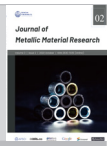
BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

**Journal of Metallic Material Research**
https://ojs.bilpublishing.com/index.php/jmmr



ARTICLE

# Tetrahydro-dibenzo[a,d] Annulene-5, 11-Dihydrazone and Magnesium Oxide Used to Control the Corrosion of Aluminium in Chloride Ions Environment

**Rajesh Kumar Singh*** **Jay Prakash Singh** **Dharmendar Kumar**

Department of Chemistry, Jagdam College, J P University, Chapra, 841301, India

ARTICLE INFO

*Article history*
Received: 21 September 2019
Accepted: 27 October 2019
Published Online: 30 November 2020

*Keywords:*
Chloride ions
Aluminium
Corrosion
Electrospray
Thermal parameters
Marine environment

ABSTRACT

Chloride ions interact with aluminium in marine atmosphere to form corrosion cell. Due to this corrosion reaction occurs on their surface, aluminium is oxidized into $Al^{3+}$. The corrosion reaction accelerates deterioration in metal and it produces galvanic, pitting, stress, crevice, intergranular corrosion. Chloride ions decrease internal and external strength of aluminium metal. It is a very important metal so used in different appliances for e.g. road, water, air transports, housing, railways and other fields. Nanocoating and electrospray techniques used to check the corrosion of aluminium metal. For nanocoating and electrospray materials applied tetrahydro-dibenzo[a,d] [7] annulene-5, 11-dihydrazone and MgO. Both materials formed composite barrier and developed a passive surface for $Cl^-$ ions. This barrier reduced the corrosion rate of aluminium. Nozzle spray and chemical vapour deposition technique used for coating process. The corrosion rate of metal was determined by gravimetric method. Corrosion potential and current density were calculated by potentiostat. The composite barrier formation was confirmed by activation energy, heat of adsorption, free energy, enthalpy and entropy. These thermal parameters were obtained by Arrhenius equation, Langmuir isotherm and Transition state equation. The adsorption of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray on aluminium surface was depicted by Langmuir, Frundlich and Temkin isotherm. The results of surface coverage area and coating efficiency were noticed that both materials were mitigated the corrosion rate of aluminium in chloride ions environment.

## 1. Introduction

Metals produce their corroding process in presence of acids [1], bases [2], salts [3], humidity [4], heat [5], temperature [6], pollutants [7], effluents [8] and particulates [9]. They also corrode when their internal morphology [10] can be change. Metals are surrounded by these hostile environments to form corrosion cell [11] and create dissolution on their surface. Corrosion chemists used several types of techniques to control the corrosion of materials like metallic [12] and nonmetallic coating [13] such coatings have done in acidic or basic medium. Cathodic protection [14] methods applied to protect metals corrosion in remote areas. Anodic protection [15] methods used in to control the corrosion of underground buried pipe. Various types of in-

**Corresponding Author:*
*Rajesh Kumar Singh,*
*Department of Chemistry, Jagdam College, J P University, Chapra, 841301, India;*
*Email: rks_jpujc@yahoo.co.in*

 DOI: https://doi.org/10.30564/jmmr.v3i2.2403

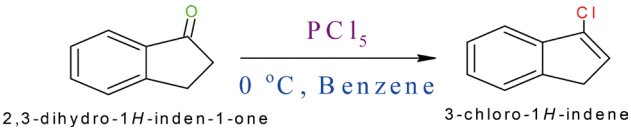
hibitors [16] like organic and inorganic compounds provided ambient environment for corrosive substances. Organic compounds used as anodic, cathodic and mixed inhibitors [17] as per nature of corrosive of medium. The affect of corrosion mitigated by change the shape and size of metals as surrounding environment. Polymeric lamination [18] checked corrosion of materials in some corrosive environment. The attack of pollutants on materials protected by the application of paint coating. Conversion coating [19] can be alter outer face of metal and produced passive layer against effluents or pollutants. Thermal coating [20] can be done for metal which worked at high temperature. Top layer coating [21] stopped corrosion reaction in acidic medium. The metals shaved by the utility of hot dip coating [22] , flame spraying [23], cladding and chemical vapour deposition. Biological corrosion [24] controlled by sparing of nitrogen and sulphur containing functional organic compounds. The aluminium corrosion suppressed by nanocoating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone such coating can be developed lot of porosities on the surface of base metal. Pollutants entered inside metal through diffusion or osmosis process and accelerate corrosion reaction. These porosities blocked by MgO by electrospraying method thus nanocoating and electrospray materials formed composite barrier that is worked as passive barrier for chloride ion environment. The coating and electrospray compounds concentration used 40 mM and 20 mM.

## 2. Experimental

Gravimetric method used to determination of corrosion rate: The sample of aluminium cut into (3X5X0.1) $cm^2$ and its outer layer rubbed with emery paper. It washed with acetone and dried with hot air gun. The corrosion rate of aluminium calculated at 283, 293, 303, 313 and 323 K temperature and these temperatures dipping duration of sample 10, 20, 30, 40 and 50 days in chloride ions solution. The sample kept into 10 M sodium chloride solution and the corrosion rates were determined above mentioned temperatures and days without coating and with coating nanocoating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray.

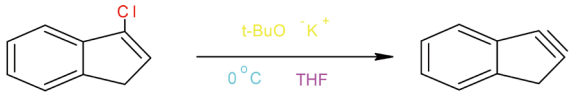
Potentiostat Techniques: Potentiostat 173 model EG & PG Princeton model used to obtain the results of corrosion electrode potential and corrosion current density. Aluminium metal kept between calomel electrode and Pt reference and these electrodes connected with wire thus external current is flowing. The corrosion electrode potential and current density recorded without coating and with coating tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray in chloride ions medium.

Coating compound tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone synthesized by following methods: Indanone was added in cold solution of phosphorus pentachloride in presence of benzene solvent and the reaction mixture was stirred for 1hour. After work up the received yield was 87% of 3-chloro-1H-indene.



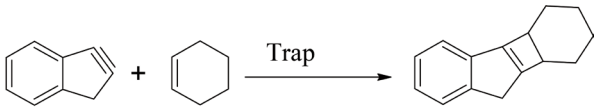

2,3-dihydro-1*H*-inden-1-one — 3-chloro-1*H*-indene

3-Chloro-1H-indene treated with potassium t-butaoxide solution and during completion of reaction mixture temperature was maintained $0^0$C. The reaction mixture was stirred for two hours then cyclohexene was added which trapped 2, 3-didehydro-1H-indene and produced 2,3-cyclohexane-indene of 86% yield.



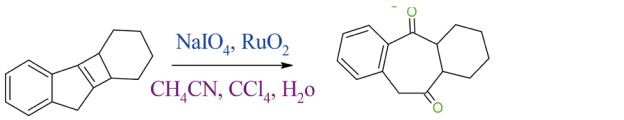

3-chloro-1*H*-indene — 2,3-didehydro-1*H*-indene

When 2,3-didehydro-1H-indene treated with cyclohexene, it is trapped with cyclohexene to give , 2,3-cyclohexane-indene.



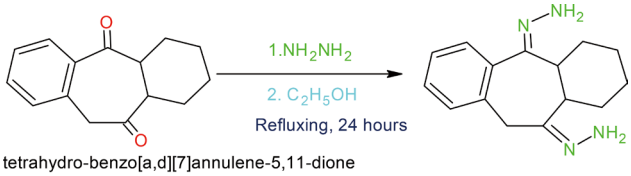

2,3-didehydro-1*H*-indene cyclohexene — 2,3-cyclohexane-indene

2,3-cyclohexane-indene was oxidized with $NaIO_4$ and $RuO_2$ in the presence of methylnitrile, carbon tetrachloride and water to give tetrahydro-dibenzo[a,d] [7] annulene-5,11-dione.




2,3-cyclohexane-indene — 3,4,4a,11a-tetrahydro-1*H*-dibenzo[*a*,*d*][7]annulene-5,11(2*H*,10*H*)-dione

When tetrahydrodibenzo[a,d] [7] annulene-5,11-dione was refluxed with hydrazine in presence of ethyl alcohol to give tetrahydrodibenzo[a,d] [7] annulene-5,11-dihydrazone.




tetrahydro-benzo[a,d][7]annulene-5,11-dione — tetrahydro-benzo[a,d][7]annulene-5,11-dihydrazone

## 3. Results and Discussion

Aluminium comes in contact of chloride ions to produce galvanic, pitting, stress, crevice and intergranular



DOI: https://doi.org/10.30564/jmmr.v3i2.2403

corrosion. Such types of corrosion were controlled by the nanocoating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and electrospray of MgO.

Tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO corrosion protection with time: The corrosion rate of aluminium was obtained without coaing and coating with tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO by formula $K_1$ (mmpy) = (13.56) $W_M$ / $D_M$ $A_M$ t (where W = weight loss of metal in kg, A = Area of metal in square meter, D = Density of metal in kg/ $m^3$, t=exposure time in hours) in chloride ions environment. The values of corrosion of aluminium were mentioned in Table 1. Figure 1 graph was plotted between $K_M$ (corrosion rate) versus t (days) found to be straight line. The results of Table 1 and the plot of Figure 1 were shown that corrosion rate of aluminium increased without coating but their values decreased with nanocoating and electrospray of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO compounds. Polymeric-coated Al was nanocoated with tetrahydro-dibenzo[a,d][7]annulene-5,11-dihydrazone thus it developed protection barrier on its surface and on that barrier MgO electrospray used in this methods composite surface film generated. It stopped osmosis of diffusion process of chloride ions.

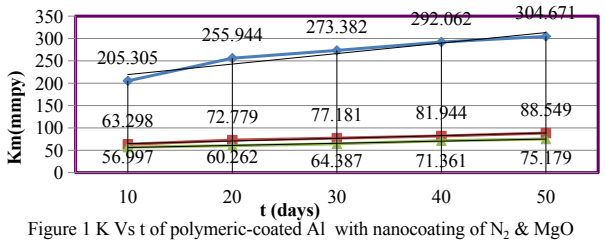



Figure 1 K Vs t of polymeric-coated Al with nanocoating of $N_2$ & MgO

Aluminium corrosion rate without and with coating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO at different temperatures: The corrosion rate of aluminium was calculated at 283, 293, 303, 313 and 323$^0$K temperatures in absence and presence of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray. The recorded corrosion rate was written in Table1 which indicated that corrosion rate increased at lower to higher temperature but their values were reduced after coating of nanocoating and electrospray materials. Such trends were clearly observed in Figture 2 which was plotted between logK versus 1/T.

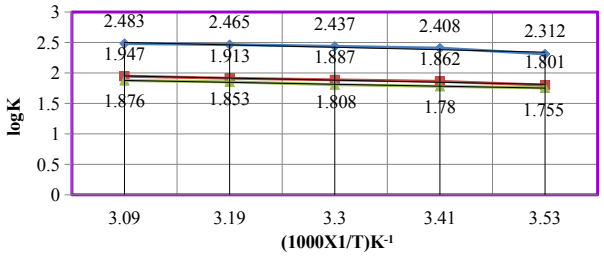



Figure 2 logK Vs 1/T for polymeric-coated Al with nanocoating of NC(2) & MgO

The values of log (ɵ/1-ɵ) for aluminium in tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO: The values of log(ɵ/1-ɵ) for nanocoating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO were given in table4.13.1 at 283, 293, 303, 313 and 323$^0$K temperature. It observed that their values were decreased as temperatures rising. In case with electrospray material got same types of results. Such types of trends clearly noticed in Figure 3 which was plotted between log(ɵ/1-ɵ) verse 1/T. MgO dispersed into marix of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihy-

**Table 1.** Corrosion rate of aluminium without and with coating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospraying of MgO in chloride ions environment

| N & E | Temp(K) | 283K | 293K | 303K | 313K | 323K | C(mM) |
|---|---|---|---|---|---|---|---|
| | Time(days) | 10 | 20 | 30 | 40 | 50 | |
| **No** | $K_{m0}$ | 205.305 | 255.974 | 273.798 | 292.062 | 304.671 | 00 |
| | $logK_{m0}$ | 2.312 | 2.408 | 2.437 | 2.465 | 2.483 | |
| **$N_2$** | $K_m$ | 63.298 | 72.779 | 77.181 | 81.944 | 88.549 | 40 |
| | $logK_m$ | 1.801 | 1.862 | 1.887 | 1.913 | 1.947 | |
| | $log(K_m/T)$ | 1.253 | 1.329 | 1.368 | 1.409 | 1.457 | |
| | $ɵ_m$ | 0.6916 | 0.7156 | 0.7181 | 0.7194 | 0.7079 | |
| | $(1-ɵ_m)$ | 0.3084 | 0.2844 | 0.2819 | 0.2806 | 0.2921 | |
| | $log(ɵ_m/1-ɵ_m)$ | 0.351 | 0.401 | 0.406 | 0.408 | 0.384 | |
| | % CE(m) | 69.16 | 71.56 | 71.81 | 71.94 | 70.79 | |
| **$E_{MgO}$** | $K_m$ | 56.997 | 60.262 | 64.387 | 71.361 | 75.179 | 20 |
| | $logK_m$ | 1.755 | 1.780 | 1.808 | 1.853 | 1.876 | |
| | $log(K_m/T)$ | 1.208 | 1.247 | 1.290 | 1.349 | 1.386 | |
| | $ɵ_m$ | 0.7223 | 0.7645 | 0.7648 | 0.7556 | 0.7532 | |
| | $(1-ɵ_m)$ | 0.2777 | 0.2355 | 0.2352 | 0.2449 | 0.2468 | |
| | $log(ɵ_m/1-ɵ_M)$ | 0.415 | 0.511 | 0.512 | 0.490 | 0.484 | |
| | %CE (m) | 72.23 | 76.45 | 76.48 | 75.56 | 75.32 | |

 DOI: https://doi.org/10.30564/jmmr.v3i2.2403

drazone and increased the values of log(ɵ/1-ɵ).

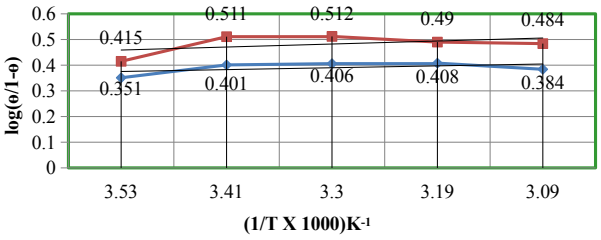



Figure 3 log(ɵ/1-ɵ) Vs 1/T for aluminium with nanocoating of $N_2$& MgO

Surface coverage area on aluminium by tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO: Surface coverage area accommodated by tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray were calculated by equation, $ɵ_m = (K_{mo}-K_m/K_{mo})$ and its values were recorded in Table1. Figure 4 plotted between $ɵ_m$(surface coverage area) versus T(temperature) indicated that electrospray of MgO enhanced the capability of surface as temperature increased. Nanocoating and electrospray compounds formed a stable barrier which blocked the osmosis or diffusion process of corrosive pollutants.

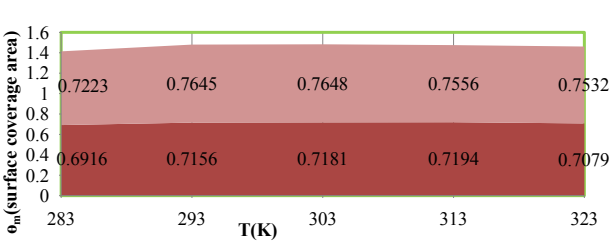



Figure 4 $ɵ_m$ Vs T aluminium with $N_2$& MgO electrospray

Percentage of coating efficiency of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO: The percentage coating efficiencies tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and electrospray of MgO were determined by formula $\%CE = (K_{mo}-K_m/K_{mo}) X 100$ and their values were given in Table1. It observed that percentage coating efficiency enhanced coating with tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone but it coated with MgO percentage coating efficiency developed more as shown in Figure5 which plotted between % CE(m) versus T (temperature). It noticed that at higher temperatures these compounds produced stable barrier.

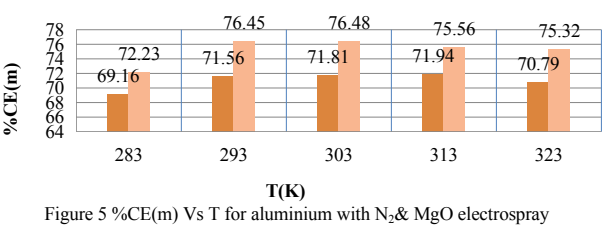



Figure 5 %CE(m) Vs T for aluminium with $N_2$& MgO electrospray

Activation energies of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO: Activation energies of these compounds were calculated at different temperatures by the use of Arrhenius equation $logK_m=logA-Ema/2.303RT$ and Figure 2 plotted between log $K_m$ versus 1/T and values were recorded in Table 2. Figure 6 graph plotted between $E_{ma}$ (activation energy) versus T (temperature) noticed that activation energies of aluminium increased without coating after coating of tetrahydro-dibenzo [a,d] [7] annulene-5,11-dihydrazone and electrospraying of MgO its values were decreased. These results were noticed that both compounds formed chemical bonding with base metal. The results of Table 2 were shown that activation energies decreased as temperature enhanced but surface coverage area increased.

**Table 2.** Thermal parameters of aluminium without and with coating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO in chloride ions environment

| Thermal Parameters | 283K | 293K | 303K | 313K | 323K |
|---|---|---|---|---|---|
| **Ema** | 156.126 | 157.081 | 153.845 | 150.425 | 146.774 |
| **$E_{2a}$** | 121.619 | 121.464 | 119.124 | 116.740 | 115.091 |
| **$q_2$** | -23.702 | -26.158 | -25.631 | -24.898 | -22.698 |
| **$\Delta G_2$** | -224.454 | -220.778 | -215.267 | -209.678 | -211.733 |
| **$\Delta H_2$** | -84.655 | -86.711 | -86.423 | -86.028 | -86.139 |
| **$\Delta S_2$** | -87.566 | -90.173 | -91.421 | -92.696 | -96.398 |
| **$ɵ_{2m}$** | 0.6916 | 0.7156 | 0.7181 | 0.7194 | 0.7079 |
| **Ea, MgO** | 118.513 | 116.115 | 114.137 | 116.740 | 110.893 |
| **q, MgO** | -28.024 | -33.334 | -32.322 | -29.902 | -28.610 |
| **ΔG, MgO** | -221.379 | -215.432 | -210.298 | -206.013 | -200.893 |
| **ΔH, MgO** | -81.580 | -81.364 | -81.454 | -82.363 | -81.936 |
| **ΔS, MgO** | -85.824 | -87.036 | -88.409 | -90.400 | -91.530 |
| **ɵ, MgO** | 0.7223 | 0.7645 | 0.7648 | 0.7556 | 0.7532 |

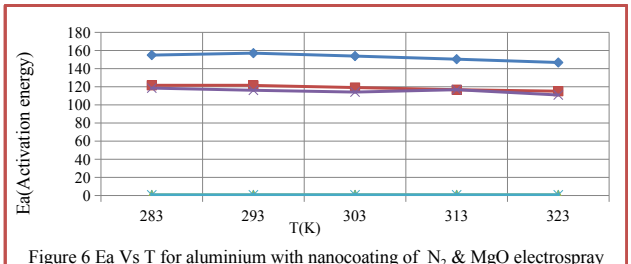



Figure 6 Ea Vs T for aluminium with nanocoating of $N_2$ & MgO electrospray

Heat of adsorption of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray: The heat of adsorption of both compounds were obtained by Langmuir equation log $(\theta_m/ 1-\theta_m) = \log (A .C) - (q_m/ 2.303 R T)$ ( where T is temperature in Kelvin and $q_m$ heat of adsorption) and Figure3. The negative sign of heat of adsorption depicted that nanocoating and electrospray compounds adsorbed by chemical bonding. The plot of Figure7 between $q_m$(heat of adsorption) verse T(temperature) with $ɵ_m$(surface coverage area) in-



DOI: https://doi.org/10.30564/jmmr.v3i2.2403

dicated as temperatures increased surface coverage area also enhanced.

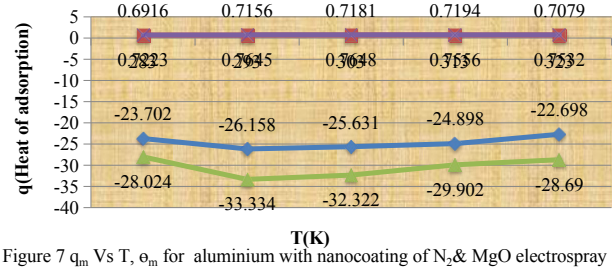



Figure 7 $q_m$ Vs T, $\theta_m$ for aluminium with nanocoating of $N_2$& MgO electrospray

Free energy of nanocoating tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray: The values of free energies of nanocoating and electrospray were calculated at various temperatures by formula $\Delta G_m$ = -2.303RT log (33.3$K_m$) and their values were written in Table 2. It was observed that free energies of nanocoating and electrospray materials decreased when temperature rose from lower to higher. Free energies of both compounds indicated that they were attached with aluminium by chemical bonding. Figure 8 plotted between $\Delta G_m$(free energy) versus T(temperature) , $\theta_m$(surface coverage area) that graph was shown that free energies reduced and surface coverage area was enhanced.

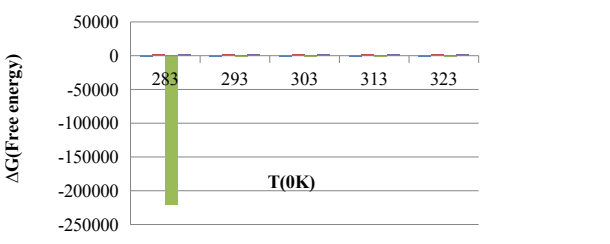



Figure 8 ΔGm Vs T,$\theta_m$ for aluminium with nanocoating of $N_2$ & MgO electrospray

Enthalpy of nanocoating tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray: Enthalpy of both compounds were determined by equation $K_m$ = R T / N h log ($\Delta S_m^{\#}$ / R) X log (-$\Delta H_m^{\#}$/ R T) and Figure 9. Their values were recorded in Table2. The results of Table2 indicated that both compounds coating process were exothermic. Figure9 the graph plotted between $\Delta H_m$ (enthalpy) versus T, $\theta_m$ for nanocoating and electrospray indicated that enthalpy decreased at lower to higher temperature then surface coverage increased. It confirmed that both compounds were attached with aluminium by chemical bonding. Enthalpy of values nanocoating and electrospray compounds were decreased so both compounds were formed a composite thin layer barrier. Enthalpy values found to be smaller with nanocoating and electrospray and increased surface coverage area as shown in Figure 10.

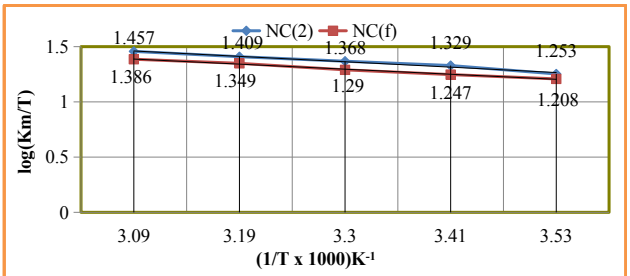



Figure 9 log(Km/T) Vs 1/T for aluminium with nanocoating of $N_2$ & MgO electrospray

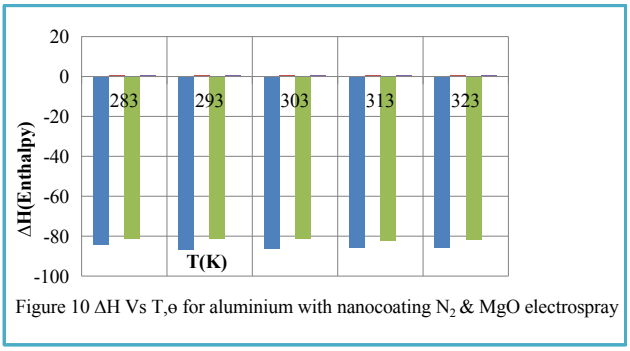



Figure 10 ΔH Vs T,$\theta$ for aluminium with nanocoating $N_2$ & MgO electrospray

Entropy of nanocoating tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray: Entropy of nanocoating and electrospray compounds were calculated by $K_m$ = R T / N h log ($\Delta S_m^{\#}$ / R) X log (-$\Delta H_m^{\#}$/ R T) and their values were mentioned in Table2. Both compounds produced negative entropy which depicted a chemical bonding occurred between nanocoating and electrospray on aluminium metal. Figure 11 plotted between $\Delta S_m$ versus T, $\theta_m$, it indicated entropy decreased then surface coverage area increased.

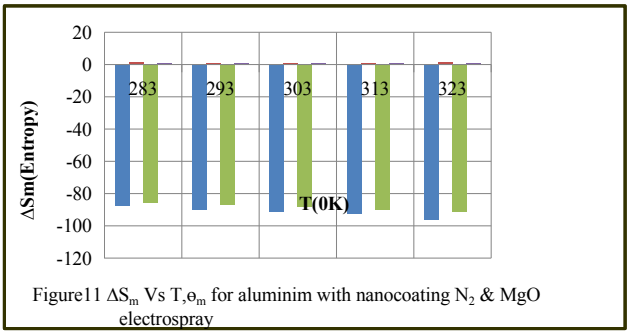



Figure11 $\Delta S_m$ Vs T,$\theta_m$ for aluminim with nanocoating $N_2$ & MgO electrospray

Potentiostat of nanocoating tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray: Electrode potential and corrosion current of aluminium, tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray were calculated by equation $\Delta E_m/\Delta I_m$ = $\beta_a$ $\beta c$ / 2.303 I ($\beta_a$ + $\beta_c$) and Tafel plot of Figure 12 plotted between $\Delta E_m$(electrode potential) verse I(current density) and their values were expressed in Table3. These results were shown that electrode potential, corrosion current density and anodic polarization were enhanced without


DOI: https://doi.org/10.30564/jmmr.v3i2.2403

coating and decreased cathodic polarization. Nanocoating and electrospray compounds reduced electrode potential, corrosion current density and anodic polarization and increased cathodic polarization. The corrosion current of aluminium reduced by nanocoating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray. MgO electrospray increased more current density with respect of nanocoating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone. Both nanocoating and electrospray materials developed composite passive barrier on the surface of aluminium in chloride ions environment.

The corrosion current density of aluminium, nanocoating and electrospray were obtained by above mentioned equation and the values put in equation, $K_{cr}$ (mmpy) = 0.1288 I (mA /cm$^2$) × Eq .Wt (g) / ρ (g/cm$^3$) to produce their corrosion rate. Their values were written in Table3 which clarified that corrosion increased without coating of aluminium but it reduced with nanocoating and electrospray. Nanocoating tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone incrased coating efficiency and surface coverage area where as these values were more enhance by MgO electrospray. The corrosion rates of materials were obtained by weight loss experiment which satisfied the corrosion rate of potentiostat measurement technique.

**Table 3.** Potentiostat of aluminium nanocoating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO electrospray

| N & C | $\Delta E_m$ (mV) | $\Delta I_m$ | $\beta_a$ | $\beta_c$ | I (mA/cm$^2$) | $K_{cr}$ (mmpy) | $^0$m | % CE | C (mM) |
|---|---|---|---|---|---|---|---|---|---|
| N(0) | -630 | 239 | 286 | 126 | 14.43 | 620.533 | 00 | 00 | 00 |
| $N_2$ | -255 | 72 | 45 | 157 | 4.29 | 184.471 | 0.7027 | 70.27 | 30 |
| EMgO) | -221 | 62 | 40 | 167 | 3.94 | 169.420 | 0.7269 | 72.69 | 10 |

Mechanism of composite barrier formation: The organic compound tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone possessed electron rich functional group hydrazone and aromatic ring and they chelated with aluminum to form complex compound. This compound developed lots of porosities on their surface that is blocked by MgO electrospraying. MgO entered into matrix of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and formed a composite barrier. The composite barrier formation confirmed by the results of activation energy, heat of adsorption, free energy, enthalpy and entropy. The composite barrier of aluminium- tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone-MgO worked as noble barrier against chloride ions environment.

## 4. Conclusion

The results of corrosion rate of aluminium were obtained by gravimetric and potentiostat techniques which indicated that corrosion rate and electrode potential increased without coating but their values were reduced by coating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and electrospraying of MgO. The surface coverage areas and percentage coating efficiencies produced by both compounds were shown that they had capability to adhere with aluminium. The coating of tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and electrospraying of MgO were an exothermic process. It confirmed by the values of free energy, enthalpy and entropy. Both compounds adsorbed on aluminium surface by chemical bonding to satisfy by the results of activation energy, heat of adsorption, free energy, enthalpy and entropy. The values of entropy indicated that both compounds were high stable on aluminium surface. The results of corrosion rate, surface coverage area, coating efficiency, corrosion potential, current density and thermal parameters values were depicted that tetrahydro-dibenzo[a,d] [7] annulene-5,11-dihydrazone and MgO were mitigated corroding effect of aluminium in chloride ions environment.

## Acknowledgement

The UGC-New Delhi provided financial grant for research work. Author thanks financial supporting agency. I give my warm regards Professor Sanjoy Misra, Department of chemistry, R U Ranchi, Professor G Udaybhanu, Department of Applied chemistry, IIT (ISM), Dhanbad and Professor INN Namboothari, Department of Chemistry, IIT, Mumbai for their valuable suggestion and guidance. I am very thankful my departmental colleagues Dr. Sanjay Kumar and Dr. Raman Kumar Singh to help me data analysis graph plotting.

## References

[1] R K Singh, Noor Alam. Study the corrosion & corrosion protection of brass sculpture by atmospheric pollutants in winter season. Modern Approach on Material Science, 2019, 1(3): 54-62.

[2] Szabo T, Molnar-Nagy L, Telegdi J. Self-healing microcapsules and slow release microspheres in paints. Progress in Organic Coatings, 2011, 72: 52-57.

[3] Videla H., L K Herrera. Understanding microbial inhibition of corrosion. Electrochem Acta, 2009, 39: 229-234.

[4] R K Singh. Corrosion protection of transport vehicles by nanocoating of Dechydrobenzo annulene-5,10-dihydrazone in corrosive environments and weather change. Journal of Powder Metallurgy and Mining, 2017, 6(1) 1-8.

[5] Wen N T, Lin C S, Bai C Y, Ger M D. Structures and characteristics of Cr (III) based conversion coatings



DOI: https://doi.org/10.30564/jmmr.v3i2.2403

on electrogalvanized steels. Surf. Coat Technol, 2008, 203: 317.

[6] Boerio F J, Shah P. Adhesion of injection molded PVC to steel substrates, J of Adhesion, 2005, 81(6): 645-675.

[7] R K Singh, Manjay K Thakur, Sabana Latif. Mild Steel corrosion control by nanocoating and filler compounds in hostile environments. J of J Material Science, 2018, 4(3): 1-12.

[8] Deveci H, Ahmetti G, Ersoz M. Modified styrenes: Corrosion physico-mechanical and thermal properties evaluation. Prog. Org. Coat. 2012, 73: 1-7.

[9] Genzer J. Templating Surfaces with Gradient Assemblies. J of Adhesion, 2005, 81: 417-435.

[10] Leon-Silva U, Nicho M E. Poly(3-octylthiophhene) and polystyrene blends thermally treated as coating for corrosion protection of stainless steel 304. J. Solid State Electrochem, 2010, 14: 1487-1497.

[11] Baier R E. Surface behaviour of biomaterials: Surface for biocompatibility. J. Mater. Sci. Mater. Med., 2006, 17: 1057-1062.

[12] R K Singh. Corrosion protection of transport vehicles by nanocoating of decahydrobenzo annulene-5,10-dihydrazone and SiC filler in H2O, O2 (moist), CO2, SO2 environments and weather change. Journal of Metallurgy and Materials Science, 2016, 58:, 167-179.

[13] Rao BVA, Iqbal M Y, Sreehar B. Electrochemical and surface analytical studies of the self assembled monolayer of 5-methoxy-2-(octadeclthiol) benzimidazole in corrosion protection of copper. Electrochim, Acta, 2016, 55 620-631.

[14] Liu X Y, Ma H Y, Hou M Z. Self-assembled monolayers of stearic imidazoline on copper electrodes detected using electro chemical measurement, XPS, molecular simulation and FTIR. Chinese Sci. Bull., 2009, 54: 374-381.

[15] Liao Q Q, Yue Z W, Zhou Q. Corrosion inhibition effect of self-assembled monolayers of ammonium pyrrolidine dithiocarbamate on copper. Acta Phys. Chin. Sin., 2009, 25: 1655-1661.

[16] Zhang D Q, He X M, Kim G S. Arginine self-assembled monolayers against copper corrosion and synergitic effect of iodide ion. J. Appl. Electrochem, 2009, 39: 1193-1198.

[17] Ghareba G S, Omanovic S. Interaction of 12-amino-dodecanoic acid with a carbon steel surface: Towards the development of "green" corrosion inhibitors. Corrosion Sci., 2010, 52: 2104-2113.

[18] Sahoo R R, Biswas S K. Frictional response of fatty acids on steel. J. Colloid Interf. Sci., 2009, 333: 707-718.

[19] Raman R, Gawalt E S. Selfassembled monolayers of alkanoic acid on the native oxide surface of SS316L by solution deposition. Langmuir, 2007, 23: 2284-2288.

[20] R K Singh. Building materials corrosion control by fiber reinforced polymers. Journal of Powder Metallurgy and Mining, 2015, 4(2): 1-5.

[21] Li D G, Chen S H, Zhao S Y. The corrosion Inhibition of the self-assembled Au and Ag nanoparticles films on the surface of copper. Colloid. Surface A, 2006, 273: 16-23.

[22] Cristiani P, Perboni G, Debenedetti A. Effect of chlorination on the corrosion of Cu|Ni 70|30 condenser tubing. Electrochim. Acta, 2008, 54: 100-107.

[23] Cristiani P. Solutions fouling in power station condensers. Appl. Therm. Eng., 2005, 25: 2630-2640.

[24] R K Singh, Rajeev Kumar. Study corrosion and corrosion protection of stainless steel in phosphate fertilizer industry, American Journal of Mining and Metallurgy, 2014, 2: 27-31.

 DOI: https://doi.org/10.30564/jmmr.v3i2.2403