THE EFFECT OF CARBON ADDITION ON CORROSION RESISTANCE OF MARINE STRUCTURE COATINGS

A. R. Mirhabibi[1,2] , K. Chizari[1], M. Edrisi[3],R. Aghababazadeh[2] and B. Rand[4]
1, Iran University of Science and Technology, Iran Tehran, 16844
2, Iran Color Research Center, Tehran, Iran
3, Amirkabir University, Iran, Tehran
4,Leeds University, UK, LS2 9JT

Corresponding author e-mail address: ar_mirhabibi@iust.ac.ir

Introduction

This work is based on the investigation of hydrophobic properties of Graphite. In comparison with other properties of graphite such as electric and isotopic properties less attention has been paid to the investigation of hydrophobic properties of this material. We attend to make an anti-corrosion paint by using graphite in a paint formulation. This paint can be used for protection of under water construction. The problem is that the graphite is an electrically conductive material which is a disadvantage in corrosion prevention. Therefore, it should be examined to see whether this is going to make any problem.

Carbon black basically has the same chemical formula as graphite, however with differences in properties [4]. So the possibilities of using carbon black in the formulation of an anticorrosion paint are being tested and results compared with the graphite containing samples.

For making anti-corrosion paint for iron and steel-based alloys, first of all their corrosion in sea water were investigated. For dispersion of carbon black and graphite in paint a dispersing agent such as soya lesitin was added to an epoxy paint containing known amount of zinc chromate (6%) as anti-corrosion agent. The mixture was mixed in a blender mixture at 600 rpm for 20 minutes. Then, the hardener (¼ of the paint weight) and appropriate amount of thinner were added and mixed for 15 minutes.

Experimental

Painting of metallic objects can usually be done by one of the following methods:
1-Spraying, 2-Dip Painting, 3-Flow Coating, 4-Roller Coating, 5-Curtain Coating, 6-Tumble Coating, 7-Electro Coating, 8-Powder Coating.

In this work a small plate (2.5×4 Cm) were cut from a steel plate. After application of cleaning processes, the plates were sprayed by the prepared paint. After drying some properties of the coated layers were measured.

Results and Discussion

According to the results of impact tests (Tables.1, 2), it can be seen that with increase in graphite content, the impact properties will decrease. This can be due to excess graphite in the paint since the more pigment in the powder form is added to paint, the more fragile the paint would be. The Carbon black pigments give more fragile paints in comparison with paints having graphite pigments. The results for the cross cut test of graphite containing paints are presented in Figs. (1, 2).

Table1

Sample No.	1	2	3	4	5	6
Graphite content (wt%)	0	2	4	6	8	10
(lb.in) Impact resistance	30	20	20	15	15	10

Table2

Sample No.	1	2	3
Carbon black content (%)	0	2	4
Impact resistance (lb.in)	30	30	20

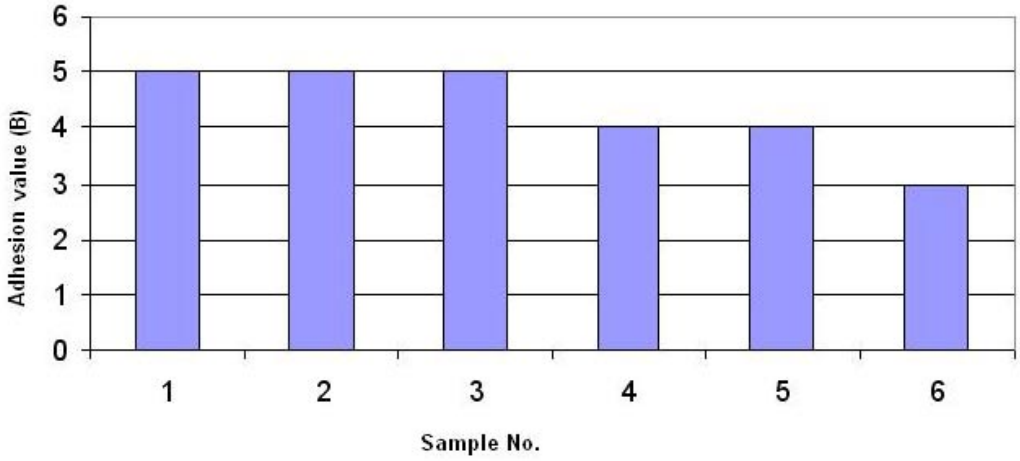

Fig. 1 Cross cut tests of graphite-containing paint.

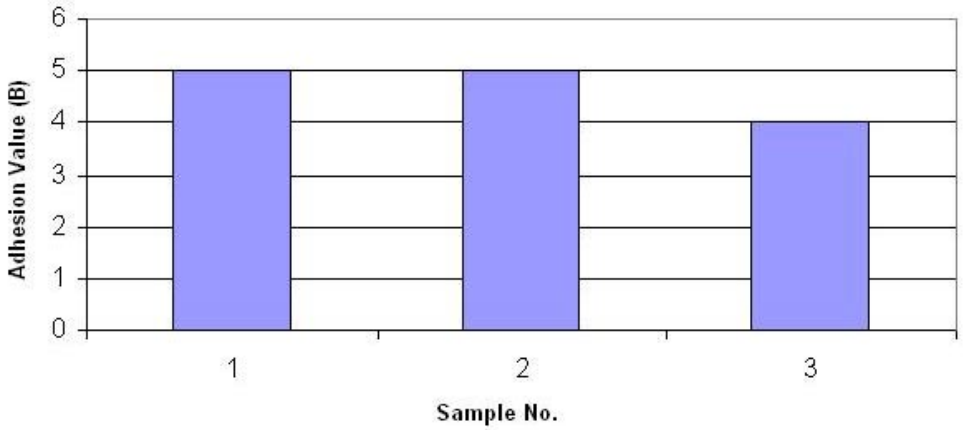

Fig. 2 Cross cut tests of carbon black-containing paint.

According to results obtained for cross cut tests an increase in the amount of pigment causes decrease in the value of cross cut tests. The results for abrasion and Taber tests for different painted samples are given in Figs.3 and 4 respectively. These values indicate that addition of graphite powder to an epoxy paints produces a stranger coating and increases the cross cut test values. The curve obtained for the Taber test shows that with increasing the amount of graphite in paint a decrease in the weight due to lower abrasion are occurred.

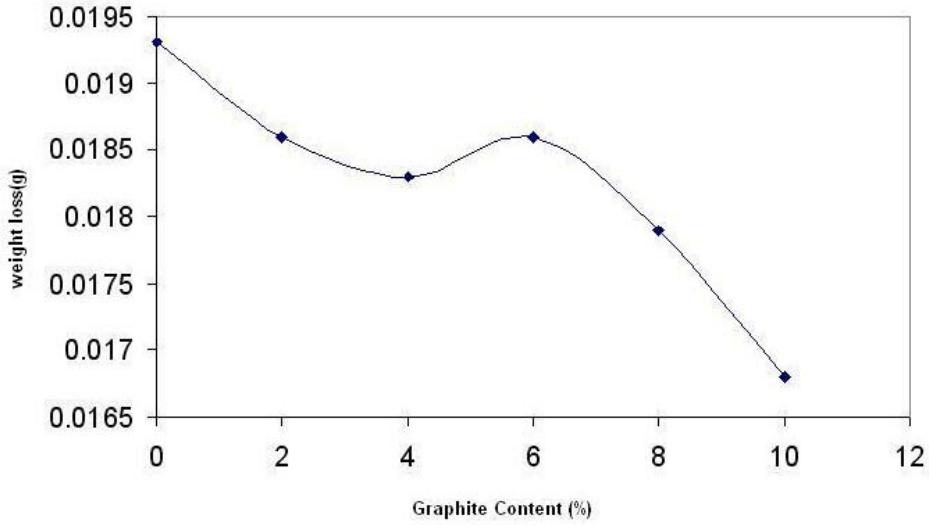

Fig. 3 Abrasion resistance of the graphite containing paints.

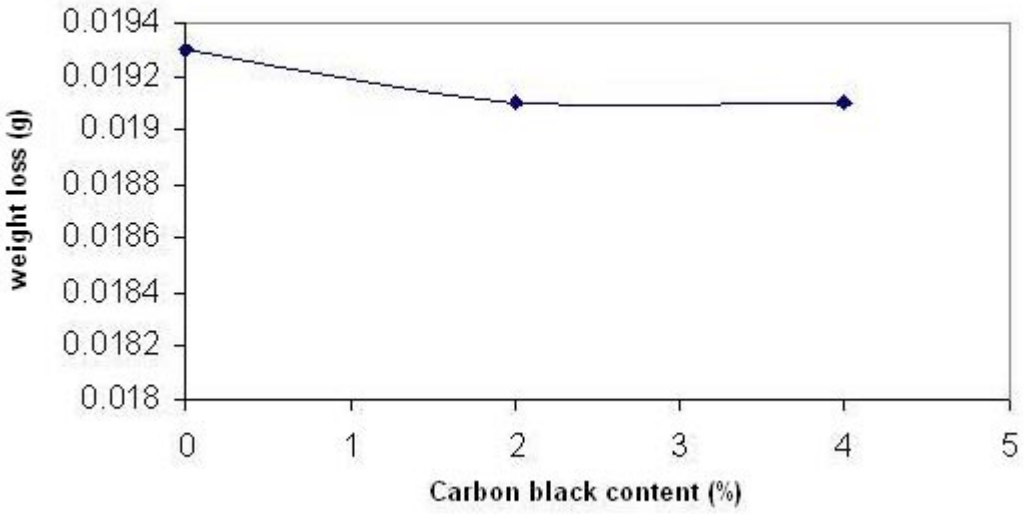

Fig. 4 Abrasion resistance of the carbon black containing paints.

The results of salt spray tests show that after 400 h salt spray, the coated layer is simply removable. After removing the coated layer the Vieew test were carried out on 8 corroded samples containing 0-10% graphite and 0-4% carbon. Results and comments are given in and Fig.5.

4% Graphite
Total Damage: 40,668.77 mm² -> **15.93 %**
Area: 40,668.77 mm² -> 15.93 %
complete Area: 255,323.21 mm²
Class: 3.5 DIN 55996

4% CarbonBlack
Total Damage: 116,874.59 mm² **46.18 %**
Area: 116,874.59 mm² -> 46.18 %
complete Area: 255,323.21 mm
Class: 2.5 DIN 55996

Fig. 5 Corrosion area measurements (Vieew test) of the same carbon contents for paints.

The salt spray results shows that an increase in the concentration of carbon black in paint up to 6% increases the resistance to corrosion in steel plate samples. In higher concentrations of carbon black (6-10%) this quality is decreased. The increase in corrosion resistance of paint against salt and water can be related to water repelling quality of graphite. In higher concentration of graphite (6.-10%) the ability of graphite to pass electrons to metal increases the corrosion process.

In contrast to graphite powder, addition of carbon black powder to epoxy paint causes considerable decrease in its resistance against corrosion. Following curves (Figs. 6-7) have been extracted from Vieew test.

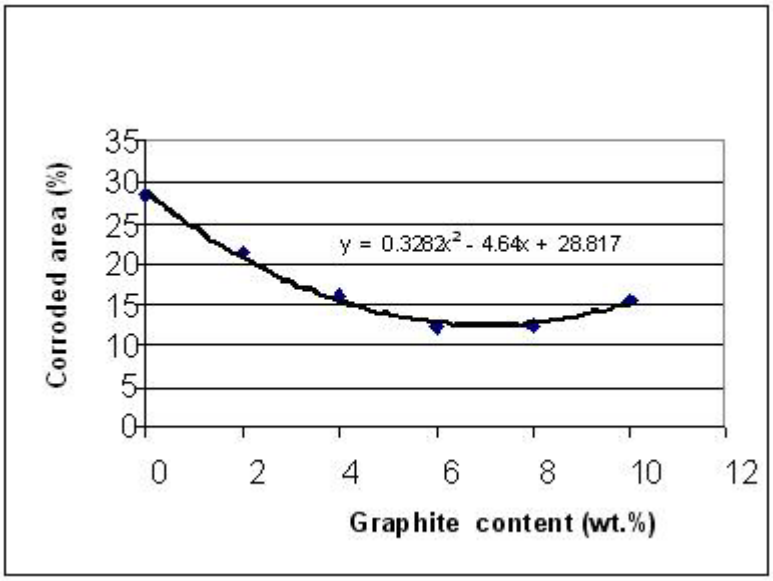

Figure 6: Corroded area (%) of the metal surface against graphite content in paint.

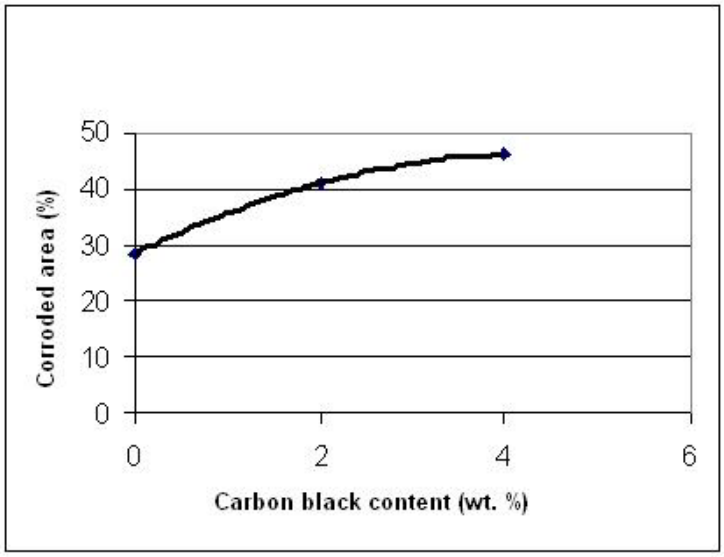

Figure 7 Corroded area (%) of the metal surface against carbon black content in paint.

According to the results of salt spray test Fig. 6-7 increase in graphite up to 6% increases resistance to corrosion, but between 6% to 10% the resistance reduces . Increase in resistance to corrosion against water and salt can be related to hydrophobic property of graphite. Introducing the graphite into the paint causes water repelling and increases anticorrosion property against brine. This property can be seen easily up to 6% graphite. From 6% to 8% graphite in paint anticorrosion properties are similar. With increase of the graphite to 10% anticorrosion property decreases. The reason can be related to decrease of the paint cross out to metal which causes easier penetration of

water to paint and metal surface, therefore, can improves the corrosion resistance in specific range.

Another reason which explains this is ability of the graphite to transfer the electrons. With graphite increase in paint, metal electrons can pass the paint and causes more corrosion.

Carbon black increase in paint decrease resistance against corrosion which is very perceptible. The reason can be the water absorption property of carbon Black (5).
Carbon black particles are water absorbent because of their high surface area property, so they can increase corrosion.

From XRD test on carbon and graphite we can understand that graphite has crystalline structure but carbon black is amorphous. In graphite there is no metallic impurity, because there isn't any clear peak, which shows metal impurity.

From XRD curve of carbon black we cannot recognize the impurity level of the phases because it does not show a clear peak .

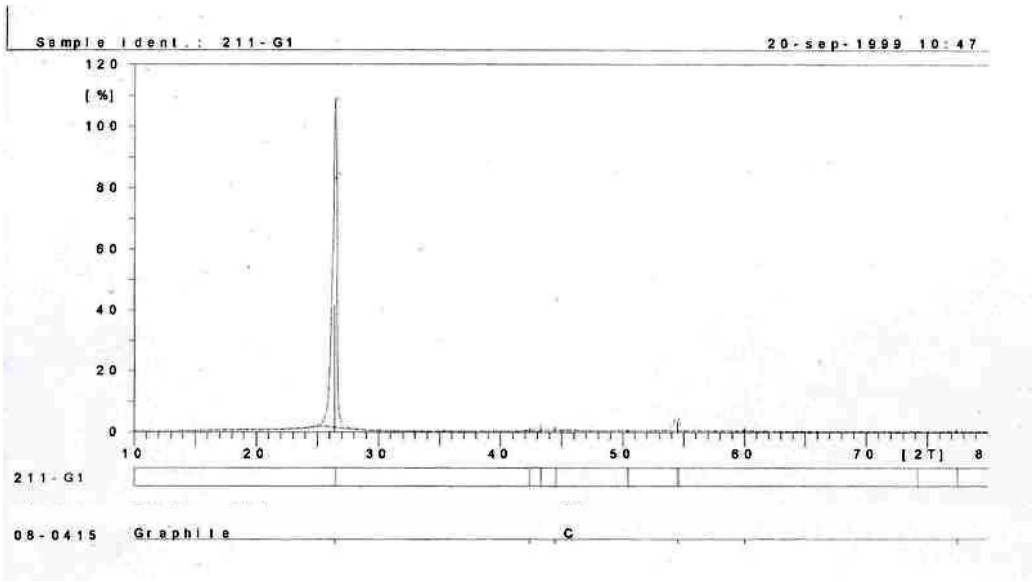

Figure 8:XRD pattern of the graphite

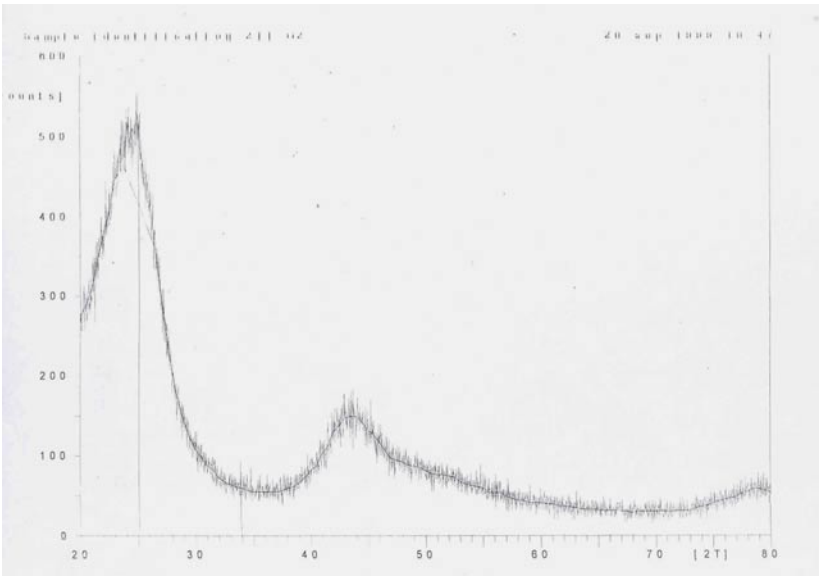

Figure 9: XRD pattern of the carbon black

The results of ash content tests show 0.5% for carbon black and 1% for graphite which shows that used graphite and carbon black have had a high purity.

Conclusions

1) Graphite added into the zinc chromate-containing epoxy paint up to 6% increases the corrosion resistance of the paint. From 6-8% decreases this property.
2) Carbon black added into the zinc chromate-containing epoxy paint decreases corrosion.
3) Carbon black and graphite added into the zinc chromate-containing epoxy paint increase resistance of the paint against abrasion.
4) Carbon black and graphite added into the zinc chromate-containing epoxy paint decreases the resistance against impact.
5) Carbon black and graphite added into the zinc chromate-containing epoxy paint decrease paint cross out to the surface.
6) The best method of application of this paint is spraying, because paint lays on the surface uniformly and there will be no bubble in the coating.

References

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