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CORROSION INHIBITOR

Stanley W. Drigot, Chicago, John M. Lebolt, Deerfield, Lawrence I. Minow, Chicago, and Albert H. Reynolds, Glen Ellyn, Ill., assignors to The Cromwell Paper Company, Chicago, Ill., a corporation of Illinois

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This invention relates to a method of increasing the effectiveness of a volatile corrosion inhibiting material when used as a component of a coating on wrapping materials and additionally relates to a composition comprising a volatile corrosion inhibitor which composition has superior effect as a coating on wrapping materials for metal articles susceptible to corrosion.

The subject of corrosion inhibition has developed in more recent years to overcome the rusting and corrosion of packaged metal parts caused by the inherently corrosive nature of the atmosphere within the package and to inhibit further extension of corrosion which might have begun before the metal parts were placed in the package. The problem in many cases was complicated by the fact that most of the commercially feasible packaging materials were not impermeable and therefore there was a constantly changing atmosphere within the package. This latter effect directed attention to the use of laminated or coated wrapping materials which, of course, minimized the permeability of the container but which did nothing to either diminish the earlier initiated corrosion or to combat the corrosive effect of the contained atmosphere.

To particularly combat such incipient corrosion, consideration was directed to materials that would provide a corrosion inhibiting atmosphere. As a result of this search, compounds were found which have come to be known as volatile corrosion inhibitors because of their volatility through the range of normal temperatures. This volatility permitting the compounds to pass into the vapor phase made possible various methods of use. In present day methods these materials have been dissolved in solvents for application directly to the parts to be protected. At other times they have been introduced into packages either as loose crystals or as liquids. Under other circumstances the compounds have been dissolved or dispersed in vehicles such as oils, oil-soluble waxes and resinous materials which in turn were used to impregnate or to coat packaging materials in which metal objects were wrapped and stored. This last method possessed the advantage of accomplishing a more uniform distribution of the corrosion inhibitor within the package, the dispersion of the inhibitor in an oil, wax or resinous material serving to eliminate any localized concentration of either liquid or particulate inhibitor within the package.

The foregoing use of volatile corrosion materials provided a simple method of placing the materials uniformly within the package and excluded from the package any loose particulate material that might abrade a metal object thus packaged but it did not properly control the dissipation of the corrosion inhibiting material. The effectiveness of these materials is a function of their volatility but that volatility was very significantly reduced by dissolving or dispersing the materials in a non-volatile carrier. The wax or resinous carriers coated most of the inhibitor except for that part at the surface of the film and thus permitted only a portion of the total

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inhibitor to pass into its vapor state. After that portion at or near the surface of the coating film had volatilized and had been utilized in corrosion inhibition or had passed through the packaging material, the packaged articles would be subject to corrosive atmospheric effects.

The petroleum waxes, oils, resins and mixtures thereof afforded advantages in ease of application and provided relatively dry films that would not transfer to the packaged articles. But these prior art media did not permit good utilization of the corrosion inhibitor because the media trapped the bulk of the inhibitor below the surface of the media so as to seriously deter its volatilization whereby it could function in its intended role as a vapor phase inhibitor.

Accordingly, it is an object of this invention to provide a method and coating composition which make possible fuller utilization of a volatile corrosion inhibitor. A further object of the invention is to provide method and means for controlling the rate at which volatilization of a vapor phase corrosion inhibitor occurs. Another object of this invention is to provide method and means for correlating availability of a volatile corrosion inhibitor with atmospheric concentrations of water vapor so that greater amounts of inhibitor become available as need increases.

The foregoing and related objects are achieved by this invention wherein the advantages of a waxy media are preserved but the volatility depressing effect of such wax on the corrosion inhibitor is eliminated. These conflicting effects are now satisfied for the first time by the use of water-soluble waxes as media for volatile corrosion inhibitors. In the same way that anti-fouling paints slowly slough to expose fresh anti-fouling agents so the novel composition of this invention slough to expose a new surface from which the volatile corrosion inhibitor can readily pass into the surrounding atmosphere, the sloughing rate being proportional to the humidity of the surrounding atmosphere.

As the media for practicing the present invention water-soluble waxes are employed. These include any of the polyethylene glycols with molecular weights above 1000, mixtures of more than one such polyethylene glycol, and mixtures of one or more with any of the polypropylene glycols, ethylene glycol, propylene glycol, glycerine or lower molecular weight polyglycols, all of these latter compounds serving as softening agents for the higher weight polyglycols to reduce their viscosity and regulate their solubility so as to promote sloughing where desired.

A comprehensive but not exclusive list of volatile corrosion inhibitors which can be used with water-soluble waxes according to this invention include the amines such as ethylamine, propylamine, isopropylamine, butylamine, isobutylamine, amylamine, isoamylamine, hexylamine, isohexylamine, octylamine, diethylamine, dipropylamine, diisopropylamine, dibutylamine, triisopropylamine, cyclohexylamine, dicyclohexylamine, morpholine, monoethanolamine and diethanolamine.

Similarly, the following acids of higher molecular weight are effective volatile corrosion inhibitors: caproic acid, caprylic acid, pelargonic acid, capric acid, 2-ethyl hexoic acid, isocaproic acid, benzoic acid, toluic acid, isopropyl-benzoic acid and gluconic acid.

The amine salts of these acids are likewise effective inhibitor materials such as cyclohexylammonium benzoate, dicyclohexylammonium benzoate, morpholine benzoate, ethylmorpholine benzoate, monoethanolammonium benzoate, diethanolammonium benzoate, dibutylammonium benzoate, amylammonium benzoate, butylammonium benzoate, cyclohexylammonium nitrite, dicyclohexylammonium nitrite, morpholine carbonate, dicyclohexylammonium carbonate, amylammonium caprate,

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cyclohexylammonium 2-ethylhexanoate, cyclohexylammonium pelargonate, dicyclohexylammonium caprylate, dicyclohexylammonium pelargonate, dicyclohexylammonium caproate, dicyclohexylammonium 2-ethyl hexanoate, morpholine pelargonate, cyclohexylammonium caprylate, morpholine caprylate, morpholine caprate.

In other circumstances aldehydes such as formaldehyde and acetaldehyde and alkyl sulfides such as methyl, ethyl, propyl and butyl sulfide are suitable.

Following are specific illustrative formulations employing the various components described above. It will be seen that the various volatile corrosion inhibitors can be used in combinations of two or more as well as singly, the particular selection varying according to anticipated atmospheric conditions, according to the nature of the wax vehicle, according to the nature of the wrapping medium and according to the particular metal material being packaged. In these formulations the number in parenthesis represents the approximate molecular weight of the polyglycols.

(1)	
	Percent
Polyethylene glycol (6000) -----	90
Amylamine -----	10
	100
(2)	
Polyethylene glycol (6000) -----	50
Polyethylene glycol (1500) -----	45
Morpholine -----	5
	100
(3)	
Polyethylene glycol (4000) -----	80
Ethylene glycol -----	10
Dicyclohexylamine -----	10
	100
(4)	
Polyethylene glycol (6000) -----	75
Glycerine -----	10
2-ethyl hexoic acid -----	15
	100
(5)	
Polyethylene glycol (4000) -----	70
Polypropylene glycol (1025) -----	20
Caprylic acid -----	10
	100
(6)	
Polyethylene glycol (6000) -----	60
Polypropylene glycol (425) -----	15
Glycerine -----	5
Morpholine caprylate -----	20
	100
(7)	
Polyethylene glycol (6000) -----	50
Ethylene glycol -----	20
Dicyclohexylammonium-caprylate -----	30
	100
(8)	
Polyethylene glycol (6000) -----	35
Ethylene glycol -----	35
Morpholine caprylate -----	15
Dicyclohexylammonium caprylate -----	15
	100
(9)	
Polyethylene glycol (4000) -----	35
Polypropylene glycol (425) -----	35
Dicyclohexylammonium caprylate -----	25
Amylammonium 2-ethyl hexanoate -----	5
	100

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(10)

Polyethylene glycol (6000) -----	45
Ethylene glycol -----	25
Morpholine pelargonate -----	30
	100

(11)

Polyethylene glycol (4000) -----	95
Formaldehyde -----	5
	100

In dispersing or dissolving the volatile corrosion inhibitor in the water-soluble wax a moderate heat of the order of 250° F. or less may be employed, but, in general, there is ready dissolution of the inhibitor in the wax. As an expedient in promoting uniform distribution of inhibitor through the wax, dissolution of the inhibitor in only a minor portion of the wax may constitute a preliminary step before adding to the total batch of the wax. By whatever means of mixing employed, the operation is aided by the fact that the water-solubility of vapor phase corrosion inhibitors required for them to be effective also makes them soluble or readily dispersible in the water soluble waxes. When mixing is completed, the composition is ready for application to the desired wrapping material in standard paper coating or impregnating equipment.

The range of water solubilities of the various polyglycols used in formulating our soluble waxes for use in combination with volatile corrosion inhibitors is from almost complete solubility for some of the lower molecular weight polyethylene glycols to less than .2% for some of the higher molecular weight polypropylene glycols. The preferred water solubility of wax or wax mixture is upward of 50% but this percentage of solubility may be reduced greatly where objects to be protected from corrosion are exposed in extremely humid localities. The term "water soluble waxes" is intended to include individual water soluble waxes, mixtures of water soluble waxes and mixtures of water soluble waxes with other water soluble materials to the extent that the ultimate mixture remains wax like in appearance. Similarly, the particular choice of corrosion inhibitor will vary according to desired volatility, the lower molecular weight compounds being generally more volatile than the higher weight ones.

By the practice of this invention which combines water-soluble waxes with volatile corrosion inhibitors, it is now possible to use volatile corrosion inhibitors whose volatility is too low to have permitted their use in the past with oil-soluble waxes of the prior art.

Having thus described the invention, what is claimed is:

1. A method of controlling the dissipation of a volatile corrosion inhibitor into its vapor-state which comprises dispersing said volatile corrosion inhibitor in a water-soluble wax, whereby, as the wax sloughs at a rate determined by the humidity of the surrounding atmosphere, new surfaces of wax and inhibitor are successively exposed, from which surfaces the inhibitor vaporizes into the surrounding atmosphere.

2. A composition of matter adapted for use as a coating or impregnant for wrapping material to inhibit atmospheric corrosion of metallic objects wrapped therein which consists essentially of a volatile corrosion inhibitor dispersed in a water-soluble wax.

3. A composition of matter adapted for use as a coating or impregnant for wrapping material to inhibit atmospheric corrosion of metallic objects wrapped therein which consists essentially of a dispersion of a minor proportion of a volatile corrosion inhibitor in a water-soluble wax mixed with a water-soluble softening agent for said wax.

4. A composition of matter adapted for use as a coating or impregnant for wrapping material to inhibit atmos-

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pheric corrosion of metallic objects wrapped therein which consists essentially of a minor proportion of a volatile corrosion inhibitor, a member of the group of water-soluble waxes consisting of polyethylene glycols having molecular weights greater than about 1,000 and mixtures thereof, and a water-soluble softening agent for said wax selected from the group consisting of ethylene glycol, propylene glycol, polypropylene glycols, and mixtures thereof.

5. A composition of matter adapted for use as a coating or impregnant for wrapping material to inhibit atmospheric corrosion of metallic objects wrapped therein, which composition has substantially the following formula:

	Percent	15
Polyethylene glycol (mol. wt. approx. 6000)-----	35	
Ethylene glycol -----	35	
Morpholine caprylate -----	15	
Dicyclohexylammonium caprylate -----	15	

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