Progress in Organic Coatings 66 (2009) 242–247

Contents lists available at ScienceDirect

Progress in Organic Coatings

journal homepage: www.elsevier.com/locate/porgcoat

New anticorrosive coating compositions incorporated ilmenite ore

H. Abd El-Wahab[a,1], M. Abd EL-Fattah[b,*], M.I. Abdou[b,2], F. Abd El-Hai[a,3]

[a] Chemistry Department, Faculty of Science, Al Azhar University, Cairo, Egypt
[b] Production Department, Egyptian Petroleum Research Institute (EPRI), Cairo, Egypt

ARTICLE INFO

Article history:
Received 2 April 2009
Received in revised form 19 June 2009
Accepted 28 July 2009

Keywords:
Alkyd resin
Corrosion-resisting alkyd
Corrosion inhibiting
Protective coating
Ilmenite ore

ABSTRACT

Objective of the research relates to corrosion-resistant coating capable of being lied to various substrates, particularly metal surfaces, as a single coat characterized as having high-gloss, good adhesion and a high degree of flexibility. Long oil alkyds were first modified with naphthalene dicarboxylic acid and then introduced in primer formulations containing an effective amount of corrosion-resisting pigment ilmenite ore. The results indicated substantial corrosion inhibiting properties.

1. Introduction

Protection of steel structure from corrosion by organic coatings is a well-known practice. The corrosion protection in conventional coatings was generally achieved with the use of inhibitors such as metallic pigments, metal oxides and salts at different concentrations [1]. Some conducting polymers have recently been studied as a new class of materials for the corrosion protection of metals [2–4]. Coating systems make use of commercial microsize pigments in order to improve their corrosion resistance and mechanical properties. Commercially available inorganic pigments however, are associated with numbers of draw-backs. For example, problems like poor adhesion, reduced coating flexibility, loss of impact resistance, loss of optical transparency, inferior abrasion and scratch resistance [5–7]. Four pigments with polyaniline phosphate coating were tested for the anticorrosion performance in coatings produced by epoxy binders on iron plates [8]. Oil based alkyds are perhaps the most widely used industrial protective coating material due to their ease of application, relatively low cost, color stability and good weather ability in most atmospheric environments [9–11]. The investigations on the corrosion-resistance performance of modified alkyd containing polyaniline against mild steel were evaluated [12]. Other modified alkyd resins were prepared and the effect of oil contents on the properties such as the drying performance, thickness of the film, solubility, viscosity and color of the alkyd resins was evaluated [13]. The effect of addition of Fe_2O_3 on the corrosion resistance and mechanical properties of alkyds based water-borne coatings also were studied [14]. Preparation of coatings with high adhesion strength and high corrosion resistance was also studied [15]. The present work reports the investigations on the corrosion-resistance performance of naphthalene-2,3-dicarboxylic acid (NDCA)-modified alkyd containing ilmenite ore as inorganic pigment against mild steel. The anticorrosive modified alkyd resins were prepared by partial replacement of polybasic used in manufacture of resin by naphthalene-2,3-dicarboxylic acid. This coating composition and the ilmenite ore which replaced titanium dioxide pigments in the formulation would expect to have good anticorrosive properties.

2. Experimental

2.1. Materials

Linseed oil fatty acid "(LOFA)" a product of Echantillon sample stall, Bruxell, Belgique, phthalic anhydride "(PA)" a product of Avondate Laboratories, England, naphthalene-2,3-dicarboxylic acid (NDCA), a product of Merck, Germany, were used without purification. Glycerol (G), sulphuric acid, anhydrous sodium carbonate, benzene, mineral turpentine, acetic acid glacial, and ethyl acetate were obtained from El Nasr Pharmaceutical Co. (Egypt).

* Corresponding author. Tel.: +20 106425240; fax: +20 222747433.
E-mail addresses: hamada19982000@hotmail.com (H.A. El-Wahab), eprimaf68@yahoo.com (M.A. EL-Fattah), Mahmoud_ibrahim_abdu@yahoo.com (M.I. Abdou).
[1] Tel.: +20 107133466.
[2] Tel.: +20 105234611.
[3] Tel.: +20 122806912.

0300-9440/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.porgcoat.2009.07.010

Table 1
Chemical analysis of ilmenite ore.

Element	Result %
Fe_2O_3	51
TiO_2	32
SiO_2	8.21
Al_2O_3	2.85
MgO	2.60
Moisture	0.69

While xylene (AR) was obtained from Ubichem "Chemicals", England. Ilmenite ore ($FeTiO_3$, iron titanium oxide) deposit of Egypt occurs in Wadi Abu Ghalaga in the South Eastern Desert. The area comprises the eastern portion of Hamata sheet, 30 km of Red Sea and 100 km South Marsa Alam. Ilmenite chemical analysis and characteristics are tabulated in Tables 1 and 2.

2.2. Methods and techniques

2.2.1. Preparation of NDCA-modified alkyd resins

A mixture of linseed oil fatty acid (LOFA), phthalic anhydride (PA), naphthalene-2,3-dicarboxylic acid (modifier) and anhydrous glycerol (G) was refluxed in the presence of 10% xylene by using Dean and Stark apparatus. The course of the esterification was followed by observing the amount of water liberated versus the time of the reaction. The various resin characteristics are tabulated in Table 3.

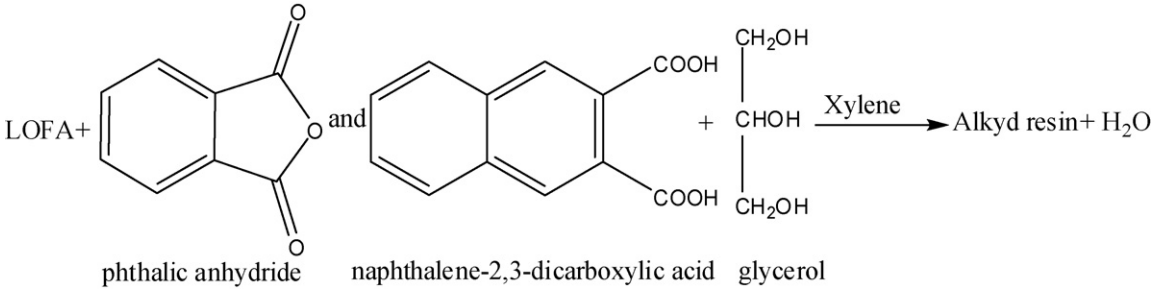

Table 2
Characterization of ilmenite ore.

Color	Black
Bulk density (g/cm^3)	2.2
Specific gravity	4.2
Mohs scale of hardness	6.5–7.0
Luster	Metallic
Fracture	Uneven
Sieve analysis (38 μm)	Passing

2.2.2. Coating evaluation

The methods of evaluation were carried out according to standard methods and divided into three stages: the first one is determining the solid content [16], viscosity [17] and color [18] of resin. The second stage includes preparation of glass panels [19] to study drying, curing or film formation of organic coating at room temperature [20], gloss [21], and pinhole [22] in addition to study the chemical resistance to water, acid, alkali and solvent [23–26]. The third stage includes preparation of steel panels [27] for measuring the dry film thickness [28], flexibility [29], resistance to scratch

Table 3
Resin characteristic constant of various NDCA-modified alkyd resins.

Resin no.	Ingredient	e_o	e_A	e_B	E	F	$W = Ee_o$	$m_o = e_o/F$	$R = e_B/e_A$	$K = m_o/e_A$	H_2O off (ml)
Ia	LOFA	0.111	0.111		280	1	31.08	0.111	1	1.047	2.00
	PA	0.149	0.149		74.1	2	11.04	0.075			1.34
	NDCA										
	G	0.260		0.260	30.7	3	7.98	0.087			
			0.260	0.260			50.10	0.272			3.34
Ib	LOFA	0.111	0.111		280	1	31.08	0.111	1	1.047	2.00
	PA (0.8)	0.119	0.119		74.1	2	8.83	0.060			1.07
	NDCA (0.2)	0.030	0.030		108	2	3.22	0.015			0.54
	G	0.260		0.260	30.7	3	7.98	0.087			
			0.260	0.260			51.11	0.272			3.61
Ic	LOFA	0.111	0.111		280	1	31.08	0.111	1	1.047	2.00
	PA (0.6)	0.089	0.089		74.1	2	6.62	0.045			0.80
	NDCA (0.4)	0.060	0.060		108	2	6.44	0.030			1.07
	G	0.260		0.260	30.7	3	7.98	0.087			
			0.260	0.260			52.12	0.272			3.88
Id	LOFA	0.111	0.111		280	1	31.08	0.111	1	1.047	2.00
	PA (0.4)	0.060	0.060		74.1	2	4.42	0.030			0.54
	NDCA (0.6)	0.089	0.089		108	2	9.66	0.045			1.61
	G	0.260		0.260	30.7	3	7.98	0.087			
			0.260	0.260			53.13	0.272			4.14
Ie	LOFA	0.111	0.111		280	1	31.08	0.111	1	1.047	2.00
	PA (0.2)	0.030	0.030		74.1	2	2.21	0.015			0.27
	NDCA (0.8)	0.119	0.119		108	2	12.87	0.060			2.15
	G	0.260		0.260	30.7	3	7.98	0.087			
			0.260	0.260			54.14	0.272			4.41

e_o: total equivalents present at the start of the reaction, e_A: number of acid equivalents, e_B: number of hydroxyl equivalents, E: equivalent weight, F: functionality, W: weight, m_o: total moles present at the start of the reaction, R: ratio of total –OH groups to total –COOH group and K: alkyd constant (m_o/e_A).