

STUDY OF ATMOSPHERIC CORROSION RESISTANCE ON METAL

Suresh Bahadur Singh¹, Anurag Srivastava², Maneesh Mishra³

¹M.Tech. Scholar of Mechanical Engineering, SRIMT/AKTU Lucknow, India

²Assistant Professor and Head of Department of Mechanical Engineering, SRIMT/AKTU Lucknow, India

³Assistant Professor of Mechanical Engineering SRIMT/AKTU Lucknow, India

ABSTRACT:- Corrosion resistance is widely used in industrial application like as automobile sector. In corrosion resistance mainly process used like as zinc electro chemical, phosphate, powder coating, cathode electro deposition paint, hard chrome, acid electro plating etc.. In this process are used in different type material and different type requirement. Basically these processes are used to increase metal life and protect the metal surface from corrosion. The atmospheric corrosion resistance is providing more powerful which process enters the pores of metal and sealed the surface of the metal. These processes protect the metal surface with help of other metal and given the performance. The trial product treated these process alkaline zinc plating, phosphate, CED, and powder coating are given the corrosion resistance life is 1008 hours at in different atmospheric temperature.

Key words- corrosion resistance, metal life, component surface, protect the surface, coating

INTRODUCTION

Atmospheric oxidation, rust, corrosion and dissolve the metal on surface are the main failure modes of components in the automobile and parts like as car and bike body, brake, pipes, brake callipers, spars and general uses components and parts like as thread bolts and nuts, screw, boiler, combustion engine and fasteners etc.

LITERATURE REVIEW

Corrosion Mechanism

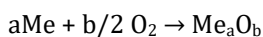
The surface degradation of automotive metal parts like as body, spar part, and other area like as power plant boilers, daily uses component and instrument is mainly the output of three distinctly separate modes of attack. These mechanics are contact with humidity air (moisture in the air), acidic nature of atmosphere, salty air and other solids and liquid chemicals forms. Metals of surface will also rusted when open to gas from metal like as vapours of acid, gases of formaldehyde, sulphur and ammonia gas. Rust basically prefer the process do the degreasing, life of metal surface.

Atmospheric Oxidation

Atmospheric Oxidation on the surface of metal occurs when different substance of atmospheric is because corrosion surface of metals. In natural phenomenon of environment oxygen and air with humidity is itself sufficient to generate the corrosion on the surfaces of metal, the mostly produce rust is iron oxide. In metal mechanical strength reduces drastically for the reason corrosion and decrease the life of metals.

Principles of Oxidation

The general chemical equation between a oxygen (O₂) and metal (Me) a for an describe reaction oxidation from given below.



The first of all reaction of metal-oxygen collaborate the gas accumulated on the fresh surface of metal. The atmospheric oxygen dissolves on surface of metal and oxide forms as leave oxide nuclei or as a continuous oxide film.

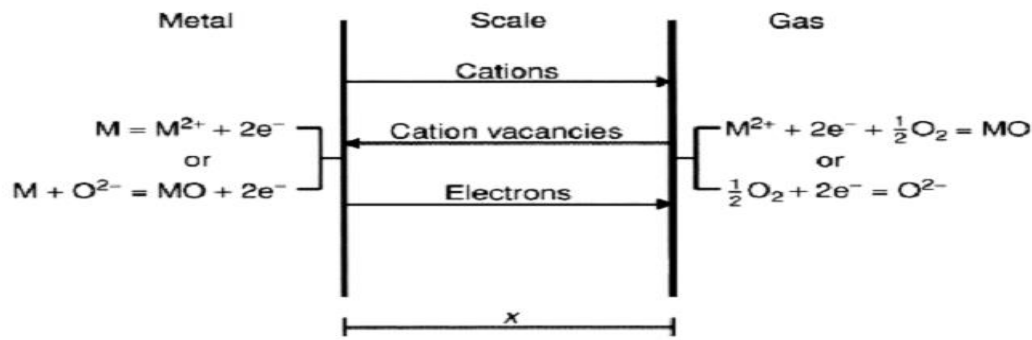


Figure 2.1:- sequence showing a simply process of oxidation where the cations and cation vacancies have to penetrate the oxide layer.

The Initial Stages of Oxidation

The atmospheric of air in surface of metal is the very first step of oxidation. This process reduces in open energy and entropy which means enthalpy decreases and makes this process normally exothermic. There are defining two manners of adsorption, chemical (chemisorption's) and physical. Chemisorption's forming is a chemically bonded upper layer of metal atom via the transfer of electrons. Physical forming Vander forces bonding the gases on surface and is reversible. Very rapid chemisorption's from gases where metal surface appearance not cleans any activation energy.

Oxidation Resistance

The resistance oxidation is covered by different process or manners. The mainly process are cadmium, chromium, copper cyanide and acid both, gold cyanide, nickel iron, lead, palladium, platinum, rhodium, silver, tin stannous and stannic and zinc. This type process is used for resistance of oxidation improve and increase the component life. The resistance are improving the oxidation corrosion resistance of the metal and alloy by the generation of an adhesive, protect gradually growing Zn (zinc) oxide layer. This oxide is gradually increased and outside layered cover the diffusion of other alloy elements and the inside diffusion to impurities of gaseous as slow transport processes and scaling the generally. The outside diffusion of Zinc (Zn) along grain boundaries has shown faster than the inside diffusion of oxygen by a factor of three and formation on zinc scale. The life of component is increase or metal to use the cathode electro deposition (paint) and powder coating. Both are also increase the life of metal it is from corrosion resistance. The CED is most advanced technology and eco-friendly paint based coating to be done on metal components. It is commonly and properly used in automotive sections.

Method of Corrosion Resistance

First step is to prepare the metal surface or component surface because surface is oiling, greasing and naked surface to direct contact atmosphere. The metal surface greasing and oiling is metal are going through different process like pressing, forming and in this operation used oil and grease. So different process are used for removing the grease and oil on the surface of component. The process is degreasing, blasting, soak cleaning, anodic cleaning, pickling (acid cleaning), and neutralizer. The process is done by different parameters controlling range. The process is used for surface preparation for new layer coated on surface metal.

Salt Spray Test Method

The salt spray test or SST is also saying that as salty fog test. The SST test is artificial atmospheres created in chamber and checks the corrosion conditions. The salty spray test used in different manners is like as the acetic acid salt spray (AASS), and copper-accelerated acetic acid salt spray (CASS), neutral salt spray (NSS) test for checking method of metal surface of life and how much time fight with corrosion, and also cover the permanent and temporary. The neutrally are using salt spray test to metals and metallic coatings their alloys, conversion coatings, anodic oxide coatings on metallic materials. The AASS test is decorative coating of copper, nickel; chromium and the CASS test copper basically prefer nickel chromium. The chamber of salt spray is like an artificial atmosphere and the artificial atmosphere is making by use different type solutions (test solutions).

Controlling method for atmospheric corrosion

Zinc electro plating

Zinc plating is like as a coating but this coating is part of chemical coating. The other reason coating of zinc is so efficiently at protecting corrosion is covered the zinc on surface of metal. Through a process called as galvanise coating because the other alloy of metal is galvanise and then through the surface of metal by using electric manners. So zinc wills other manners the surface of metal protecting. Its process called as Electroplating and safe the surface of metal to cover the other metal, mainly done to provide protection from corrosion.

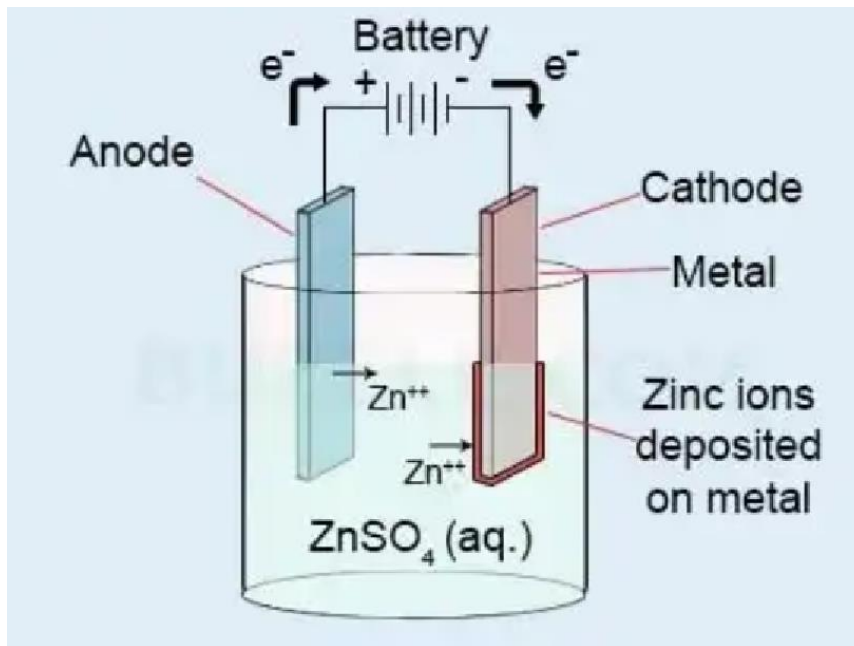


Figure- 2.4 Electro plating principal

CATHOLIC ELECTRO COATING

PRINCIPLES

The CED full form is cathodic electro deposition. This type coating is based on electro or direct current conductivity. The metal or component is positively cathode based and current is flow in solution tank and the aqueous paint is deposit on the surface of component. CED coating are mostly or too much used in automobile sector. CED is eco-friendly process. The basic principal of CED coating an objective having a conductive surface connected to circuit as the cathode by positively charged paint particles suspended in aqueous medium, under direct current. Pictorially define the process is given fig 2.6.2.1



Figure2.5- CED bath solution

CED is most advanced; upgraded and eco-friendly paints based coating to be done on surface of metal component. CED having a good adhesive properties and also given good life of atmospheric temperature and also good appearance. CED is mechanically durable and chemically resistant. CED coating is provide primary layer of next process and also gives good corrosion resistance. CED is an epoxy based coating and epoxy word is described Greek words, which is two word epi (over) and oxi (oxygen combining from). Today, this term logy are described the function of ced coating it means cover the oxygen layer on component of surface. CED is the main function is protecting the oxidation layer from generate the corrosion on the surface of component. CED process flow describes the different manners. The process sequence is given

Powder coating

Powder coating is also electro method but it is powder form not chemically form. It is fallow the same principal of cathode electro deposition or chemical electro plating depositions means component is cathode(+) and deposit powder anode (-). Powder coating is not state of liquid, it used basically thicker layer of coating on component surface. The powder coating process we are used free flowing dry powder. It is applied fundamental of electrostatically and is then baked under oven temperature. The powder is thromboplastic or thermoset polymer. It is used mainly metals, aluminium and automobile sector metal. The powder coating process was introducing the word around 1945 by Daniel Gustin US. The powder coating properties is many types.

No solvent contain in powder coating process and also volatile organic a little bit of component into the atmosphere. And also used different way of colour on the component surface.

Thick coating is used which baked to uniformly compare to other coating. Coating thickness controlled easy way for manually or movement of gun.

In the coating process is used powder grain size 2 to 45 μ (microns) and softening temperature 80 to 220 $^{\circ}$ c.

The process of powder coating is not more expensive or complex to camper then other process.

The powder coatings are main two type's thermosets and thermoplastic. Both types powder is formulation of verity incorporates. When baked the powder, reacts improving the performance other polymerize, properties. The common polymers are used mostly polyurethane, polyester, epoxy, polyester epoxy and acrylics.

Gun spraying

Powder coating process is using Gun spray method. The gun spray process are good adhesive strength because it is spray process of thermal base.in powder coating gun spraying method is given low porosity and compressive residual stresses in coating surface. The main perimeters are in gun spraying flow of powder and current and other parameters are air pressure.

These parameters are controlling different function like as air pressure is controlled flow of powder to the surface of component and current parameters is controlled the deposition of powder and metal are accepting powder. In gun spraying process different parts used like as drum where the powder is stored in drum and equalize and powder go through with the help of pipe and gun pull the powder from drum with the help of air and other is controller. In controller for using to controlled the parameters from like as current, air flow, spraying method.

MATERIALS AND EXPERIMENTAL METHODS

Materials: -CRC sheet (cold rolled coil sheet), HRC (hot rolled coil sheet) Boiler Steel SAE-431 and Coating Stellite-6 & Stellite-21 have been selected. This alloy has been selected as they are used in boiler and gas turbine components due to their high strength and creep resistance.

Table 3.1(a) Chemical Composition of cold rolled closed steel sheet IS:513 .

Material	C	Mn	Si	S	P	Cr	Ni	Fe
JIS G3141	0.04-0.15	0.30~0.60	0.75	0.05(max)	0.055(max)	17-20	9-13	Bal

Specimen preparation for test

Sample size:

The sample were shaped to dimensions of 70x150x2 mm³

Surface treatment:

Before the testing the samples were polished with 120,180,220,240,400 & 600size SiC grit paper. After these the samples washed in acetone for removing dirt. During sample preparation the process parameters should be control. Table 3.2.2 zinc plating observation sheet during process

These above table monitor control data during sample preparation. After complete sample process we take one component for salt spray test and other is going through to another or next processor CED or powder coating. Before doing this process we check the appearance and thickness of the component by using thickness tester and note down thickness check sheet. The thickness data is 10 μ , 11 μ ,10 μ ,9 μ ,10 μ . Another component is going to next process CED.

Development of CED:

In CED process also prepared the surface before is donning the paint coating or cathode electro deposition of paints ions. The process perimeter is standard during the sample preparation time parameters of CED process.

Development of Coating:

The Ni-80%Cr powder with 100 μ m thickness was sprayed by Detonation Gun method for bond coat after that Stellite-6 & Stellite-21 with 150 μ m thickness was sprayed by Detonation Gun method After powder coating the output is get fresh powder coated parts. The powder coated part is going through the testing lab in wipe jagdispur. The test is salt spray test, adhesion test (tape test).

Environment for Oxidation:

Firstly sample washed with acetone then exposed to pure oxidation in air in the salt spray oxidation at 25°C & 35°C.

Environment for atmospheric corrosion:

In case of atmospheric corrosion, deposition of salt is necessary to produce corrosive environment. So for that after washing with acetone the samples were heated in furnace to 250°C. The heating of specimens were found necessary for proper adhesion of the salt layer. Thereafter a layer of mixture Na₂SO₄-82Fe₂(SO₄)₃ salt was applied uniformly on the specimens with the help of camel hair brush. Amount of the salt coating was kept in the range of 3.0-5.0 mg/cm² the salt coated specimens as well as the alumina boats were the kept in the chamber for 3-4 days at 25°C.

RESULTS AND DISCUSSIONS

Fig 4.1 shows the salt spray cycle in hours by checking atmospheric salt spray chamber and check visually when white spot or rust (red) spot come on component surface (panel). Firstly we check the alkaline zinc plating phosphate or panel 1. This process only covers a thin layer surface of component and disconnects the surface to atmosphere. 24 hours complete then completed one cycle. We also research the how much take the time to break the coated surface on the component surface

Shows salt spray cycle in hours by checking atmospheric salt spray chamber and check visually when white spot or rust (red) spot come on component surface (panel). Fourthly we check the alkaline zinc plating phosphate and powder coating or panel 4. In This process covers a thin layer added powder on surface of component and strongly disconnects the surface to atmosphere. 24 hours complete then completed one cycle. We also research the how much take the time to break the coated surface on the component surface. In this process also check how much life gain on component done only zinc plating phosphate and powder coating.

We done this process only protect the surface and also increase the life of component .we periodically monitors the whole salt spray chamber and controlled the perimeters. Like as temp -35 \pm 2 °c, pressure 2.5 \pm 0.4 kg , nozzle pressure 1 \pm 0.1 Kg.

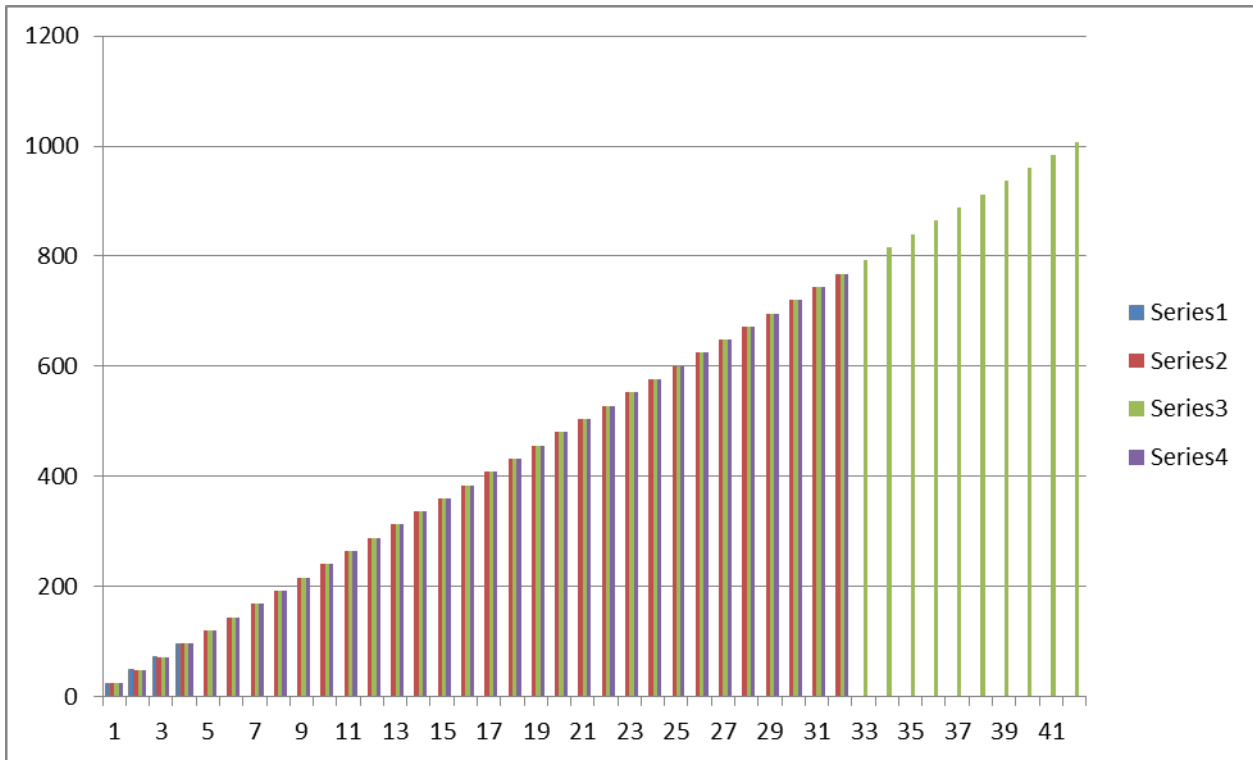


Figure 4.5:- Bar chart showing overall Salt spray performance of CRC sheet IS: 513 at atmospheric all

These above process are describe the properly and result is found in different process. The summary report is briefly describe and we will find the Panel 3 process going to Alkaline zinc plating and then phosphate and surface sealing and then go to the next process is CED Coating and baking and then go to the powder coating. In this process life of corrosion resistance is 1000 hours but we found that life is cross the limit 1008 on record but visually we found that 1024 hours extent. We will judge this process is good and too much protect the metal surface.

CONCLUSION AND FUTURE SCOPE

In the present investigation, atmospheric corrosion tests of automobile car wiper CRC sheet ARE: 513 have been carried out at the temperatures 35 ± 2 °c. Further to improve the atmospheric corrosion resistance CRC sheet ARE: 513, CED coating and Detonation Gun sprayed powder coatings have been investigated. Following conclusions are drawn: Wiper CRC sheet ARE: 513 alloys has shown higher atmospheric corrosion resistance at alkaline plating, CED coating, powder coating compared to that at alkaline plating, powder coating. From the atmospheric corrosion tests under $Na_2SO_4-82Fe_2(SO_4)_3$ environment nozzle spray per surface area CRC sheet ARE: 513 are found to 768 hours and 1008 at Pelting, CED, and Coating C respectively. CRC sheet ARE: 513 panels 3 has shown lower atmospheric corrosion rate at plating, ced and coating as compared to a panel 1 alkaline Plating and panel 4 alkaline plating and powder coating . Stellite-6 & Stellite-21 coating has been successfully deposited on the CRC sheet ARE: 513 by Detonation Gun Spraying method. Both the coatings have shown improvement in oxidation and atmospheric corrosion resistance of panel 3 and panel 4 CRC sheet ARE: 513 have been obtained. CED coating has shown approximately 90% & 92% improvement in the oxidation and Atmospheric corrosion resistance respectively of CRC sheet ARE: 513. Whereas approximately 50% & 55% improvement in the oxidation and atmospheric corrosion resistance respectively of alkaline plating and CED coating on CRC sheet ARE: 513 steel has been observed by applying coating on it.

REFERENCES

[1] H. Singh, D. Puri and S. Prakash , 2007 , “Advance Material Science” ,Vol. 16 , pp. 27-50
 [2] R. A. Rapp and Y. S. Zhang, 1994 ,”Corrosion Science” , Vol . 47, pp. 67-72
 [3] R. A. Rapp , 2002,” Corrosion Science”, Vol. 44, pp. 209-211.
 [4] T. S. Sidhu, S. Prakash, R.D. Agrawal, 2007, “Material Science & Engg.”, Vol No. 445, pp. 210-218.

- [5] A.M. Beltran and D.A. Shores, In: The Superalloys, ed. by C.T. Sims and W.C. Hagel, (Wiley Publ., John Wiley and Sons, N. Y., 1972), Ch. 11: HotCorrosion.
- [6] M. M. Barbooti, S. H. Al-Madfai and H. J.Nassouri ,1988, " Thermochemical Acta", Vol.126, pp. 43-47.
- [7] K. L. Luthra and H.S. Spacil ,1982, " Electroche Soc.", Vol . 129, pp 649-654.
- [8] K. Natesan, 1976, "Corrosion science", Vol . 32, pp. 364-367.
- [9] N. Eliaz, G. Shemesh and R.M. Latanision , 2002, " Engg. Failure Analysis" Vol .9 pp. 31.
- [10] M.A. Uusitalo, P.M.J. Vuoristo and T.A. Mantyla ,2003, "Material Sci. Engg", Vol. 346 pp.168.
- [11] Metals Handbook, Failure analysis and Prevention, Vol.10 (ASM Publication, Meta Park OH, USA, 1975).
- [12] S. Prakash, S. Singh, B. S. Sidhu and A. Madeshia, In: Proc. National Seminar Advances in Material and Processing, Nov9-10 (2001) (IITR, Roorkee, India,2001) 2
- [13] J. A. Goebel, F. S. Pettit and G. W. Goward, 1973,"Metall. Trans." Vol. 4 ,pp. 261.
- [14] Pettit, F.S. and Goward, G.W., '1981',"Metallurgical Treatises" Vol. No. 605, pp.13-22 .