VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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A Project Report
On

"SALT FOG CHAMBER ASTM B117"

Submitted in partial fulfillment of the requirements as a part of the curriculum,

Bachelors of Engineering in Mechanical Engineering

Submitted by

Chidananda
(1CR17ME401)

Kumaraswamy C
(1CR17ME406)

Rachitha N
(1CR17ME416)

Yogesh S
(1CR17ME423)

Carried out at
**Indian Space Research Organisation (ISAC),
Bengaluru-17**

Under the Guidance of
Manikandan H
Assistant Professor
Department of Mechanical Engineering

Department of Mechanical Engineering
CMR INSTITUTE OF TECHNOLOGY
132, AECS Layout, Kundalahalli, ITPL Main Rd, Bengaluru – 560037
2019-20

CMR INSTITUTE OF TECHNOLOGY

132, AECS Layout, Kundalahalli colony, ITPL Main Rd, Bengaluru-560037

Department of Mechanical Engineering

CERTIFICATE

Certified that the project work entitled "**Salt Fog Chamber ASTM B117**" is a bonafide work carried out by **Mr. Chidananda, Mr. Kumaraswamy C, Ms. Rachitha N, Mr. Yogesh S,** bonafide students of **CMR Institute of Technology** in partial fulfillment for of the requirements as a part of the curriculum, **Bachelors of Engineering in Mechanical Engineering,** of **Visvesvaraya Technological University, Belagavi** during the year **2019-20**. It is certified that all correction/suggestion indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of the project work prescribed for the bachelor of engineering degree.

(Manikandan H)   **(Dr. Vijayanand Kaup)**   **(Dr. Sanjay Jain)**

Signature of the Guide   **Signature of the HOD**   **Signature of the Principal**

External Viva

Name of the examiners   **Signature with date**

1.

2.

DECLARATION

We, students of Eighth Semester, B.E, Mechanical Engineering, CMR Institute of Technology, declare that the project work titled **"Salt Fog Chamber ASTM B117"** has been carried out by us and submitted in partial fulfillment of the course requirements for the award of degree in **Bachelor of Engineering in Mechanical Engineering** of **Visvesvaraya Technological University, Belagavi,** during the academic year 2019-2020.

Mr. Chidananda   **Mr. Kumaraswamy**   **Ms. Rachitha**   **Mr. Yogesh**
(1CR17ME401)   **(1CR17ME406)**   **(1CR17ME416)**   **(1CR17ME423)**

Place: Bengaluru
Date: 23 May 2020

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ABSTRACT

The main aim of this project is to design and fabricate low cost salt spray testing machine which is able to identify the corrosion formation in any type of metals; from this testing process we can improvise the life span of the particular metal. A motorbike has a paint coated footrest made of stainless steel, so this part when comes in contact with atmosphere nearly after a year it is corroded so if salt spray testing machine is used at this point can found out that for additional coating of paint, whether it will withstand up to longer duration likewise, this process can be analyzed. This salt spray testing machine is fabricated for low cost and the stainless steel is tested and analyzed.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the year 1939 ASTM B117 was recognized as the first international salt spray standard .The formation of rust is evaluated after a pre-determined period of time. Time duration completely depends on the corrosion resistance of the coating, in general if the corrosion resistance is coated more may be five or six layers then it takes longer period of time to appear rust or corrosion. water of salt atmosphere is introduced into the chamber at specific air pressure. Synthetic seawater solutions are also commonly used and preferred by standards. The salt spray test is a popular test corrosion method; it is used to measure the corrosion resistance of materials at high temperature. The salt spray test in other words ASTM B117 and fog testing .This salt spray test implements the corrosive attack to the samples which is coated completely on the selected material.

Expert ASTM B117 salt fog and cyclic corrosion testing, with Houston's largest salt fog (and cyclic) chamber and PhD corrosion consulting. B117 is widely used as a rapid method for evaluating coating and materials performance under highly corrosive marine conditions. ASTM B117 is commonly used for metals, plastics, woods, and coated materials of all kinds; ideally to compare two or more materials.

Figure. 1.1: Salt fog testing Chamber

ASTM B117 Salt Fog and Salt Spray testing is relatively fast way to analyze the corrosion caused by salt water and chlorides on coated metals and alloys. The ASTM B117 standard for operating a salt fog or salt spray cabinet, aka the "Salt Spray" or "Salt Fog" test, is a widely used corrosion test required by many companies and government agencies, including the US DoD and DoE. The purpose of salt fog testing is to collect corrosion resistance data from coated and non-coated alloys and also a wide variety of other materials including plastics

The American Society of Testing and Materials (ASTM) test B117 is one of the most widely adopted standards for salt spray testing. Its use is internationally widespread and its provisions have been frequently re-written into the national standards of other countries, and also appear in other industry specific corrosion test standards.

ASTM B117 is an excellent reference document for the salt spray practitioner, with many helpful hints and tips contained in its useful appendixes. It is also regularly updated, by an active and broad based ASTM sub-committee, so it is a standard that is continuously evolving. The suffix to the main standard number indicates the year of publication. For example, ASTM B117 – 11 indicates a 2011 publication date. Practitioners applying the ASTM B117 test standard are responsible for checking they are using the most appropriate version for their application.

The ASTM B117 Salt Spray Test standard is extensively used to measure normal corrosion resistance to ocean water type environments. Test duration depends on the specification or the corrosion resistance of the material.

Chamber construction, testing procedure and testing parameters are standardized under national and international standards, such as ASTM B 117 and ISO 9227. These standards describe the necessary information to carry out this test; testing parameters such as temperature, air pressure of the sprayed solution, preparation of the spraying solution, concentration, pH, etc. Daily checking of testing parameters is necessary to show compliance with the standards, so records shall be maintained accordingly. ASTM B117 and ISO 9227 are widely used as reference standards. Testing cabinets are manufactured according to the specified requirements here.

However, these testing standards neither provide information of testing periods for the coatings to be evaluated, nor the appearance of corrosion products in form of salts. Requirements are agreed between customer and manufacturer. In the automotive industry requirements are specified under material specifications. Different coatings have different behavior in salt spray test and consequently, test duration will differ from one type of coating to another. For example, a typical electroplated zinc and yellow passivated steel part lasts 96 hours in salt spray test without white rust. Electroplated zinc-nickel steel parts can last more than 720 hours in NSS test without red rust (or 48 hours in CASS test without red rust) Requirements are established in test duration (hours) and coatings shall comply with minimum testing periods.

Artificial seawater which is sometimes used for Salt Spray Testing can be found at ASTM International. The standard for Artificial Seawater is ASTM D1141-98 which is the standard practice for the preparation of substitute ocean water.

Figure. 1.2: Salt fog testing Chamber

CHAPTER 2

METHODOLOGY

This methodology is to be used to perform the ASTMB117 test standard in an Ascott corrosion chamber. This should be used in conjunction with the ASTM B117 standard document. The test standard takes precedence over this method statement and this method may need to be altered in order to follow/ comply with the standard.

This method is based on ASTM B117 which consists of: Continuous salt spray test exposure at 35C +/-2C with a salt concentration of 5% Sodium Chloride (NaCL) +/-1%. 1.3 The chamber will be loaded with test samples as required by the customer (or in accordance with ASTMB117).

All measuring equipment must be calibrated. The recalibration renewal date must not fall within the test duration. 2.1.1 The Ascott corrosion chamber should be calibrated for chamber air temperature as a minimum. If required, the following 'chamber' items may also be calibrated: • Chamber air saturator temperature. • Chamber air pressure gauge (atomiser pressure). Ascottcorrosion chambers may be fitted with a relative humidity sensor. Calibration is not required for as this is not in use during salt spray testing.

Peripheral devices also should be calibrated prior to use and may include the following: • Hand Held pH Meter – is calibrated using buffer solutions and following manufacturers' instructions.

Salinity Refractometer is calibrated using Refractometer calibration liquid calibration solution (3.5%). • Conductivity meter is calibrated using standard solution, used for checking the conductivity of the water used for the salt solution.

The chamber temperature may be continuously monitored if required, using an independently calibrated data logger. For salt spray testing, it may be satisfactory to record the chamber temperature using the Ascott chamber display on a daily basis.

CHAPTER 3

SALT FOG TESTING

3.1 What does Salt Fog mean?

Salt fog is a type of accelerated corrosion test that is performed to assess the comparative corrosion resistance of certain materials when exposed to salt fog or salt spray at increased temperature levels.

In this test, specimens are put inside a chamber or cabinet for salt fog testing, with constant salt water spray or indirect fog, while the climate is maintained during the test.

Salt fog is also known as the fog test or salt spray test.

3.2 Corrosionpedia explains Salt Fog

The salt fog test is widely used since it is repeatable and consistent. It is commonly applied in various industries such as the following:

- Automotive

- Marine

- Military

- Aircraft

The test is highly beneficial in corrosion resistance evaluation of finished surfaces, equipment parts and more. This test is also one of the best ways to examine the permeability of seals and coatings. Such coatings are used to provide metallic parts with adequate protection against corrosion. The most common type of coatings that this test can evaluate include:

- Organic coatings, phosphates and painted metals

- Electroplated chromium zinc, zinc alloy, copper, tin and nickel

- Non-electronic coatings like zinc flakes

- Painted surfaces subjected to hot-dip galvanized coatings

This is a very cost effective technique that is usually performed in an enclosed chamber. The sample is exposed to salt fog, which is very corrosive in nature. The period of exposure to salt fog is identified by the existing standards and coating type. Normally, this test lasts for about 72 hours, but it can be longer or shorter depending on the existing conditions. After the assigned period, element experts inspect the sample and assess its resistance to corrosion by identifying the existence of oxides.

3.3 When to use the Salt Fog Test?

Finding the right corrosion test can be difficult but a few tips may help to see if the ASTM B117 will be beneficial. Common materials that can be tested using the salt spray test are:

Figure. 3.1: Corrosion material

- Paints

- Organic coatings

- Phosphated surfaces

- Zinc and Zinc-alloy platings

- Electroplated chromium, tin, nickel, copper

- Non-electrolytic coatings

3.4 The Salt Fog Test

This accelerated laboratory test was invented at the beginning of the 20th century. It provides a controlled corrosive environment and has been used to produce relative corrosion-resistance information for specimens of metals and coated metals exposed in a test chamber. The classical salt spray (fog) test ASTM B117 consists of atomizing a salt solution into uniform droplets on specimens supported or suspended between 15-30° from the vertical.

The salt solution is a solution of 5% (in weight) of NaCl, (more than sea water, which is only 1.8% to max 3%). The exposure zone of the salt spray chamber is maintained at 35°C.

The pH of the salt solution is such that when atomized at 35°C, the collected solution will be in a pH range from 6.5 to 7.2. The test is continuous for the duration of the entire test period.

The period of exposure is mutually agreed upon between the purchaser and the seller. It can reach more than 1000H. There exist other accelerated testing procedures – in ageing tests, quite often used in automotive industry. These tests are briefly described below. The most important corrosive element is moisture, which is applied in all ageing tests, supplemented by salt mist and/or changing temperature.

Testing procedure	Short description	Main impact
VDA 621-415 (VDA – Wechseltest)	Salt mist, condensed water, standard climate (18°C<_T ≤ 40°C)	Moisture, corrosion
VW P 1200	80°C/95% relative humidity/ - 40°C	Moisture, changing temperature conditions
VW P 1210	Salt mist, condensed water	Moisture, corrosion
VDA - KKT	3 weeks VDA 621-415, salt mist 1 week VW P 1200	Corrosion, moisture, changing temperature conditions
SCAB-test	60°C/-25°C, salt mist 60°C/ 85% relative humidity 30°C/60% relative humidity	Corrosion, moisture

Table 3.1: Tests and important corrosive elements

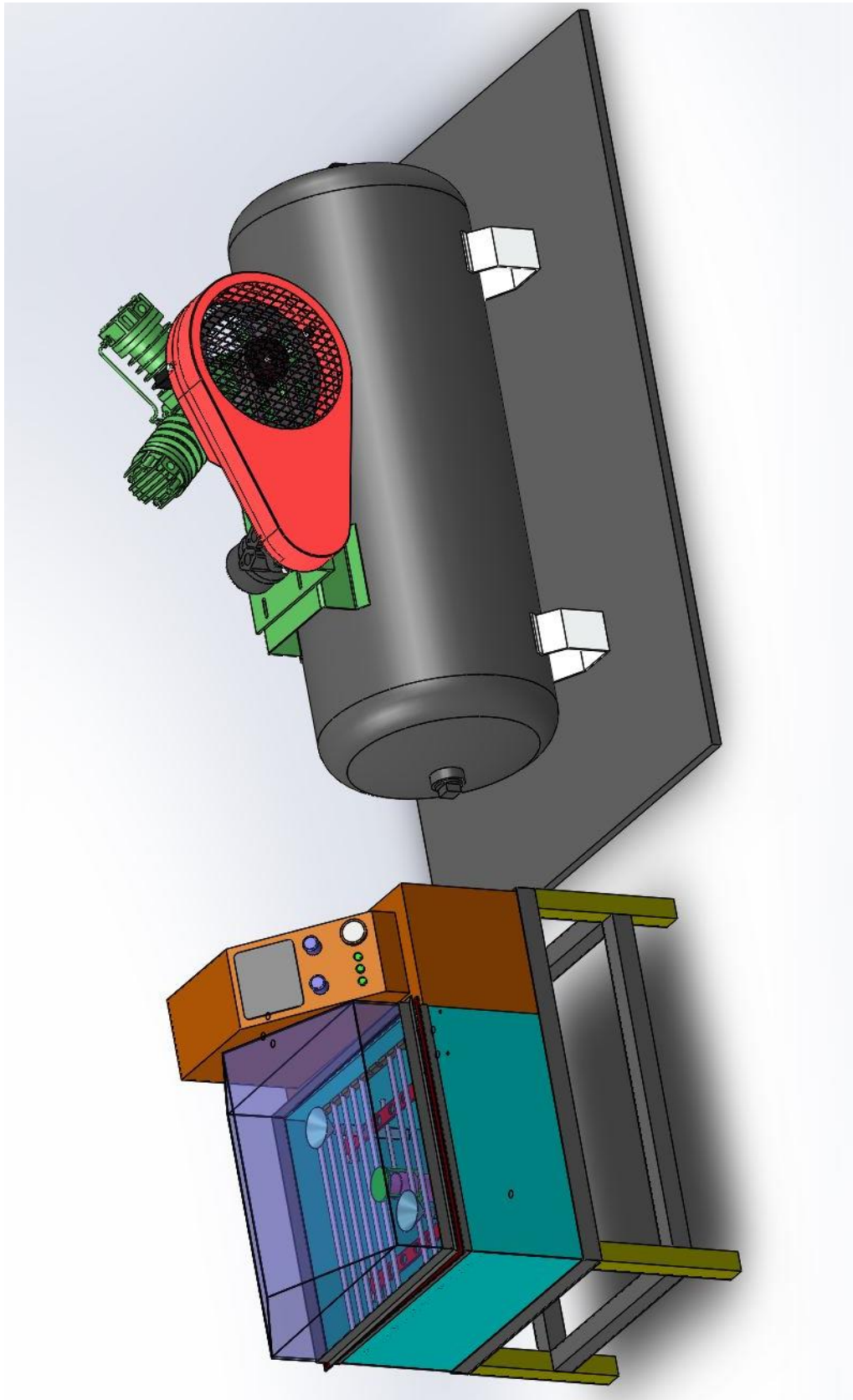The results are given rather in qualitative than quantitative form.

Figure. 3.2: Salt fog testing Chamber Module

CHAPTER 4

ASTM B117 STANDARD

4.1 ASTM B117 Standard Practice For Operating Salt (Fog)

The standard ASTM B117 (or its equivalent CEI 60068-11) is used in this part to highlight specific points. It is to be remembered that the standard does not describe the type of samples, the exposure time for a given product or the procedure for interpreting the results.

It is therefore necessary to present here the choices made by the laboratory, such as the type of sample and its preparation (test duration and validation criteria should be decided in agreement with the customer). We also highlight the risk of misinterpretation and suggestions for good practices deduced from reading the standard.

It is generally not possible to assess the behaviour of a material (especially for stainless steels) in a natural environment from the results of a salt spray test.

In addition, reproducibility is highly dependent on the type of specimen and is not even good for similar samples.In the absence of recommendations provided by the standard, it is nevertheless possible to deduce the type of sample from extract 6. It should be flat, since an angle from 15° to 30° from the vertical must be respected. This extra ct illustrates the difficulties in interpretation of the salt spray test performed on shaped items with horizontal zones with retention. At the laboratory, rectangular samples (100mm x 150mm) are typically used.

In addition to the sample-cleaning method recommended in the standard (laboratory procedure: ultrasound in an ethanol/acetone mixture, then rinsing with distilled water and finally drying), it is essential to suitably protect the edges. Regarding coated materials (which are finally the only ones for which the standard is useful, by highlighting possible porosity of the coating), the standard recommends protecting the cut edges and zones in contact with the support by paint, wax or suitable tape.
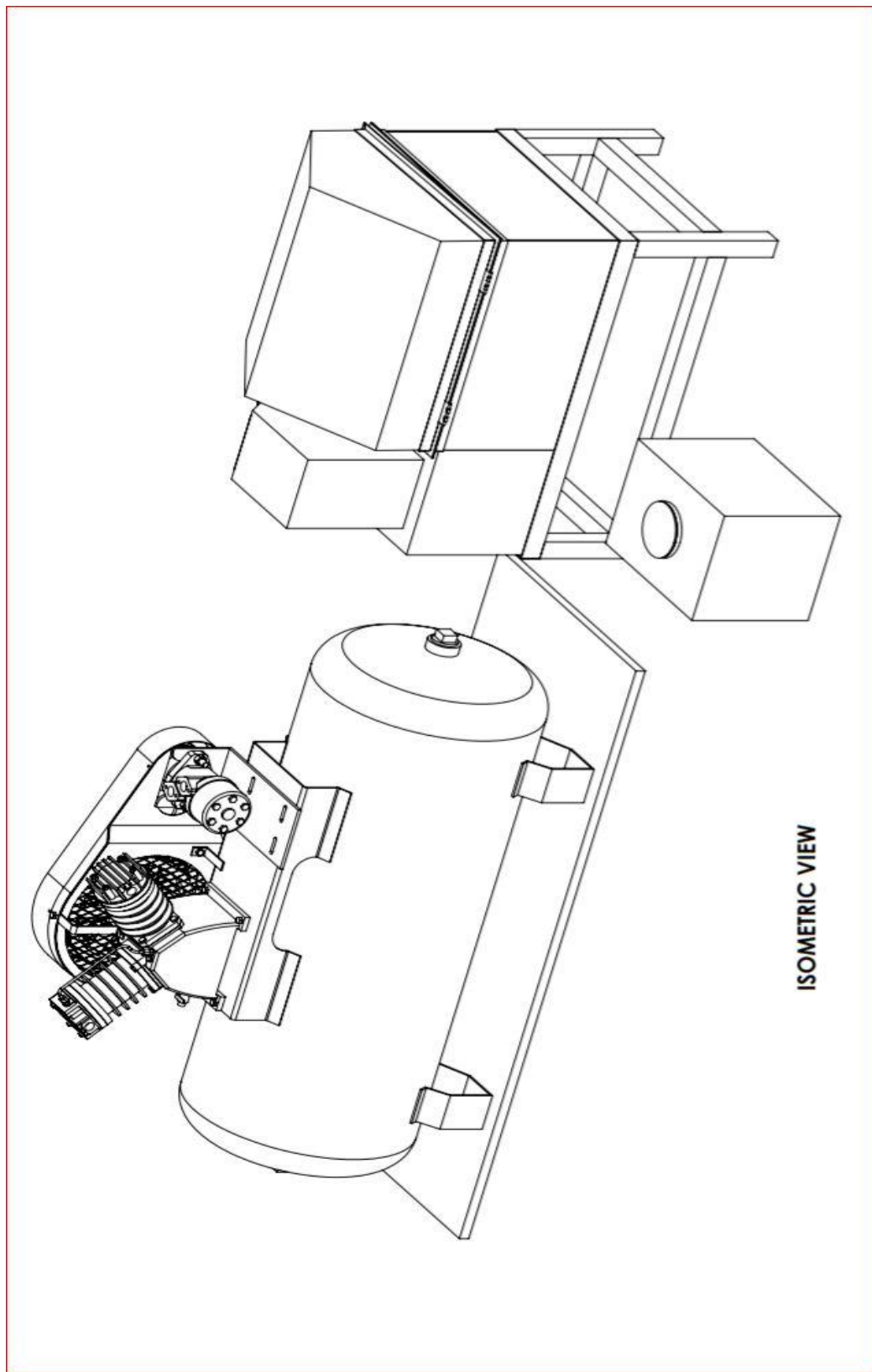
CHAPTER 5

SALT FOG TESTING CHAMBER DRAWINGS

ISOMETRIC VIEW

Figure 5.1 : Salt Fog Testing Chamber Isometric views

Bill of Material

ITEM NO	DESCRIPTION	Qty	COST
1	CHAMBER	1	1,500.00
2	SEALING STRIP	8	1,200.00
3	STRIP SUPPORT	4	320.00
4	TUBE	1	180.00
5	SPARY CONE	1	1,800.00
6	SAMPLE TRAY	2	600.00
7	TUBE RUBBER HOLDER	2	730.00
8	SAMPLE TUBE	2	1,800.00
9	TUBE PLUG	2	1,780.00
10	COLLECTOR FUNNEL	2	600.00
11	GASKET	1	960.00
12	CHAMBER TOP COVER	1	3,400.00
13	HINGE 1	2	60.00
14	HINGE 2	2	60.00
15	RACK SUPPORT	2	1,800.00
16	GLASS ROD	12	2,570.00
17	40X40 ANGLE	2	160.00
18	40X40 ANGLE-2	2	740.00
19	40X40 ANGLE-3	1	740.00
20	40X40 TUBE 1	4	740.00
21	40X40 TUBE 2	2	740.00
22	40X40 TUBE 3	2	740.00
23	BOTTOM PLATE	1	980.00
24	TOWER BOTTOM PLATE	1	680.00
25	GLASS CYLINDER	1	4,600.00
26	TOWER TOP PLATE	1	800.00
27	M6 STRUD	4	70.00
28	HEAT SENSOR	3	600.00
29	PRESSURE SENSOR	1	900.00
30	PIPE CONNECTOR	7	300.00
31	AIR COMPRESSOR	1	-
32	HEATER ADAPTER	2	1,700.00
33	HEATER	1	5,700.00
34	T CONNECTOR	2	980.00
35	CONTROLLER COVER	1	868.00
36	PUMP	1	1,500.00
37	SALT TANK	1	2,700.00
38	SALT TANK COVER	1	100.00
	Total Cost		45,698.00

NOTE:
1.The approximant Material cost is mentioned in BOM

2. And for Salt fog solution- Sodium chloride and deminaralised water are used

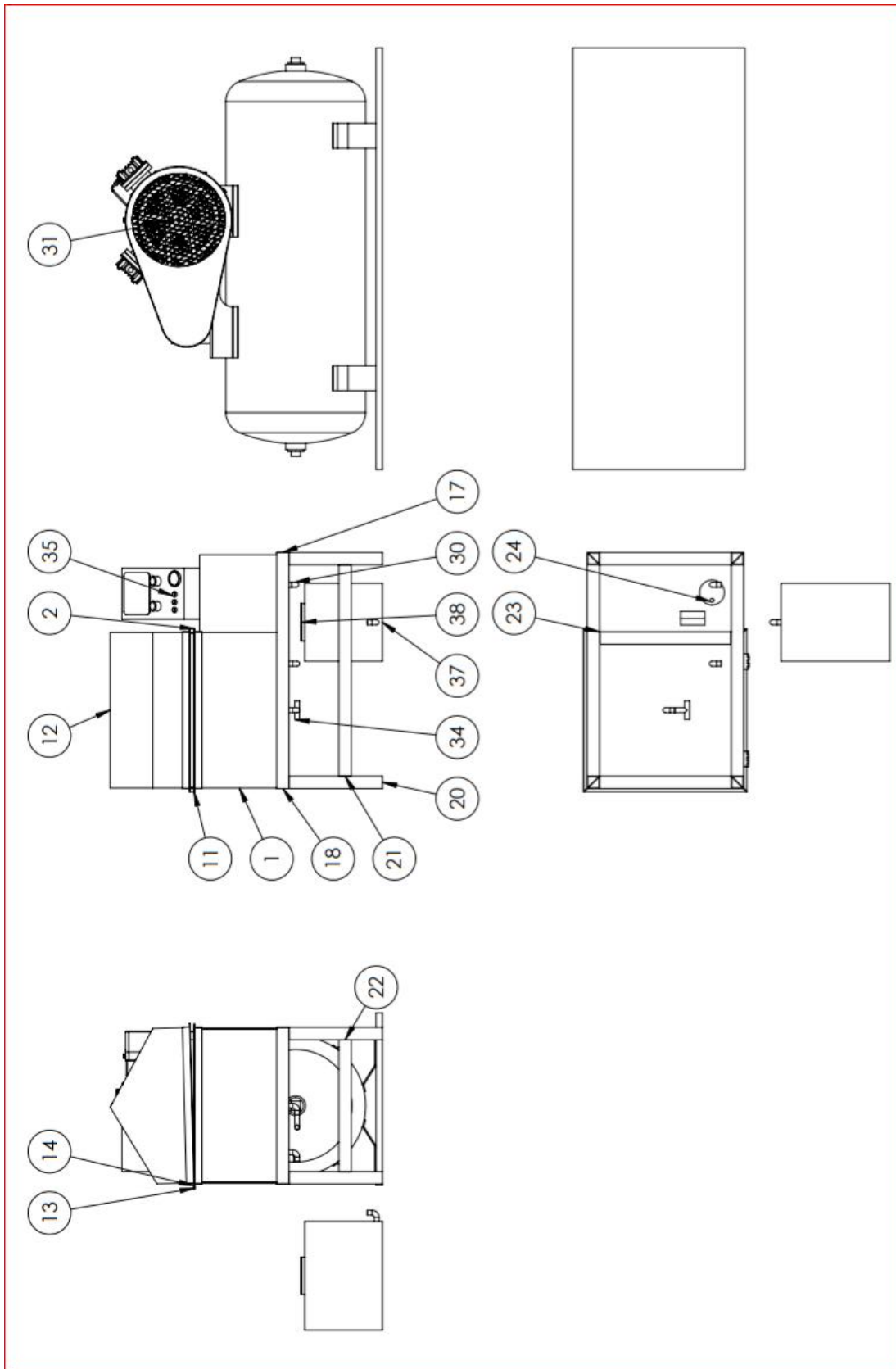**Figure 5.2 :**Salt Fog Testing Chamber Bill of Materials BOM

Figure 5.1 : Salt Fog Testing Chamber details views

CHAPTER 6

MATERIAL TESTING

6.1 Test With Stainless Steels, What Is Happening In Reality

The salt spray fog test puts materials in the very harsh environment of a high-chloride test medium. The chloride concentration specified is more than hundredfold higher than in drinking water and even higher than in sea water (chloride concentrations of 3.0% for the test solution, 1.8% for sea water and max. 0.025% for drinking water according to the European drinking water directive). So the salt spray test does not usually serve for reproducing real service conditions. Only occasionally it is used for a very rough simulation of high chloride environments to be met in, for example, marine service – and even in these cases it cannot really map the conditions and often leads to corrosion reactions and material rankings that are different from those in field exposure.

The salt spray test just generates a defined high-corrosive environment which is quite well reproducible, often just used for production and quality- control purposes. It can serve to detect unsuitable items or material samples in series of known behaviour.

If stainless steels are prone to corrosion in the salt spray test, no general thinning, but forms of localized attack are normally observed. The prevalent types are pitting and crevice corrosion. With these corrosion forms, attack is normally confined to very small surface areas, while the surrounding surface shows no thinning and exhibits the original surface topography, more or less covered with rusty corrosion products. Whereas pitting is also found on bare surface areas, crevice corrosion only occurs in case of crevice configuration. The corrosion morphology is characterized by pits that have a small diameter compared to their depth, in the case of pitting, and shallower forms in the case of crevice corrosion (Fig. 1 and 1b). Pitting in the salt spray test often leads to localised or cloudy rust spots.
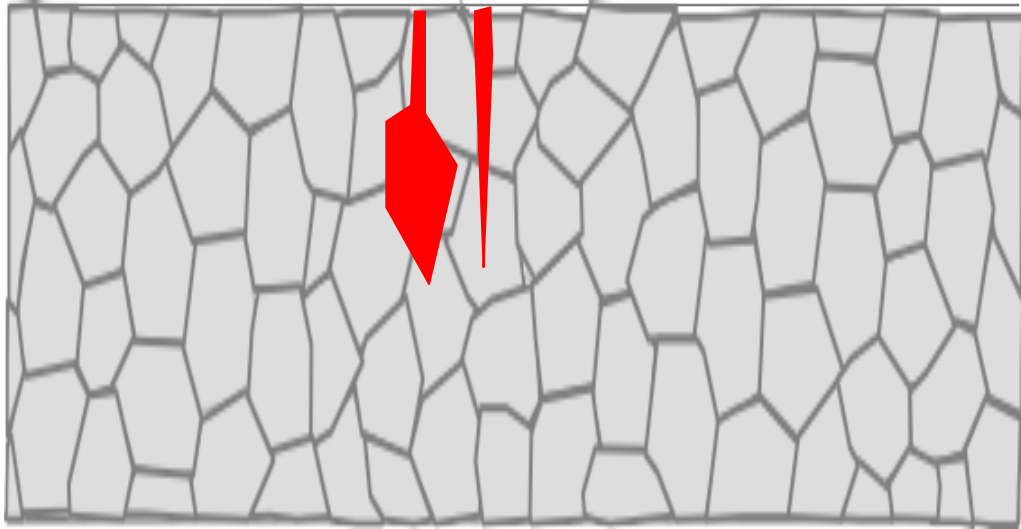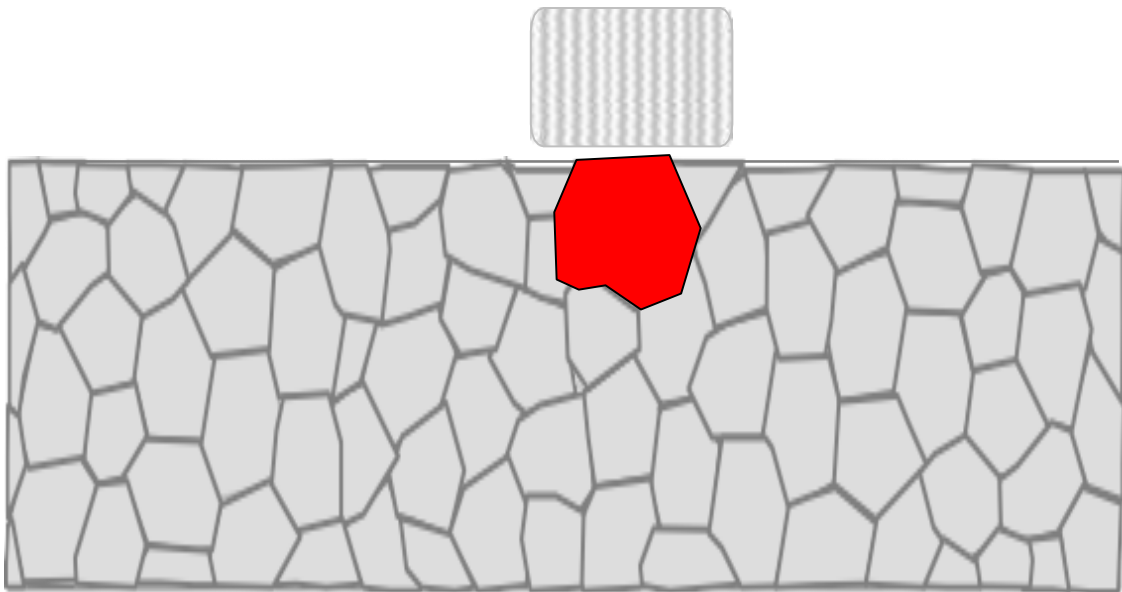
Figure. 6.1: Diagram of pitting corrosion

Figure. 6.2: Diagram of crevice corrosion

The corrosive medium of the salt spray test impacts on stainless steel directly from the start of exposure, without any protection over time afforded by, for example, a coating.

There is therefore no long incubation time before a corrosion reaction occurs. It will be seen rather soon, after several hours or a few days when the steel is not resistant. Also, when the test continues further, the corrosion attack proceeds gradually and corrosion behaviour does not usually change abruptly, as can be seen with other materials.

Coated steels, for instance, which are also often evaluated by means of the salt spray test, may remain free from any visual degradation for quite a long time, until the coating can no longer offer protection.

Then the behaviour of the material changes drastically and severe corrosion sets in (**Fig. 2**). So different types of materials exhibit completely different corrosion reactions in the salt spray test and therefore should not be compared by means of this test.
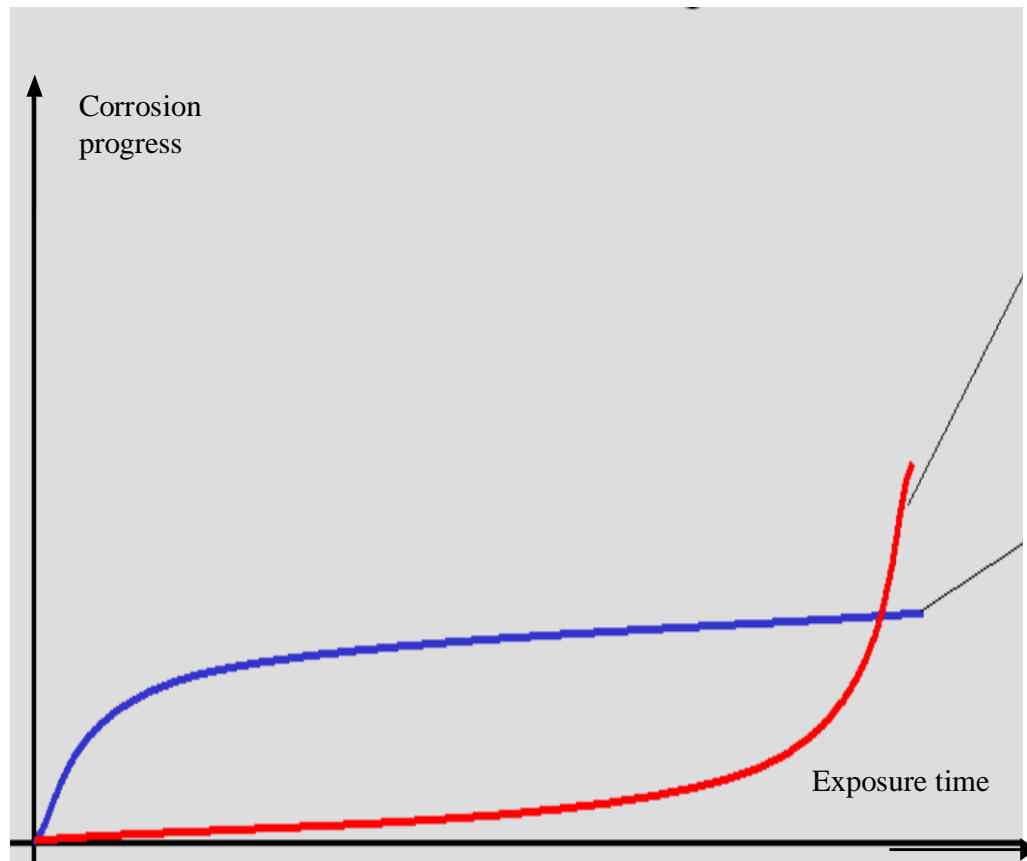

Figure 6.3:: Diagram of the corrosion progress of stainless steel (blue) and
coated steel (red) when exposed to the salt spray test.

Due to its very high chloride level, the salt spray test often induces corrosion in stainless steels that are resistant to the much lower chloride impact of actual applications. The salt spray test then changes the corrosion behaviour of stainless steels and can neither serve as an accelerating nor as a simulating test.

The salt spray test is also of rather limited use for comparing the corrosion resistance of different stainless steel grades and for establishing a ranking or even more ambitious – quantifying the differences in corrosion resistance.The reason is that the corrosive conditions of the test are fixed and cannot be adjusted to the resistance of the steel grades to be tested. This is completely different for other tests better suited to stainless steels, such as critical pitting potential or critical pitting temperature measurements in $NaCl^-$ and $FeCl^-$ solution respectively. In these tests, corrosivity is progressively increased by shifting continuously or stepwise one[3] test parameter (e.g. the potential or the temperature) until critical conditions are reached and corrosion initiates. The critical value of the variable test parameter where corrosion initiates then serves as a measure of the corrosion resistance of the material tested. Critical pitting potentials or temperatures of different materials can therefore be determined, serve as a quantitative measure of corrosion resistance and be compared.

With the salt spray test it is not possible to measure corrosion resistance in such a quantitative manner. Because corrosion attack on stainless steels in the salt spray test proceeds as pitting and crevice corrosion, the factors influencing these corrosion forms also determine the behaviour of stainless steels in this test.In addition, features that influence the rinsing-off of the test medium from the samples are relevant for the resistance in this test. The sample shape and geometric effects are therefore important.

Chromium and molybdenum are the most important alloying elements of stainless steel in terms of corrosion resistance. The higher the content of these two metals, the more aggressive must the conditions be to initiate pitting and crevice corrosion.

Molybdenum is more effective than chromium, which is expressed by the so- called PRE-value:

PRE=%Cr+3.3x%Mo

The PRE value is the resistance of a stainless steel against pitting and crevice corrosion that can be expected on the basis of its alloy composition.

Stainless steels with only 12% chromium, such as 1.4512, develop severe rusting within only a few hours in a salt spray test.

Figure. 6.4: 12% Chromium

Steels with ~18% chromium (1.4301 *et al*) are quite resistant for much longer. Higher-alloyed grades containing additional molybdenum, such as 1.4404, are quite resistant, even in more endangered areas such as crevices.

Figure. 6.5: 18% Chromium + molybdenum

Besides the alloying elements chromium and molybdenum, nickel is beneficial for salt spray test behavior. In contrast to chromium and molybdenum, nickel does not increase resistance to pitting and crevice corrosion initiation but it very effectively slows down the corrosion process once it has started. Thus nickel-austenitic grades often show better salt spray test results, with much less rusting than low-nickel ferritic grades with similar PRE-values.

Figure. 6.6: Nickel- austenitic grade

Figure. 6.7: Ferritic grade without nickel Same behaviour for low-nickel austenitic grades

Since the salt spray test detects surface flaws and suboptimal surface states very sensitively, it is often used for comparing polished finishes. Smoother finishes tend to show better test behaviour but roughness is not the only influencing factor. More important is a coherent surface without micro-cracks and micro-crevices, for example in the form of material overlaps. Residues of the polishing material can be detrimental, contaminate low-alloyed steel, leading to very rapid rusting.

Heat tint colours resulting from heat treatments or welding operations reduce pitting and crevice corrosion resistance. In addition the oxides forming these colours can react in corrosive environments, transforming to brownish hydroxides. Heat tinted areas are therefore often prone to corrosion and rusting in salt spray tests

Figure. 6.8: Effect of heat tint colors and weld cleaning operations on the salt spray test resistance of stainless steel 1.4301

Corrosion at the cut edges of the sample often makes the carrying out of a salt spray test and its evaluation more difficult, if corrosion products emerging at the upper and lateral edges spread out over the sample surface, masking large area fractions after longer testing times. The appearance of the sample is then governed by the corrosion behaviour of the cut edges, which is usually of less interest, while the corrosion behaviour of the rolled surfaces can no longer be adequately evaluated. Corrosion of the cut edges and holes is often caused by ferrous contamination from drilling and cutting.
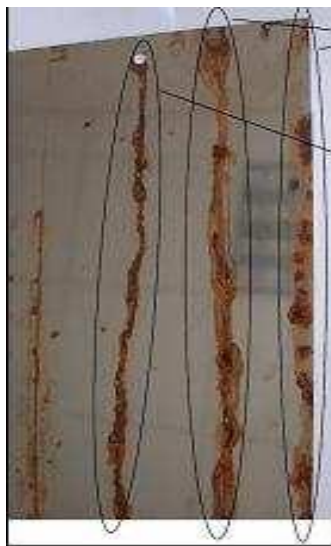

Figure. 6.9: Hole edges can lead to corrosion

Figure. 6.10: Bad adhesive tape can lead to corrosion

To reduce these experimental shortcomings, cut edges can be masked with adhesive tape or prepared to obtain a smoother surface. The sample areas covered with corrosion products coming from the cut edges should be ignored when evaluation is performed

Figure. 6.11: Good adhesive tape can avoid corrosion

According to the test specification, the salt fog has to fall vertically. With flat samples standing inclined, according to the standard, the test medium does not stagnate on the surface but drains off rapidly and is continuously replenished.

If other sample layouts let the test medium stagnate in crevices, depressions or on horizontal sections, these areas are much more prone to corrosion and the positioning of the sample in relation to the falling direction of the salt has a considerable influence on test behaviour. It is therefore recommended to test only plane samples rather than constructional elements with complex geometries.

CHAPTER 7

WORKING STEPS

7.1 Salt Water Spray Test procedure and steps

Salt water spray tests are often used to evaluate the corrosion resistance performances of metal materials and inorganic and organic plate coatings applied on metal materials. Neutral salt water spray test methods are explained here.
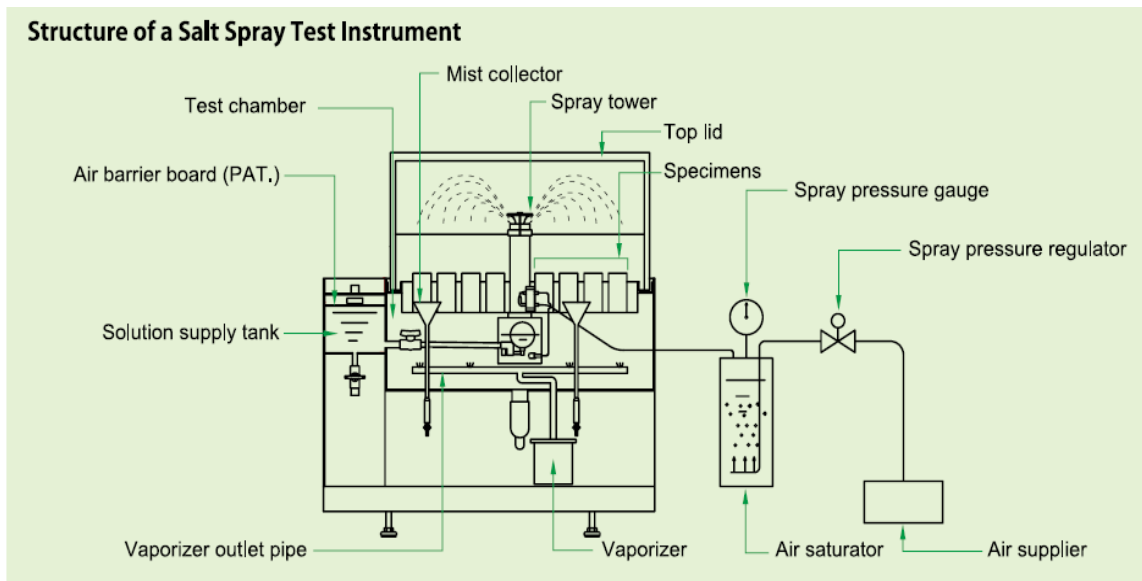
7.1.1 Test equipment

Figure. 7.1: Structure of a salt fog test instrument

The system is comprised of Salt water spray device, Specimen holder, temperature controllable spray chamber, Air saturator that saturates the test environment air with water. Required conditions for the test equipment are as follows.

- The spray equipment is to be of Spray tower or Nozzle type.
- The spray chamber is to be 0.2 m 3m or more.
- The chamber ceiling or the cover is designed not to drip the test solution on the specimen.
- The equipment is to be corrosion resistant.
- The chamber environment is not to be affected by the external air, and the solution dripped from the specimen is not to be re-deposited on the specimen.
- The test specimen can be held in prescribed angles.

- Two or more spray liquid collectors with horizontal collection area of 80cm2 are to be provided.

7.1.2 Test specimen

a) To be 70×150×1.0 or 60×80×1.0 flat plates, but they can also be of materials agreed upon by the parties involved.

b) The metal or plated metal specimens are to be properly cleaned.

c) Cut sections of the specimen are to be protected with tape, paint, paraffin, etc.

d) The specimen during the test is to be held at $20\pm5°$ in relation to the vertical line.

e) The positioning and spacing of the test specimens are not to prevent free falling of the spray, and the solution dripped from the specimen is not to fall on other specimen.

7.1.3 Testing salt water solution

The solution is to be adjusted to salt concentration of 40g/L by dissolving class1 sodium chloride reagent in deionized water, with a specific gravity of 1.0250~1.026 at 25℃.

7.1.4 Air supply

The compressed air used to spray the salt water solution is to be kept at 0.098±0.01Mpa.

7.1.5 chamber condition

a) Spray chamber and test solution reservoir is to be at 35±2℃.

b) The spray is to be of free fall, and not to be directly sprayed on the test specimen.

7.1.6 Post testing handling of test specimen

- Test specimen is to be removed carefully.

- Immediately water wash at a room temperature and dry in order to remove the salt from surfaces.

- Corrosion born products are removed by mechanical means such as brushing or chemical means.

7.1.7 Judgment method

- Area method: By Rating Number Evaluation.

- Weight method: Weight variations before and after the test.

CHAPTER 8

TESTING CONDITIONS

8.1 Testing Zinc Nickel Coatings under ASTM B117 conditions

Prior to the appearance of white rust the approximate test duration should be c.350hrs and for red rust to appear the approximate test duration should be c.1000hrs. The principle application of the salt spray test is therefore to enable relatively quick comparisons to be made between actual and expected corrosion resistance in terms of the time taken for oxides to appear on the samples under test. This is compared to expectations, to determine whether the test is passed or failed. For this reason the salt spray test is most often deployed in a quality audit role, where, for example, it can be used to check the effectiveness of a production process, such as the surface coating of a metallic part. The salt spray test has very little application in predicting how materials or surface coatings will resist corrosion in the real-world, because it does not create or accelerate real-world corrosive conditions. Cyclic corrosion testing (CCT) is much more suited to this application.

8.2 Test Exposure Conditions

- Position samples within the chamber in accordance of the test standard.
- Ensure that no samples 'touch' or 'shadow' other samples and that droplets from one sample cannot fall on to other samples.
- Start the test cycle and record test parameters at start.
- Spray continuously with atomized salt water at a constant chamber temperature of +35C.
- Exceptions to continuous testing are permitted in order to record fallout collection rates and PH of collected solution daily. Typically, this would be at the same time daily and omitted at weekends.
- Insert clean and empty salt spray collection vessels around the samples, preferably at sample height inside the chamber, and never underneath samples or anything else that could drip into them from above.
- Photographs may be taken of the samples at customer specified intervals throughout the test.

8.3 Quality Control

- Daily checks to ensure the standard is being followed with variable parameters within limits – Record all parameters.
- Check that the chamber temperature is within acceptable limits.
- Check that air saturator temperature is within acceptable limits.
- Check that atomizer air pressure is within acceptable limits.
- Check that collected solution is within acceptable limits for fallout rates.
- Check the reservoir salt solution is within 5.0% +/-1.0% NaCl.
- Record the reservoir salt solution pH.
- Check that collected salt solution pH is within acceptable limits.
- Record the conductivity of the DI water when used.
- Monitor the level of salt solution in the reservoir and ensure that there is enough for the next 24/48 hours. (Allow extra for weekends).

8.4 After Exposure

The test samples should be rinsed with deionized water and carefully dried. Exact method determined by customer. Photographs of the samples should be taken.

8.5 Deviation Handling

General deviations such as downtime, out of tolerance recordings should be noted in the test report, including details of any alterations made.

CHAPTER 9

ADVANTAGES AND LIMITATIONS

9.1 Popularity and Advantages

The salt spray test is the oldest "corrosion test" and the most widely used by users of highly corrosion- resistant material. It has become a "universal" test. The reason is that the salt spray test offers numerous advantages. One of the most interesting is that the test is multi-material. For example, it is possible to test a bare material, a painted one and a noble or sacrificial coating [Figure 2].

The test duration is short compared to the natural environment, the cost is limited and a standardised material is required. There is a limited number of standards dedicated to this technique, so the framework is widely known.

	Electro-galvanized carbon steel	AISI 441 type stainless steel
48h		
380h		

Table 9.1: Electro-galvanized carbon steel and AISI 441 type
stainless steel after short and long salt spray test exposure.

The salt spray test can also be a combined test of material and surface finish, due to the fact that roughness and wet ability play a considerable role in the final result. Many users do not even hesitate to test shaped items or equipped parts. In addition, we should not forget that the results provided by such tests are impressive and easy to comprehend.

The test is consequently appreciated for being useable in a commercial argument. On the other hand, systematic abuses are sometimes noted, especially when stainless steels are tested. As a first approach, it is sometimes found that the standard itself is not well enough known. In the next part, an in- depth reading is therefore suggested. To conclude, the salt spray test unfortunately has serious drawbacks. It is a destructive test, very scattered and not correlated with actual performance.

a. This practice provides a controlled corrosive environment which has been utilized to produce relative corrosion resistance information for specimens of metals and coated metals exposed in a given test chamber.

b. Prediction of performance in natural environments has seldom been correlated with salt spray results when used as standalone data.

c. Correlation and extrapolation of corrosion performance based on exposure to the test environment provided by this practice are not always predictable.

d. Correlation and extrapolation should be considered only in cases where appropriate corroborating long-term atmospheric exposures have been conducted.

e. The reproducibility of results in the salt spray exposure is highly dependent on the type of specimens tested and the evaluation criteria selected, as well as the control of the operating variables. In any testing program, sufficient replicates should be included to establish the variability of the results. Variability has been observed when similar specimens are tested in different fog chambers even though the testing conditions are nominally similar and within the ranges specified in this practice.

9.2 Limitations

This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

CHAPTER 10

APPLLICATIONS

This test can be used to test the relative resistance to corrosion of coated and uncoated metallic specimens, when exposed to a salt spray climate at an elevated temperature.

Typical coatings that can be evaluated with this method are:

- Phosphated (pre-treated) surfaces (with subsequent paint/primer/lacquer/rust preventive)
- Zinc and zinc-alloy plating (see also electroplating). See ISO 4042 for guidance
- Electroplated chromium, nickel, copper, tin
- Coatings not applied electrolytically, such as zinc flake coatings according to ISO 10683
- Organic coatings, such as rust preventives
- Paint Coating

Hot-dip galvanized surfaces are not generally tested in a salt spray test (see ISO 1461 or ISO 10684). Hot-dip galvanizing produces zinc carbonates when exposed to a natural environment, thus protecting the coating metal and reducing the corrosion rate. The zinc carbonates are not produced when a hot-dip galvanized specimen is exposed to a salt spray fog, therefore this testing method does not give an accurate measurement of corrosion protection. ISO 9223 gives the guidelines for proper measurement of corrosion resistance for hot-dip galvanized specimens.

Painted surfaces with an underlying hot-dip galvanized coating can be tested according to this method. See ISO 12944-6.

Testing periods range from a few hours (e.g. 8 or 24 hours of phosphated steel) to more than a month (e.g. 720 hours of zinc-nickel coatings, 1000 hours of certain zinc flake coatings).

CHAPTER 11

CONCLUSION

The salt spray testing machine is adapted to be operated in sequence to faithfully reproduce outdoor conditions. Namely, at first the brine spray is produced, and then the specimens are rinsed, then dried by hot or ambient air, and cooled. The test pieces are moistened to simulate formation of dew on the surfaces of the test pieces and then drying is affected. It will be understood that this cycle of operation, reproducing outdoor conditions, provides a test which has a high degree of conformity with natural outdoor corrosion conditions.

The test results can be examined visually to measure the integrity of the alloy and or its coating. Comparisons of pre- and post-testing photos will be taken and if needed a comparison of a corroded sample from the field may also be used. Weight loss or gain are recorded before and after exposure to estimate the corrosion rate. Monitoring of pH and water collection is performed at the twice a day. Then we provide a thorough report with data, analysis, pictures, and discussion that helps you understand and apply the results.

The Salt Spray Test is widely used test the durability of protective coatings. However, though it is a standardized test, its results do not have any correlation with the number of years that the coating can last before showing signs of corrosion.

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