

Midget Salt Spray Testing Machine For Rapid Corrosion Test

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Abstract: The metals in the environment can corrode in an ordinary condition and some special conditions. The main aim of this project is to design and fabricate salt spray testing machine which is able to identify the corrosion formation in any type of metals; from this testing process we can improve the life span of the particular metal. For example, 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 analysed. This salt spray testing machine is fabricated for low cost and the metals are coated and analysed.

1. INTRODUCTION

Materials under saline environment will corrode rapidly than we expect. Hence suitable testing process is required to overcome this problem. There are different corrosion testing methods available. Salt spray test is the one of the best process to find out corrosion rate of material in earliest possible time. It provides controlled corrosive environment which can be utilized to get information about the corrosion resistance of the given specimen. 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. Corrosion is a characteristic procedure that changes over a refined metal into an all the more synthetically stable structure, for example, oxide, hydroxide, or sulfide. It is the continuous demolition of materials (normally metals) by chemical or potentially electrochemical response with their condition.

2. LITERATURE REVIEW

M.P.Papadopoulos (2007) worked on Impact of salt splash consumption presentation on the mechanical exhibition of various specialized class fortifying steel bars. For experimentation fake erosion is done on the pliable examples of various strengthening steel bars in research center salt shower tests and then the pre-eroded examples were pliable tried to consider the corruption of the mechanical properties of the material with collecting consumption harm. L.A.Dobrzanski (2007) Corrosion obstruction of sintered duplex tempered steels in the salt mist splash test. In this exploration work, they have examined that the consumption properties have been considered through salt haze shower test which is applied by the car business end-users.

It is come about out that sintered duplex treated steels shows great erosion properties in chloride condition. Steven Van Raay (2007) worked on ASTM B117 Standard practice for Operating salt spray apparatus. In his work, corrosion test is done by sodium chloride fog on the abraded part of the material. Fog testing alludes to an immediately paced consumption potential assessment that is directed to decide the overall opposition of a metal to debasement in a salt as well as haze condition. It is additionally used to decide the porousness of coatings and seals in raised encompassing temperatures. It is principally referenced by modern staff directing metallic establishments in sea, ocean and other high salt focus environments. The material to be tried is splashed with a salt answer for a foreordained timeframe and afterward inspected for reactivity. Holly J.Martin (2010) worked on Effects of variations in salt spray conditions on the corrosion mechanism of an AE44 magnesium alloy. In his work, Dampness strongly affects material and item stress. Luckily, it very well may be precisely determined. In dampness testing, every one of the information acquired is basic to arranging and choice of coatings, paints, items and materials. By appropriately securing against mugginess, the life expectancy of the item can be broadened. In a stickiness test, dampness and mist are controlled explicitly for erosion investigation. This is utilized for a wide scope of items, running from electrodeposited paints or coatings to copper tube frameworks. Stickiness tests are commonly used to survey materials' destructiveness or the effects of substances like lingering contaminants. A variety of the test, known as the cyclic mugginess test, is performed to repeat high warmth and stickiness presentation. The bureau that is utilized in the test must have a solid criticism controller and moistness sensor. With this test, different things can be concentrated, for example, parameter move disappointments, mechanical disappointments, covering debasement just as different elements, which are immeasurably significant in keeping up the nature of tasks. M.Sathishkumar (2018) worked on Fabrication of lowcost saltspray chamber for testing corrosion resistance of the materials. In his work, corrosion resistance work is done by weight loss method. The weight reduction investigation is described by the utilization of coupons. It is a procedure which includes the arrangement of the coupons in a particular situation, the expulsion of the examples after an assigned time interim, cleaning them for net weight and recording the weight distinction in understanding to the time interims. The information got can be inputted in a known designing equation and along these lines create the consumption rates. The evaluated time of coupon introduction

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is for the most part between 60–180 days relying upon the productivity required, yet most labs lean toward 90 days. The examination requires promptly accessible and solid hardware for exact data. It is a reasonable technique for deciding consumption levels in multifaceted structures. Some weight reduction investigation incorporates tests which give limited subtleties of the consumption occasions; the polarization shows the erosion rate change. The nuclear weight, thickness, charge number, and Faraday steady will help in evaluating the erosion rates. Aside from consumption rates, the information from the investigation can be utilized to evaluate the thickness decrease. M.P.Papadopoulos (2011) worked on Corrosion of uncovered rebars, related mechanical corruption and connection with quickened consumption tests. In their examination work, they have learned about consumption in an enormous number of steel fortified solid structures in Greece in which spalling of the bond has left the steel support (rebars) presented to the environment. An enormous number of tests (areas of uncovered rebars) were gathered from structures as long as 96 years of age, and weight reduction estimations, malleable testing and fractographic investigation were conveyed out. Salt splash testing is completed on new comparable evaluation rebars so as to build up a relationship with the normally consumed uncovered rebars. It was come about out that uncovered rebars experience the ill effects of uniform consumption pursued by debasement of mechanical properties. Shaogang Wang (2011) worked on Portrayal of microstructure, mechanical properties and erosion obstruction of disparate welded joint between 2205 duplex tempered steel and 16MnR. In their examination work, The joint of divergent metals is done between 2205 duplex hardened steel and 16MnR low amalgam high quality steel are welded by tungsten idle gas circular segment welding (GTAW) and protected metal curve welding (SMAW) individually. It is come about out that mechanical properties of joints welded by the two sorts of welding innovation are fulfilled and the consumption opposition of the weldment delivered by GTAW is better than that by SMAW in chloride arrangement utilizing salt splash test in research facility. M.Palm (2012) worked on Neutral salt spray test on Fe-Al and Fe-Al-X. In his work, Wonder inactivity is firmly identified with assurance of metals from consumption. Term inactivity is first used by 'Schonbein' in 1836 to portray the abnormal conduct of iron in concentrate HNO_3 . Presently it is ordinarily acknowledged this marvel to every one of the metals A bit of iron when plunged in weaken HCl develops H_2 gas, supplant Ag from AgNO_3 and Cu from CuSO_4 arrangement. However, on the off chance that equivalent bit of iron is first plunged in conc. HNO_3 or chromic corrosive for quite a while and afterward responded with above reagents, it remain unattacked. In this way iron by treatment of conc. HNO_3 is rendered latent or inactive and the wonder is known as 'Detachment'. "The dormancy displayed by metal under conditions in which synthetic movement is normal is called concoction latency and the substances which cause this marvel are called passivators". Normal passivators are conc. HNO_3 , chromic corrosive, warming in air. Marvel in which a metal or a composite displays an a lot higher erosion obstruction than anticipated from it position in the electrochemical arrangement. Detachment is the aftereffect of the development of exceptionally defensive yet extremely flimsy and very imperceptible film on the outside of metal or of a composite, which make it respectable. Such film is viewed as insoluble, nonporous and when broken will fix itself.

A.K.Lakshminarayananet (2013) worked on Analysis of Corrosion Prevention Methods in Railway Coaches and Bogies. In their work, they studied about the effect autogenously arc welding processes on tensile and impact properties of ferritic stainless steel conformed to AISI 409M grade. They have used Rolled plates of 4 mm thickness used as the base material for preparing single pass butt welded joints. Evaluation of Tensile and impact properties, micro hardness, microstructure, and fracture surface morphology of continuous current gas tungsten arc welding (CCGTAW), pulsed current gas tungsten arc welding (PCGTAW), and plasma arc welding (PAW) joints are done & results are compared. It is resulted out that the PAW joints of ferritic stainless steel show high tensile and impact properties when compared with CCGTAW and PCGTAW joints which is mainly due to lower heat input, finer fusion zone grain diameter, and higher fusion zone hardness. Thiago J.Mesquita (2014) worked on Corrosion and metallurgical examination of two supermartensitic hardened steels for oil and gas situations. In their work, the erosion properties of two supermartensitic tempered steels were contemplated in chloride and H_2S situations. The two SS grades 1.4542 and 1.4418 warmth treatment and their microstructure considered. In H_2S media, the 1.4418 displayed a higher steadiness and passivation contrasted with 1.4542. The Electron backscattering and X-beam diffraction were utilized to describe the measure of held austenite in the 1.4418 and afterward its impact on setting and SSC opposition researched. A.Guedon Gracia (2016) worked on Effect of saltspray test on lead free solder alloy. In his work, Polarization is a component that regularly brings about an adjustment in the capability of a terminal during electrolysis, when the anode's potential gets nobler than that of the cathode. It has the impact (in view of states) of diminishing the yield voltage of batteries, and expanding the voltage required for electrolysis cells or bringing down flows. Focus polarization of a terminal is the aftereffect of the arrangement of a dispersion layer nearby the outside of the cathode where there is an angle of particle fixation. Dispersion of the particles through the layers controls the electrochemical response and is significant for procedures, for example, electroplating and erosion. Focus polarization might be diminished by expanding tumult or raising the temperature of the electrolyte. The coated abrasive materials are used for this operation. Salt spray humidity conditions has been taken for this operation. The amount of sodium chloride (NaCl) concentrates are used for measurement of the corrosion rate. Corrosion resistance can be determined by the pit density ratio. Weight loss method is used to find corrosion rate of the material.

3. METHODOLOGY

Identification of the problem. Collect related literatures. Analysis of gap. Conceptualization of the project. Checking the feasibility. Designing of the components. Fabrication of the project. Testing and analysing results. Scope for improvement.

4. FABRICATION PROCEDURE

The problem in the current salt spray testing machine was identified by physical observation and experimentation. The literatures related to salt spray testing machine were collected from different sources and observed the methodologies used. Analysed the gap and drawbacks found in the collected literatures, nature of the project and cost involved. Conceptualization of the project to solve the problems found in

the currently available methodologies by applying the engineering principles. Feasibility of the project checked by analysing the process parameter in the salt spray testing machine with the proposed mechanism and materials were selected. Design calculations are carried out to meet up the process requirement for each component. Materials are purchased for each component according to the requirement and design. Fabrication of each component were done according to design and assembled to achieve the proposed mechanism. The project was operated to perform the process of spraying the salt solution in the form of fog and the results were noted. The performance of the machine was analysed continuously to improve the quality of the work.

5. DESIGN CALCULATION

Size of the acrylic chamber

$$\begin{aligned} \text{Length, } L &= 60 \text{ cm} \\ \text{Breadth, } B &= 40 \text{ cm} \\ \text{Height, } H &= 45 \text{ cm} \\ \text{Volume, } V &= L \times B \times H \\ &= 60 \times 40 \times 45 \\ V &= 108000 \text{ cm}^3 \end{aligned}$$

Flow rate of solution through copper pipe

$$\begin{aligned} \text{Radius, } R &= 0.3 \text{ cm} \\ \text{Area, } A &= \pi \times R^2 \\ &= 3.14 \times (0.3)^2 \\ A &= 0.2826 \text{ cm}^2 \\ \text{Velocity, } v &= 3 \text{ m/s} = 300 \text{ cm/s} \\ \text{Flow rate, } Q &= A \times v \\ &= 0.2826 \times 300 \\ Q &= 84.78 \text{ cm}^3/\text{s} \end{aligned}$$

Steam flow rate

$$\begin{aligned} \text{Diameter of the pipe, } D &= 0.6 \text{ cm} \\ \text{Velocity of steam, } v &= 300 \text{ cm/s} \\ \text{Mass of the solution, } m &= 3.79 \text{ kg} \\ \text{Volume of the solution, } V &= 108000 \text{ cm}^3 \\ \text{Specific volume, } V_s &= V / m \\ &= 108000 / 3.79 \\ V_s &= 28496.042 \text{ cm}^3/\text{kg} \\ \text{Steam flow rate, } m_s &= 3600 \times \pi \times (v / V_s) \times \\ (D / 2)^2 &= 3600 \times 3.14 \times \\ &= (300 / 28496.042) \times \\ &= (0.6 / 2)^2 \\ m_s &= 10.71 \text{ kg/hr} \end{aligned}$$

Mass of NaCl required

$$\begin{aligned} \text{Mass of water, } m_w &= 11.37 \text{ kg} \\ \text{Mass of NaCl required} &= m_w \times 0.053 \\ &= 11.37 \times 0.053 \\ \text{Mass of NaCl required} &= 0.603 \text{ kg} \\ \text{pH range of the solution is } &6.5 \text{ to } 7.2 \text{ at } (20^\circ\text{C to } 26^\circ\text{C}) \end{aligned}$$

Size of the reservoir

$$\begin{aligned} \text{Radius of the reservoir, } r &= 14 \text{ cm} \\ \text{Height of the reservoir, } h &= 30 \text{ cm} \\ \text{Volume of the reservoir, } V &= \pi \times r^2 \times h \\ &= 3.14 \times (14)^2 \times 30 \\ V &= 18463.2 \text{ cm}^3 \end{aligned}$$

Experimental Setup

The assembly unit consist of acrylic chamber , reservoir , heater, arduino board and RTD (Resistance Temperature Detector). First the reservoir is filled with the salt solution and the salt solution is transmitted to the heater with the help of pump. The pump is operated with the help of sensors in the arduino board. The salt solution is heated inside the heater and the salt solution is converted into steam. Now the steam is fed into the acrylic chamber through a pipe. Inside the acrylic chamber, specimen holder is placed in the top portion of the chamber. In that specimen holder, the work samples are placed inclined. The steam inside the acrylic chamber is monitored with the help of RTD and the values are shown in the display in the arduino board. The coated and non-coated work samples are placed in the specimen holder. This process is carried out for three days continuously under required conditions. The temperature maintained inside the acrylic chamber is 46°C to 49°C. After the three days of experiment, the work samples get corrode and the corrode samples are taken and the corrosion rate is tested by means of weight loss method.



CONCLUSION

Thus the developed salt spray testing machine can be used effectively. The quality of the fabricated salt spray testing machine is better than the already existing machine. The

program interfaced with machine work flawless and the accurate results are given. The developed machine is simple and can be easily known by everyone and it is cost effective than any other presently available machine. This project explains the test conducted in salt fog chamber to evaluate the effectiveness of the specimens. The test were conducted and followed by the ASTM standards.

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