटाने के लिए प्रयुक्त विलायक की संक्षारण के लिए परीक्षण

(पहला पुनरीक्षण)

Test for Corrosivity of Solvent used for Removal of Water Formed Deposits

(First Revision)

ICS 77.060

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November 2022 **Price Group 8**

Water Quality for Industrial Purposes Sectional Committee, CHD 13

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on recommendation of the Water Quality for Industrial Purposes Sectional Committee and approval of the Chemical Division Council.

Internal surfaces of water steam circuit of any heat exchanger are generally fouled with water formed deposits. For effective and efficient heat exchange, it is necessary to remove these water formed deposits. Very occasionally, mechanical means like nylon brushing, jet washing are employed to dislodge the deposits, but more often solvent like acid, alkali, mixtures of acids are invariably utilized to remove the deposits from surface of water steam circuits. However, it is necessary to examine the solvent before its use whether the same could be detrimental to metal surfaces, by way of corrosion.

This standard prescribes the methods of test for corrosivity of solvent before or during use for removal of water formed deposits. Since, in most of the cases, it may not be practicable to isolate the components of equipment either in full or in part, standard coupons of material of construction of such equipment would form the basis for evaluating the corrosive attack on industrial components of equipment.

This standard was published in 1993. In this revision the following modifications have been incorporated:

a) Salt Spray/Fog corrosion testing technique has been incorporated; and

b) Ultrasonic thickness monitoring testing technique has been incorporated.

Different solvents used for removal of water formed deposits shall be as indicated in 0.3 of IS 12479 : 1988 'Methods for analysis of solvent systems used for removal of water formed deposits'. These solvents are categorized as acid, alkali and others.

Acids which are highly corrosive are generally mixed with suitable inhibitors so that they only descale the metal surfaces, but do not attack the bare metal. For the purpose of this standard, inhibitor together with acid will be treated as acid solvent.

In formulation of this standard, considerable assistance has been derived from ASTM G4-01 standard guide for conducting corrosion tests in field application.

The composition of committee responsible for the formulation of this standard is listed in Annex B.

In reporting the test result or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’.

Indian Standard

TEST FOR CORROSIVITY OF SOLVENT USED FOR REMOVAL OF WATER FORMED DEPOSITS

(First Revision)

1 SCOPE

1.1 This standard covers the methods of tests for corrosivity of solvents/mixture of aqueous solutions of different chemicals used for chemical cleaning of equipment.

1.2 It also outlines the procedure for qualitative assessment of degree of corrosion as ready test methods for adoption whenever found necessary. Examination of suitability of solvents, the hazardous/safety aspects associated with the use of the chemicals/solvents are not covered.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, which constitute provisions of this standard. At the time of publications, 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 listed below:

IS No.	*Title*
IS 11671 : 1985	Glossary of terms relating to boiler water

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 11671 shall apply.

4 LIMITATIONS OF TESTS

4.1 Metal specimens/coupons in a specific solvent may not get corroded at the same rate or in the same manner as in equipment. Effects caused by high velocity, abrasiveness, contact time, contact area, amount of chemicals, corrosion product, etc which may be typical in pipe, elbows, pumps, etc may not be easily reproduced in coupon tests. Users will have, therefore, to establish appropriate interpretation of coupon test results on their own.

4.2 Coupon corrosion testing is predominantly used to describe general corrosion rate. However, specific type of corrosion may be evaluated by naked eye or by casual, inspection or by metallographic examinations.

4.3 A well designed coupon programme should give results within appreciable limits which can relate to the existing material of construction and the solvent used for removing deposit from its surfaces.

5 SOLVENTS

During chemical cleaning process of industrial equipment for removing water formed deposits, the following most efficient commercially available solvents or solutions or liquid mixtures could be encountered in different environments as indicated below.

5.1 Acid Solvents [Circulation Washing Velocity (1 m/s)]

5.1.1 Hydrochloric acid (5 percent m/v) mixed with suitable inhibitor at a temperature of 65 °C ± 5 °C under mild steel construction for removal of scale including corrosion products.

5.1.2 Ammoniated citric acid (3 percent m/v) mixed with suitable inhibitor at a temperature of 90 °C under austenitic steel or non-ferrous alloys construction for removing thin layer scale and corrosion products at variable *pH* 3.5 to *p*H 4 for oxides of iron and at high *pH* 9.5 to 10 with ammonia for copper removal using suitable oxidizing chemical such as potassium bromate, sodium nitrite, hydrogen peroxide etc.

5.1.3 Compounds based on chelating agent (1 percent m/v) like EDTA, Trilon B, etc mixed with suitable inhibitor at 90 °C under austenitic steel or non-ferrous alloys construction for removing thin layer scale and low degree of corrosion products.

5.1.4 Sulphonic acid/phosphoric acid/adipic acid/phthalic anhydride (2 percent, m/v to 3 percent, m/v) mixed with suitable inhibitor at 90 °C under austenitic steel or non-ferrous alloys construction for removing thin layer scale and low degree of corrosion products.

5.1.5 Hydrofluoric acid (0.5 percent, m/v to 1 percent, m/v) mixed with suitable inhibitor at 65 °C to 70 °C in all metal construction for removing most of the scales (excluding calcium) and most of the corrosion products.

NOTE — Optimum temperature as mentioned in the above clauses shall be maintained, as Car as possible, throughout the process.

5.2 Alkali Solvents

5.2.1 Solution of trisodium phosphate (0.1 percent m/v) mixed with suitable surface active agent, at 130 °C to 140 °C under mild steel surfaces for removing oil borne matters, organic species and silica deposits.

5.2.2 Solution of caustic soda (0.5 percent, m/v) along with 0.5 percent of sodium nitrate at 60 °C under mild steel surfaces for removing oily matters, thin layer of silica deposits, etc.

5.2.3 Triammonium citrate at a *p*H of 9.5 to *p*H 10 with suitable oxidizing agent to remove copper deposits from mild steel equipment.

NOTE — Optimum temperature as mentioned in the above clauses shall be maintained, as far as possible, throughout the process.

6 INHIBITORS

For each of the above solvent different types of inhibitors are recommended for use which prevents the bare metallic surface to react with the solvent in use. Inhibitors subjected to corrosion test at different working conditions shall be used.

7 TEST COUPONS

7.1 Standard metal coupons of the metals employed in industrial equipment from the surface of which water formed deposits are to be removed, are made to establish corrosion rates by loss in weight in the different solvent environments encountered as mentioned in **5.3**.

7.2 Test coupons having a minimum exposed surface area of 26 cm^2 (typically 50 cm^2) are obtained and prepared as described in **7.3**. However, the specimen should be as large as can be, for convenient handling depending on the available analytical balance and the operating equipment, that is, laboratory corrosion test rig. The test coupons could be either rectangular or circular but sufficient thickness should be allowed to minimize the possibility of perforation of the specimen during the test exposure. While preparing the coupons, sharp edges are to be avoided as far as possible. Again if they are subjected to severe cold work, they need to be stress relieved.

7.3 Preparation of Test Specimen

7.3.1 The test specimen of required size from the material of construction actually in use of the industrial process arc cut either from plate if available or from the equipment sample. A convenient size for a standard corrosion coupon is 38 mm in diameter and 3 mm to 5 mm in thickness with 11 mm hole at the center of the circular coupon. For a rectangular type, the size could be 50 mm x 25 mm x 3 mm. Other sizes, shapes and thickness for the specimen can be made for special purposes or to comply with the design of a special type of corrosion rack. Usually no specific finish is necessary for the specimen, unless special aspects have to be examined or studied (like testing on pre passivated sample, machining/polishing to eliminate cold worked metal, etc). However, uniformity in surface including its shining characteristics are desirable to facilitate comparing data from different tests.

7.3.2 After cutting, it is necessary that each of the specimens are coded with some identification marks by notching the edge of the specimens or by stamping or embossing 3 mm high letters or numbers. When identifications on each of the specimens are marked, it is necessary that the specimens are perfectly cleaned to remove all previously formed oxides or films. The stainless steel alloy specimens are given a surface conditioning using wet 40 grit silicon oxide paper, whereas all other materials are scrubbed under a slurry of 53 micron pumic stone with a bristle brush. The lead coupons are mechanically cleaned and then polished with soft cloth. However, before abrasive cleaning, the specimens should be degreased first by acetone or trichloroethylene vapour.

7.3.3 The treatments are completed by hot and cold distilled water washing, acetone washing and warm air drying followed by swabbing and rinsing in hexane to remove any residual cleaning materials and then followed by 100 °C air drying. Then the coupons are cooled in circulating dry air and stored under desiccator prior to repeat weighing. The coupons are weighed to 0.10 mg accuracy. Triplicate specimens are used for important testing and duplicate for all other normal testing.

NOTE — Average surface roughness values for the exposed materials should generally be 0.2 µm for mild steel, low alloy steel, cast iron, etc and 4.0 µm to 5.0 µm for copper, brass, lead and zinc.

8 TEST COUPONS SUPPORT AND SPACERS

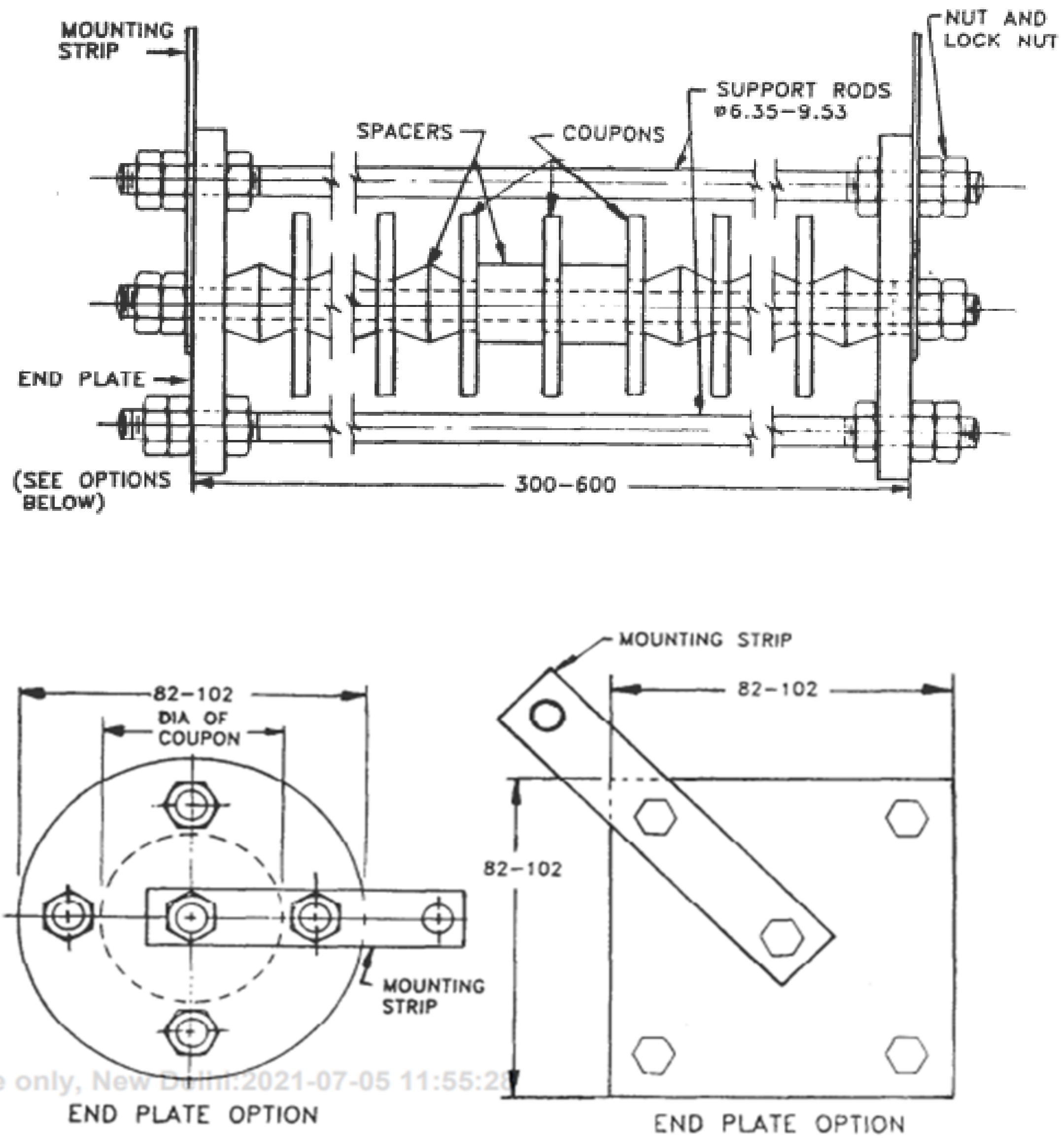
8.1 To hold specimens firmly in space inside the corrosion test rig either singly or jointly and to prevent loss or damage to specimens, suitable support of corrosion resistant material preferably, of polytetrafluoroethylene (PTFE) or metal rod coated with PTFE arc provided. Specimens are generally held by the hold in them, the hold should be made large enough for sliding the specimen over the supporting rod. Clamping devices should not be used to support the specimens.

8.2 For exposing more than one specimen on the same holder and to prevent interference of one specimen with the other during the test period, it is necessary that each of the specimen is suitably separated by insulating material like PTFE. These separators are called ‘spacers’ which also give firm support for the specimen without occupying more area.

8.3 Although there are many ways of supporting and spacing the test coupons, these are generally made as per requirement of tests and accommodating freely in the test exposure apparatus. A typical assembly of support and spacers called ‘spool rack’, which is useful for exposing in open vessels such as reactors and tanks is given in Fig. 1. All materials used in the assembly should be sufficiently corrosion resistant to ensure the assembly remaining intact for the duration of the test. Also a typical insert rack as given in Fig. 2 is desirable for use in pipes or other units which have flanged connections which allow access to the system. A rack suitable for larger diameter pipes, long length of horizontal and vertical pipe called ‘Dutchman’ type rack as shown in Fig. 3 is also employed. A ‘Slip in’ corrosion rack as shown in Fig. 4 is ideally suited for effecting the entry and removal of corrosion coupons from the exposure equipment when required without affecting the active service.

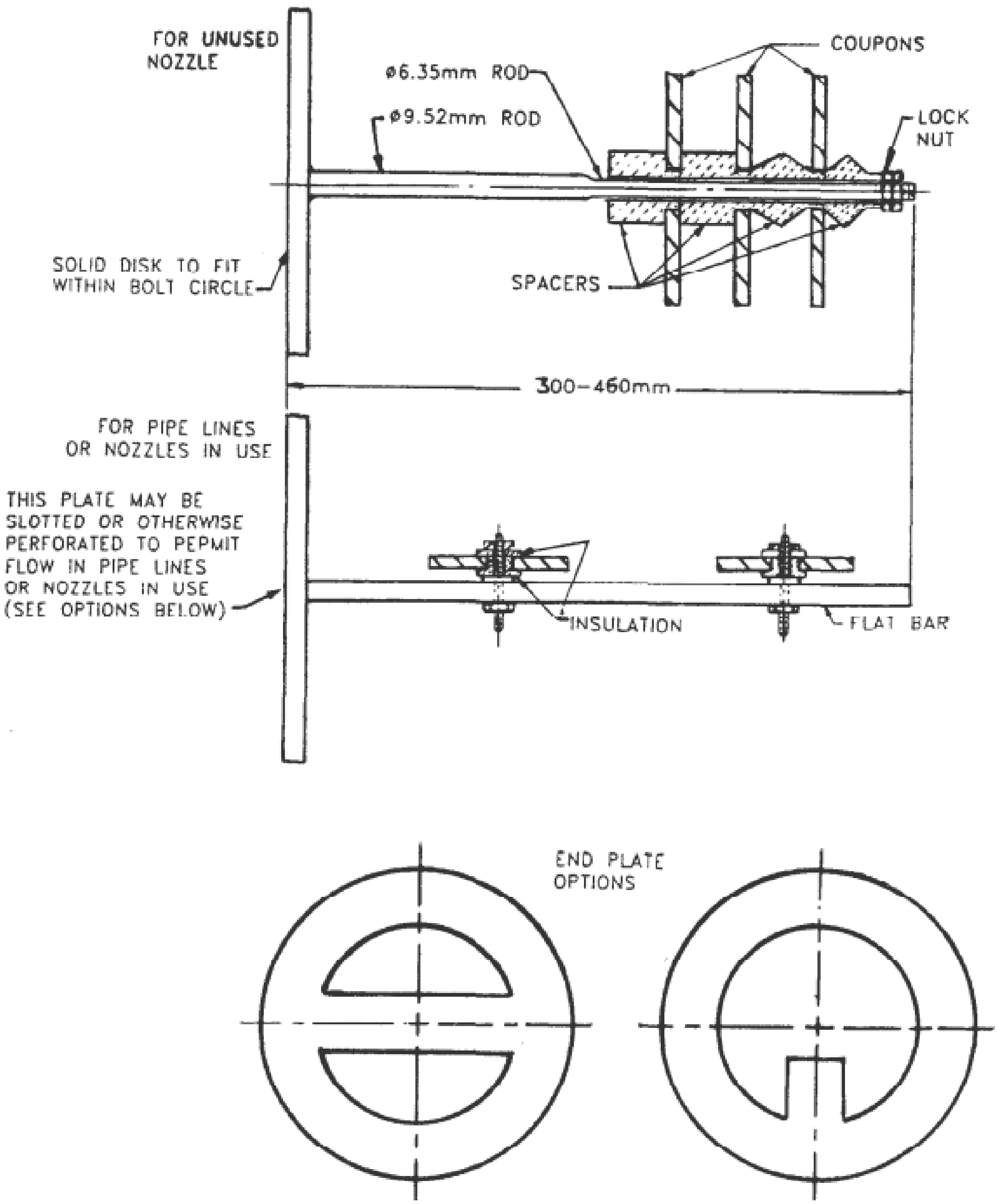
9 PROCEDURE

9.1 Suitable specimen rack is chosen as per the exposure apparatus in which respective solvent indicated earlier for removing water formed deposits are placed or circulated as per the operating conditions required. Already weighed, prepared test coupons in duplicate are then properly put in the rack. The specimen rack with test coupons are then inserted into the exposure apparatus to dip into the liquid suitably without touching the walls of the exposure apparatus. The preferred position of the rack shall be such that drippage of corrosion products from one specimen to another is prevented and the flow of liquid, if any, should be adjusted accordingly. The same condition of agitation of the liquid should then be encountered by all specimens. Also, the position of different specimens in the same rack should be such that galvanic reaction due to different metals in solution is avoided.



All dimensions in millimetres.

FIG. 1 TYPICAL SPOOL RACK

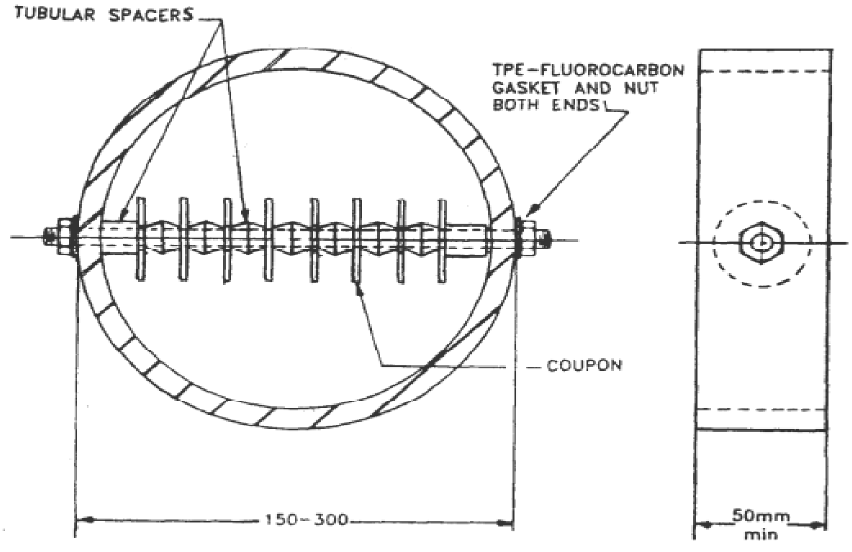


All dimensions in millimeters.

FIG. 2 TYPICAL INSERT RACK

9.2 The duration of exposure is based on known rates of corrosion of the materials or more often by the mode of actual operation in removing water formed deposits. However, short exposure (as in actual operation) may lead to incomplete study in view of protection given by films on the metal surfaces initially while extended exposure of more than two weeks may cause for nonuniform effects such as pitting and phase selective corrosion to occur. As per thumb rule, approximate minimum duration of the test in hours should be either 50 divided by expected corrosion rate expressed in mils per year, or 2 000 divided by the expected corrosion rate expressed in millimeter per year.

9.3 After the test exposures for a stipulated period, the test coupons are taken out and the condition and appearance of the holder and specimens together with adhesion of any coatings of films on the surface are examined and recorded. As a record, it is advisable to have the test coupons photographed, and the loose corrosion product mechanically removed for X-ray, spectrometer, chemical analysis etc. The test coupons are then carefully washed with distilled water and chemically cleaned with suitable solvent to remove soluble materials from the surface of the test coupons, or chemical cleaning methods to remove corrosion products as indicated in Table 1, Table 2, and Table 3 as given in Annex A are to be applied.



All dimensions in millimeters.

FIG. 3 TYPICAL DUTCHMAN TYPE RACK

After successive chemical cleaning, the loosened corrosion products are scrubbed off with a wet nylon bristle brush. The cleaned coupons are washed in cold and hot distilled water, dried in warm air and then vacuum desiccated before being weighed. The effectiveness of cleaning is judged, visually and supported by mass loss measurement. Mass loss results are obtained for one of the two or two of the three coupons exposed in each environment prior to deciding whether the remaining coupon shall be used for metallographic examination or additional mass loss evaluation.

10 RESULTS

10.1 The material loss is defined as the mean thickness of the material wasted in corrosion during an exposure period. Mass loss results obtained from the tests are converted to value of 'material loss' and 'corrosion rate'.

$$\text{Material Loss (ML), mm} = \frac{S}{P*A} \qquad \ldots(1)$$

where

S = mass loss in mg;
P = density of the test material, mg/mm^3; and
A = exposed area of the test material, mm^3.

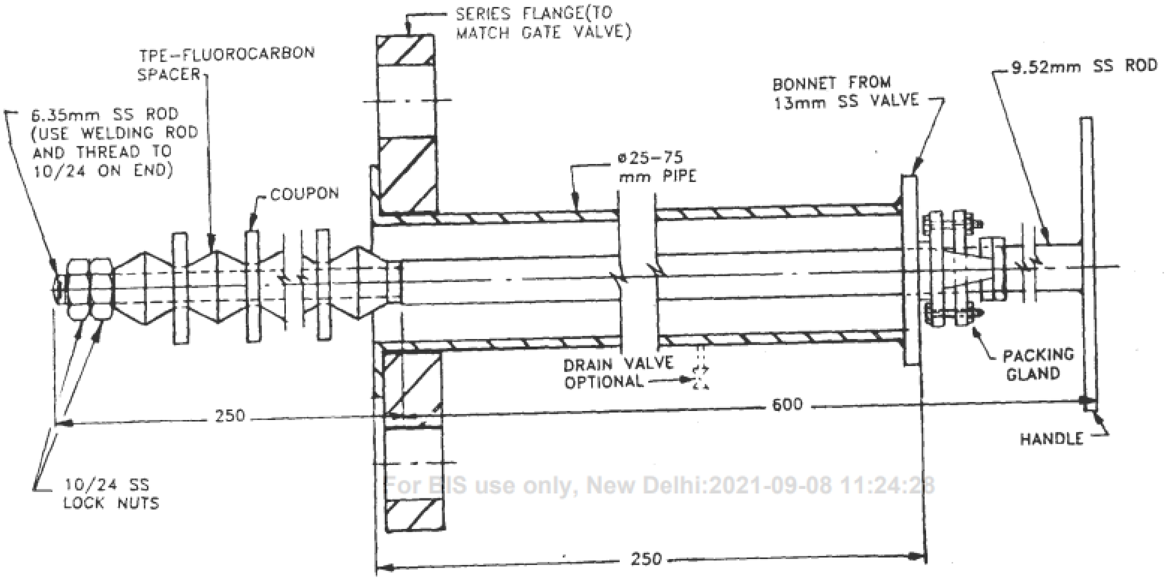
$$\text{Corrosion Rate (CR), mm/year} = \frac{\text{Material loss}*\text{K}}{t} \qquad \ldots(2)$$

where

K = 31.557 x 10^6 in seconds per mean solar year; and
t = duration of exposure period in seconds.

The above unit for expressing results relate to corrosion in terms of penetration damage. However, where the corrosion has been substantially uniform in distribution over the surface of the specimen, an evaluation based on mass loss is appropriate, the unit of which is expressed as g/m^2/day.

10.2 The specimen should be carefully examined for type and uniformity of surface attack such as etching, pitting, de-alloying or parting, tarnish, film, scale, etc. The maximum and minimum depth of the pits can be measured with a calibrated microscope or by the use of a depth gauge to the nearest 0.02 mm and not interpolated or extrapolated. Corrosion at or under the insulating spacers is an indication of susceptibility of the material to crevice corrosion whereas pitting on the surface is indicative of the intrinsic pitting tendency of the environment.



All dimensions are in millimeters.

FIG. 4 TYPICAL SLIP IN CORROSION TEST RACK

10.3 The ability of coupons to simulate the performance of the materials of construction is largely dependent on the design of the programme and on a number of factors including metals tested, variability of the environment and nature of corrosion process. Accordingly the reproducibility of the results may vary to the extent of ± 20 percent from the mean value.

11 REPORT

The following proforma is recommended to be adopted for reporting the results of corrosivity of solvent for removing water formed deposits.

11.1 Process Description

11.1.1 Operating equipment from which water formed deposits to be removed;

11.1.2 Material of construction of operating equipment;

11.1.3 Nature of deposits formed on the equipment;

11.1.4 Solvent proposed to be used to remove water formed deposits; and

11.1.5 Temperature velocity, strength of solution and any other information on actual operation during cleaning of equipment.

11.2 Corrosion Test

11.2.1 Material, size and number of test coupons.

11.2.2 Surface condition of coupons (mill finish machined, polished 120 grit, etc).

11.2.3 Type of rack prepared.

11.2.4 Type of exposure equipment, solvent taken and its concentration.

11.2.5 Temperature maintained during test.

11.2.6 Test conducted by circulation of solvent or static solvent.

11.2.7 Duration of test in hours.

11.2.8 Cleaning method for coupons applied after test.

11.3 Corrosion Results

11.3.1 Percentage loss in mass of coupons.

11.3.2 Corrosion rate, micrometer per year.

11.3.3 Type of corrosion.

11.3.4 Specific observation on corrosion products.

12 SHORT TERM/PRELIMINARY TEST FOR INHIRITOR EFIFCIENCY/CORROSIVITY OF HYDROCHLORIC ACID COMMONLY USED FOR REMOVING WATER FORMED DEPOSITS

12.1 Hydrochloric acid when used in the system to remove water formed deposits, can cause vigorous reaction with the steel surfaces of the system after removing the deposits if suitable inhibitor is not mixed with hydrochloric acid before its use. Since it is a general practice of removing water formed deposits by circulating hydrochloric acid for 3 to 4 h continuously in the system, it could be quite possible that at any stage due to temperature and other effects, inhibitor efficiency could have come down to undesirable values. Under such circumstances, it is necessary that intermittently acid coming from the system, is tested for inhibitor efficiency so that the bare metal surface is saved from corrosion. Corrosion coupon test for testing such corrosion action or inhibitor efficiency will take considerable time and, therefore, the following tests are recommended to establish inhibitor efficiency in a short time:

12.1.1 A degreased steel wool ball is placed in a test sample. If the solution is not effectively inhibited, hydrogen gas is evolved and the ball will float in the solution instead of sinking.

12.1.2 An untarnished carbon steel specimen is added in a sample of acid at its working concentration and temperature. If one or more streams of bubbles appear, rather than an occasional isolated bubble, the acid is not safe to be used without using fresh inhibitor addition.

12.1.3 A more elaborate test can be made as follows: The loss of weight after machining the material with known surface area may be measured for 30 min immersion in the inhibitor acid diluted to strength and maintained at a temperature that is to be used in acid cleaning. The loss of weight should not be more than 1 mg/cm^2/30 min.

12.2 Efficiency Test for Inhibitors used along with Acids for Removal of Water Formed Deposits

12.2.1 Two test coupons of equal surface area with blunt sharp ends and corners are pickled in uninhibited hydrochloric acid of 5 percent m/v strength, for about 45 min for removal of all oxide layer and other contaminants. Acid cleaned coupons are rinsed in Demineralized Water (DM) water and dried with acetone and weighed to fourth decimal accuracy.

12.2.2 A solution of acid of required strength to be used is prepared in two separate beakers and correct proportion of inhibitor is added in one. Temperature of both solution, is raised to the recommended level. One test coupon is immersed in inhibitor solution and the second in uninhibited solution under identical condition for 1 h or more. After 1 h or more, both the coupons are removed, rinsed with DM water and dried with acetone and weighed.

Percentage of parent metal protection is calculated as:

$$\frac{\text{Weight loss without inhibitor} - \text{Weight loss with inhibitor}}{Weight\ loss\ without\ inhibitor} \times 100$$

NOTE — Inhibitor efficiency test or metal loss test shall give more than 99 percent efficiency of inhibitor or less than 1 $mg/cm^2/h$ metal loss under conditions.

13 OTHER CORROSION TESTING TECHNIQUES

Apart from coupon exposure method, a brief description of other testing techniques are given in Table 1 of Annex A with their advantages and disadvantages. The user may adopt any method of tests as per their choice and facilities available at site.

14 CHEMICAL CLEANING METHODS

A brief description of individual chemical cleaning methods are given in Table 2 of Annex A. The different types of chemical cleaning methods used for removal of corrosion products are given in Table 3 of Annex A.

ANNEX A

(*Clause* 9.3)

CORROSION TESTING TECHNIQUES AND CHEMICAL CLEANING METHODS

Table 1 Corrosion Testing Techniques

(*Clauses* 9.3 a*nd* 13)

Sl No. (1)	Methods (2)	Brief Description (3)	Advantages (4)	Disadvantages (5)
a) Main Methods				
i)	Coupon exposure	Long term exposure of metal coupons. Monitor change in weight	Test all materials. Can be in a remote site. Accurate and comprehensive corrosion information	Long evaluation. Requires intensive labour. Multiple exposure often necessary
ii)	Corrosometer probes	Changing resistance due to corroding metal elements	Actual corrosion rate can be obtained in a short time. Continuous record of corrosion rate	Cannot distinguish the type of corrosion. Limited material choice. High cost. Requires daily monitoring
iii)	Hydrogen probes	Volumetrically measures the hydrogen gas liberated by corrosion reactions	Good warning means for a sudden change in a system. Continuous record of the corrosion	Cannot distinguish the type of corrosion. Useful for carbon steel only. Requires daily monitoring
iv)	Electro-chemical	Measures the corrosion rate by electro chemical polarization resistant	Instantaneous measure of corrosion rate. Provides rapid assessment of environments and material	Applicable only to liquid dominated environments where the conductivity of the fluids is suitable
v)	Stress Ruptures Tests ‘U’ Bend Selected Stress	Measures the corrosion rate by electro chemical polarization resistant	Indicates allowable stress levels	Requires intensive labour. Sensitive minor chemical changes
vi)	Corrosion Fatigue Test	Testing the susceptibility of rotor and blade steels to stress corrosion cracking	Indicates degradation of fatigue performance due lo environment	Test is sensitive to exposure time

Table 1 (*Concluded*)

vii)	Salt spray/fog testing	5 % NaCl solution is atomized in a chamber at a temperature adjusted to 95 °C (95 °F). The time that samples can resist against corrosion is the criterion used to understand test sample durability.	Indicates the corrosion probability in accelerated marine environment	Test is sensitive to sodium chloride (NaCl) atomization.
b)	Supplementary Methods			
i)	Chemical analysis	Measure concentrations of corrosive species and corrosion products	Characterize specific environment for comparative purposes	Sensitive to sampling and analysis technique. Requires expertise
ii)	Corrosion product analysis	Energy dispersive X ray spectroscopy (EDX); X-ray diffraction (XRD), X-ray photoelectron spectroscopy(XPS) and electron micro-probe, Identify major corrosion product species	Suggest corrosion mechanisms	Limited equipment availability. Sensitive to sampling and analysis techniques. Requires expertise
iii)	Metallographic examination	Optical-Sem-(Tem) microscopic examination of corrosion and corrosion products	Reveals form and type of corrosion. Suggests history of ‘corrosion	Limited equipment availability. Requires expertise
iv)	Theoretical evaluation	Potential *p*H diagrams. establish equations describing equilibrium	Indicates stable corrosion products. Suggests possible corrosion mechanisms	Results generally apply to equilibrium conditions only
v)	Ultrasonic thickness monitoring	Used to monitor the internal corrosion of pipelines or storage tanks. The ultrasonic sound wave, which is produced by an ultrasonic transducer, traverses to the back wall and reflects back to the source, making it possible to calculate the thickness of metal by measuring the reflection time and considering the velocity of sound waves in the tested material.	Actual corrosion rate can be calculated as thick ness measurement is very accurate	It is sensitive to ultrasonic probe

Table 2 Description of Individual Chemical Cleaning Methods

(*Clause* 9.3, *and* 14)

Method A	
Electrolytic cleaning in :	
Triammonium citrate	200 g
Distilled water to make	1 l
Temperature	70 °C
Time (10 min repeated)	10 to 40 min
Anode	Carbon
Cathode	Test material
Current density	0.001 A/cm^2-0.02 A/cm^2
Method B	
Electrolytic cleaning in :	
Dihydrogen ammonium citrate made from triammonium citrate	233 g
Citric acid	402 g
Distilled water to make	3l
Solution, pH	3
Temperature	70 °C
Time (10 min repeated)	10 min to 40 min
Anode	Carbon
Cathode	Test material
Current density	0.001 A/cm^2-0.02 A/cm^2
Method C	
Dip in :	
Triammonium citrate	200 g
Distilled water to make Temperature	1l
Temperature	60 °C
Time (10 min repeated)	10 min to 40 min
Method D	
Dip in :	
Nitric acid (specific gravity 1/42)	200 ml
Distilled water to make	1l
Temperature	60 °C
Time (5 to 10 min, repeated)	5 min to 20 min
Timing control by indication of hydrophobic surface film in acid solution, a modification of ASTM test for hydrophobic surface films by the Water-Break test	
Method E	
Electrolytic cleaning in :	
Hydrochloric acid (specific gravity 1.19)	0.5l
Hexamine	2.0 g
Distilled water to make	1l
Temperature	Room temperature
Time	5 min to 20 min
Anode	Carbon
Cathode	Test material
Current density	0.01 A/cm^2-0.02 A/cm^2

Table 2 (*Concluded*)

Method F	
Dip in:	
Potassium cyanide	50 g
Distilled water to make	1l
Temperature	Room temperature
Time	1 min to 2 min
Method G	
Dip in:	
Sulphuric acid (specific gravity 1.25)	100 ml
Distilled water to make	1l
Temperature	Room temperature
Time	1 min to 10 min
Method H	
Wash in cold water and scrub lightly using a medium hard nylon bristle brush remove all foreign corrosion products and monitor weight again	
Method J	
Electrolytic cleaning in:	
Sodium hydroxide	100 g
Distilled water to make	10 min to 40 min
Time (10 min repeated)	10 min to 40 min
Anode	Carbon
Cathode	Test material
Current density	0.01 A/cm^2-0.02 A/cm^2

Table 3 Chemical Cleaning Methods used for Removal of Corrosion Products
(*Clause* 9.3 and 14)

Sl No.	MateriaI	Cleaning Method (Refer Table 2)
(1)	(2)	(3)
i)	Carbon steel, low-alloy steel	Use A or B or both
ii)	Cast irons	Use A only
iii)	Types 304, 321, 347, 316, 410 stainless steel; E-Brite 26-1 FV520 (B), 3RE60, 2RK65, Carpenter 20-Cb3, Incoloy 825	Use C or B followed by D (and E, H if necessary)
iv)	Deoxidized copper and arsenical aluminium brass	Use F and alternate with G after the major portion of soluble corrosion products have been removed
v)	Ti, IM1318, IM1550	Use H
vi)	Nickel alloys, cobalt alloys, lead, zinc, tantalum, molybdenum, zinconum alloy GR 32	Under review
vii)	Removal of deposited amorphous silica	Use J

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Water Quality for Industrial Purpose Sectional Committee, CHD 13

Organization	*Representative(s)*
Bhabha Atomic Research Centre, Mumbai	SHRI K. P. BHATTACHARYYA (***Chairperson***)
Bhabha Atomic Research Centre, Mumbai	SHRI SHIVAYYANAMATH S. SHRI T. K. DEY (*Alternate*)
Bharat Heavy Electrical Limited, Thiruchirapali	SHRI SHAILENDRA KUMAR SHRI K. ANANDA BABU (*Alternate*)
Central Ground Water Board, Faridabad	DR NEELAM NIGAM SHRIMATI POOJA MEHROTRA (*Alternate*)
Central Leather Research Institute, Chennai	DR C. MURALIDHARAN DR K. SRI BALA KAMESWARI (*Alternate*)
Central Pollution Control Board, New Delhi	SHRI NAZIMUDDIN SHRI VISHAL GANDHI (*Alternate*)
Central Pulp and Paper Research Institute, Sharanpur	DR NITIN ENDLAY DR SANJAY TYAGI (*Alternate*)
Central Salt and Marine Chemicals Research Institute, Bhavnagar	DR SOUMYA HALDAR DR D. N. SRIVASTAVA (*Alternate*)
Consumer education and Research Centre, Ahmedabad	MISS ANINDITA MEHTA MISS DOLLY JAIN (*Alternate*)
Chennai Petroleum Corporation Limited, Chennai	SHRI S. SHANKAR
CECRI, Karaikudi	DR S. VASUDEVAN DR R. MALINI (*Alternate*)
Department of Industrial Policy and Promotion, New Delhi	SHRI T. S. G. NARAYANAN SHRI UDAY SINGH MINA (*Alternate*)
Department of Science and Technology, New Delhi	DR NEELIMA ALAM DR SANJAI KUMAR (*Alternate*)
Delhi Jal Board	SHRI ASHUTOSH KAUSHIK
Grasim Industries Limited, Nagda	SHRI S. N. SASTRY SHRI ALOK SINGH (*Alternate*)
Indian Farmers Fertilizer Cooperative Limited, Allahabad	SHRI GORAKH SINGH SHRI K. S. S. MOORTHY (*Alternate*)
Indian Chemical Council	DR MRITUNJAY CHAUBEY SHRI KEDAR OKE (*Alternate*)

Ion Exchange India Limited, Mumbai	Shri Sachin Saha Dr Renu Saraph (*Alternate* I) Shri Anil K Khera (*Alternate* II)
Maharashtra State Electricity Board, Chandrapur	Shri V. P. Ghodmare Shri Rajesh Dattatraya Chivane (*Alternate*)
Ministry of Drinking Water and Sanitation ,New Delhi	Shri D. Rajasekhar Shri Sumit Priyadarshi (*Alternate*)
Ministry of Urban Development and Poverty Alleviation, New Delhi	Dr Ramakant Miss Chaitra Devoor (*Alternate*)
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