AD/A-000 237

USE OF CORROSION INHIBITORS IN THE PRO-DUCTION OF PACKING PAPER FOR PROTECTION OF METAL PARTS

S. A. Balezin, et al

Army Foreign Science and Technology Center Charlottesville, Virginia

20 May 1974

DISTRIBUTED BY:



U. S. DEPARTMENT OF COMMERCE



DEPARTMENT OF THE ARMY U.S. ARMY FORFIGN SCIENCE AND TECHNOLOGY CENTER

220 SEVENTH STREET NE. CHARLOTTESVILLE, VIRGINIA 22901

TRANSLATION

1. Repix Refer for 1×10 HT 23 230-74 DIA Lisk No. 1741801 Date: 20 May 1974 Use of Corrosion Inhibitors in the Production ENGLISH FILLE: of Packing Paper for Protection of Metal Parts SOF RCT Ingibitory korrozii metallov (sbornik 3), Moscow, 1969, pp. 276-86 CIRC: CSP 72519123 11114 Balezin, S. A., Babich, L. V., Shekhter, Yu. N., Khoroshilova, L. D. Russian ANC ACH USSR N 16 N GE - Prelle per existe RANS ALOR Leo Kanner Associates, Redwood City, CA (DPS)

ABSTRACT:

The possibility of producing a single-layer anticorrosion wrapping paper for metal parts, by means of addition of various kinds of additives to the paraffinning corpound, was investigated. Effective protection from atmospheric corrosion of ferrous and nonferrous metal parts, by means of paraffinned wrapping paper containing corrosion inhibitors, was demonstrated. Formulas for the protective layer of paraffinned wrapping papers for metal parts were presented. It was found that wrapping metal parts with inhibitor paper and then paraffinned paper increases the corrosion resistance of the paper to a negligible extent in the majority of cases.



 e^{-1} is a set of $\sqrt{16}$ because has been translated is presented in the original test. Notation probasible termadors consist where e^{-1} is a statement contained herein. This translation is published with a summary of copy of ting and at entry of which is not over the specific the dissemination or information.

1

A second they have a part Distribution infinited.

NATIONAL TECHNICAL PRORMATION SERVICE Summary of the

16

For protection of metal parts from corrosion during shipment and storage, atmospheric corrosion inhibitors are widely used. Under these conditions, both volatile and contact inhibitors can be used.

The "contact" inhibitors include substances which have a protective effect under conditions of direct contact with the surface of the metal being protected. Volatile inhibitors protect metal parts from corrosion in the vapor phase; therefore, they frequently are called vapor phase inhibitors.

A large number of water-soluble and oil-soluble compounds are used at the present time as inhibitors of atmospheric corrosion of metals.

Water-soluble inhibitors of metal corrosion, forming true solutions in water, but not dissolving in mineral oils, are used in the form of water solutions and powders, and they are applied to wrapping paper [1].

The following requirements should be placed on this group of atmospheric corrosion inhibitors: a specific vapor tension, metal surface sorption and their solubility in water media, considering that there is a thin film of moisture on the surface of the metal under almost any conditions [2].

The protective effect of inhibitors is connected to a great extent with their surface-active properties. An increase in surface activity of inhibitors

-2-

strengthens their protective effect. The effective concentration of them is sharply reduced in this case [3].

One of the principal characteristics of a volatile inhibitor is the pressure of its saturated vapor. It should be sufficient to create a protective concentration of inhibitor vapors in the space surrounding the metal being protected and not too high, in order to guarantee prolonged protection.

In leading up to a summary of many years of use of water-soluble inhibitors for protection of metals from atmospheric corrosion, it should be noted that both fatty and aromatic organic amines and their salts with weak organic and inorganic acids are the most effective. These are substances, the molecules of which are formed by ionic or polar bonds, and their hydrophilic groups assist in solution of the inhibitor in water.

Oil-soluble inhibitors are organic substances consisting of two parts: a quite high molecular weight, branched hydrocarbon radical, providing for solubility of the entire molecule in oil, and a functional group (or several groups): providing the protective properties of a given compound [4].

Nitro and amino groups, as well as sulfonate and oxygen-containing ones-ester, carboxyl, carbonyl and hydroxyl groups--can emerge as such functional groups.

The mechanism of action of oil-soluble inhibitors have been studied very little. The fundamental difference between water- and oil-soluble inhibitors of corrosion affecting their mechanism of action and protective properties consists of the fact that oil-soluble inhibitors, in distinction from watersoluble ones, do not dissociate. Apparently, for this reason, they cannot have a significant effect on the electrode processes taking place in an atmosphere of corrosion, and they act on the metal in another manner. Thus, for

-3-

example, while sodium nitrite and dicyclohexylammonium mitrite have much in common in the mechanism of action, both have passivating properties, both stimulate corrosion of some nonferrous metals, oil-soluble inhibitors, for example, nitrated oil, differ sharply from them. They protect ferrous and nonferrous metals.

In this manner, despite the fact that water-and oil-soluble corrosion innibitors frequently have one and the same functional groups, their mechanisms of action are completely different: the first act in a water medium, for example, in a moisture film on the surface of the metal; the second prevent penetration of the moisture to the metal surface.

The adsorption film created by oil-soluble corrosion inhibitors on the surface of the metal can physically prevent penetration of moisture and reactive substances, they can have hydrophobic properties, and they can displace moisture from the metal surface. In some cases, the molecules of an oil-soluble inhibitor can chemically bind reactive components of the environment. Thus, basic alkali earth metal sulfonates (having excess alkalinity above the stoichiometric) can bind reactive gases (sulfur dioxide, hydrogen sulfide) and, as a consequence of this, protect the metal from corrosion.

Under conditions of warehouse storage and transportation of metal parts, the carriers of oil-soluble inhibitors are oils and greases and the carriers of water-soluble inhibitors most often are the wrapping paper. Paper continues to be the cheapest packaging material at the present time.

An essential defect of regular inhibitor paper is its high gas and vapor permeability.

To provide more reliable protection of metal parts, they are wrapped additionally in paraffinned paper. Another method of increasing the protective properties of inhibitor paper is the manufacture of multilayer paper.

-4-

The purpose of this work was the creation of a single-layer inhibitor wrapping paper, guaranteeing protection from corrosion of parts of ferrous and nonferrous metals during the transportation and warehouse storage periods.

Experimental Section

For solution of the problem stated, three series of corrosion tests were carried out on ferrous and nonferrous metals (steel 20, copper M3, brass L62):

I. Corrosion tests of samples of metals wrapped in kraft paper impregnated with inhibitor solution;

Il. Corrosion tests of metal samples wrapped in inhibitor paper and in paraffinned paper over it;

III. Searching for an additive to the paraffin, which would increase the anticorrosion protective properties of paraffinned paper.

All corrosion tests were carried out in a heat and humidity chamber, under variable storage conditions.

To conduct the first two series of tests, we used substances soluble in water or alcohol, known to be effective inhibitors in neutral media.

Samples of kraft paper were immersed in a solution with a specific concentration of inhibitor, then dried at room temperature, after which the gravimetric content of inhibitor in the paper was determined in g/m^2 . If the content of inhibitor in the paper proved to be insufficient, the sample was impregnated several times in the same solution until the optimum concentration was achieved.

The corrosion tests were conducted over a period of 100 hours in a heat and humidity chamber at 100% relative humidity and variable storage conditions. For a period of 2 hours a day, the temperature was maintained at 45° C and, during the remaining time of the day, natural cooling to 20° C took place. The

-5-

state of the metal surface was evaluated by a 10-point system (see Table 2), after 100 hours of testing.

Q nin. NaNe	}	р Танменование ингибитора	С Конц. раств., %	d р-ра	Солержание ингибитора в бумаге, г.м.	Примечание	
1 2 3 4	Беі Беі Пи Хро	изоат натрия	10 10 5 унасы-	7,2 6,7 5,4 6.8	13,26 13,15 10,39 13,11		
5 6	Хр на Беі	омат гексаметиленднами- изотриазол	10 5	8,25 5,5	14,16 12,52	спиртовый раствор	
Key:	a. b. c. d. 1. 2.	Number Inhibitor name Solution concentr Solution pH Sodium bonzoate Ammonium benzoate	ation,	e. f. % g. h.	Inhibit Note Saturat Alcohol	er conten ed soluti solution	t in paper,g/m ² on
	3. 4. 5. 6.	Dicyclohexylamino Cyclohexylamino c Hexamethylenediam Benzotriazole	nitrit hromate ine chr	e omate	2		

TABLE 1:	CHARACTERISTICS	OF	INHIBITOR	SOLUTIONS	USED	FOR
	IMPRFGNAT	INC	G KRAFT WR	APPING PAPI	ER	

[Translator's note: Commas in tabulated figures are equivalent to decimal points.]

The results of the tests carried out (Table 3) show that additional wrapping of the samples in paraffinned paper has a very insignificant effect on the corrosion behavior of the metal samples tested, in the majority of cases. These data permit it to be concluded that this method of wrapping, which frequently is used at present, is inadvisable. The results of tests of paper inhibited with ammonium benzoate and hexamethylenediamine chromate were somewhat unexpected. Additional wrapping of semples in paraffinned paper reduces the protective properties of the inhibitor paper.

	External Appearance of Samples								
Points	Steel	Brass							
0	No change	No change	No change						
1-2	Appearance of 2 or 3 corrosion points on ends.	Appearance of 2 or 3 rust spots, Surface bright.	Indelible strips.						
3-4	Increase in number of corro- sion points on ends.	Formation of thin oxide layer without loss of shinc.	Single corrosion points. Tarnishing of surface.						
5-6	Appearance of 1-2 corrosion points on sample surface.	Tarnishing of surface and ap- pearance of sep- arate foci of corrosion.	Corrosion and temper color.						
7-8	Increase in number of cor- rosion foci.	Increase in number of corro- sion spots.	Significant cor- resion of part of surface of sample.						
9-10	Heavy corro- sion of entire surface of sample.	Considerable corrosion of en- tire surface of sample.	Considerable cor- rosion of entire sur face of sample.						

TABLE 2: SCALE FOR DETERMINATION OF CORROSION DAMAGE TO STEEL, COPPER AND BRASS

•

On the basis of visual observations, this can be explained in the following manner: paper impregnated with ammonium benzoate is very hygroscopic and, after a day of testing in the heat and humidity chamber, it becomes moist. The samples became covered with drops of water inside the wrapping, but the surface of the steel remains shiny and is not corroded during the entire test period.

-7-

Under these conditions, an optimum protective concentration of inhibitor evidently is created. Paraffinned paper, decreasing the vapor permeability of the wrapping, decreases the protective properties of the ammonium benzoate under these conditions.

The decrease in time of protective effect on nonferrous metals by paper inhibited with hexamethylenediamine chromate, with additional wrapping of the samples in paraffinned paper, apparently can be explained in this same manner. During corrosion tests in the heat and humidity chamber, drops of condensed moisture do not form on the surfaces of the samples, but the inhibitor paper itself is strongly wetted.

		[d CT	аль	e Me	<u>2</u> 6	<u></u> ла	тунь
CC NyNe n/n.	b Илгибитор	с Серия опыта	время до 20 наступления коррозии.	оценка 7 поверхности, балл	время досо наступления коррозии.	оценка поверхности, балл	время до СС наступления коррозии, сутки	оценка V поверхности. балл
1	Контроль (крафт-бу- мага без ингибитора)		1	10	12	5	12	7
. 2	Бензоат натрия	1	60 100	1	9 9	8 4	9	8 -1
3	Бензоат аммония		100 30	02	=			-
4	Нитрит дициклогекси-	1	100 100	0	20 40	6 2	15 15	4
5	Хромат циклогекси-	1	100 100	0	$\frac{25}{25}$	4 3	25 -40	$\frac{2}{2}$
6	Хромат гексаметилен- диамина	1 11	10 10	$\frac{2}{2}$	100 30	1 3	100 60	0
7	Бензотрназол	1 11	14 90	4 1	100 100	0	6 30	21
Key:								
a.	Number	e. (lopper					

TABLE 3: PROTECTIVE PROPERTIES OF INHIBITOR PAPER

b. Inhibitor

c. Test series d. Steel

f. Brass

g. Time to onset of corrosion, daysh. Evaluation of surface, points

1. Control (kraft paper without inhibitor) 5. Cyclohexylammonium

2. Sodium benzoate

3. Ammonium benzoate

4. Dicyclohexylammonium nitrite

- chromate o. Hexamethylenediamine chromate
- 7. Benzotriazole
- -8-

The next series of tests was devoted to selection of the additive to the paraffin which would increase the anticorrosion protective properties of paraffinned paper. For this purpose, those additives to the paraffin mass should be selected which would act on the metal surface as contact inhibitors, or which would sharply decrease the vapor permeability of the paraffinned paper and increase its elasticity.

We investigated oil-soluble inhibitors as additives, which are successfully used by the "Neftegaz" plant, as an inhibiting grease, as well as certain organic amines and their salts, which have low solubility in oil.

The oil-insoluble inhibitors were introduced into the paraffinning compound in the form of a suspension, produced by means of an ultrasonic unit. Paper base ODP-35, made of 100% unbleached sulfate cellulose (GOST¹ 5175-53), and grade B paraffin (GOST 784-53) were used for paraffinning.

To increase the elasticity of the cover layer of paraffin, together with the oil-soluble inhibitors, we mixed spindle oil (GOST 1707-51) and petrolatum (GOST 4096-54) with the paraffin. The results of the investigation are presented in Tables 4, 5, and 6.

[[]GOST--All-Union State Standard.]

Q Nelle	Добозка в парафии	Кой- цен- тра-	время до начала коррозни, сутки			
		ция. %	Сталь	€ _{мель}	9.narym	
1	2	3	4	5	6	
1	и Контроль (парафинированая бу- мага)	_	7	40	40	
2	Сокисленный петролатум	3	19	50	50	
3	Окисленный петролатум	3 20	27	55	55	
4	Окисленный петролатум	3 30	29	120	52	
5	Окисленный петролатум	1,5 8,5	70 <u>`</u>	50	40	
6	•Окисленный нетролатум	1,5 5,5 3	42	60	55	
7	Окисленный петролатум МНитрованное масло Солеат алюминия	1,5 7,5 0,5	40	45	45	
8	Р Окисленсый церезии	3	17	30	12	
9	Скисленный церезин Верстенное магло	3 20	24	55	40	
10	РОкисленный церезии	3 30	7	12	5	
11	• Присадка — ингибитор коррозни Акор *	10	100	120	60	
12	г Хромат гексаметилендиамина	2	22	120	120	
13	S Вазелинозое масло	63 3	100	_	30	
14 '	S Вазелиновос масло • Бензоат моноэтаноламниа • Триэтаноламии • Оленновая кислота	17 1 1	50	29	79	
15	З Вазелиновое масло	63 3	60	-	32	

TABLE 4: COMPARATIVE EFFECTIVENESS OF PARAFFINNED PAPER SAMPLES

-10-

TABLE 4 (continued)

Key:

- a. Number
- h. Paraffin additive
- c. Concentration, % d. Time to start corrosion, days
- e. Steel
- f. Copper
- g. Brass

.

- h. Control (paraffinned paper)
- i. Oxidized petrolatum
- j. Spindle oil
- k. Petrolatum
- 1. Oil solution of calcium sulfonate

- m. Nitrated oil
- n. Pyropolymers
- o. Aluminum oleate
- p. Oxidized ceresin
- q. Additive, Akor corrosion inhibitor^l
- r. Hexamethylenediamine chromate

- s. Mineral oil
 t. Octadecylamine
 u. Monoethanolamine benzoate
- v. Triethanolamine
- w. Oleic acid
- x. Latex

	,	c	d	Состо	яние по	верхност	ги, бал.	1 6
Ne.Ne	b	Концен-	€ ста	1.715	+ me	дъ	5 .78	гунь
n/n.	добањки в парафии	трация, %	р после 60 ты суток	После 120-ти суток	и иосле Ости сугок	После 120-тн суток	ћ После 60-ти суток	После 120-ти суток
_!	2	3	4	5	6	7	8	9
1	Ј Контроль (парафини- рованная бумага)	-	10		5	6	5	6
2	К Окисленный петрола- тум	3	6	8	4	7	3	4
3	к Окисленный петрола- тум Веретенное масло	3 20	5	8	1	4	1	4
4	КОкисленный петрала- тум м Лстролатум	3 30	5	5	0	0	3	3
5	КОкисленный петрола- тум м Масляный раствор сульфоната кальция .	1,5 8,5	1	1	1	1	I	2

TABLE 5: EFFECT OF ADDITIVES TO PARAFFIN ON ANTICORROSION PROTECTIVE PROPERTIES OF PARAFFINNED WRAPPING PAPER

Akor additive has the following composition: nitrated oil, 85.7%; technical stearin, 9.5%; technical lime (calculated as CaO), 4.8%.

Table 5 (continued)

;	2	3	4	5	6	7	8	<u> </u>
6	К Окисленный петрола- тум с Пигрованное масло р Пирополимеры	1,5 5,5 3	6	G	0	4	3	6
7	КОкисленный петрола- тум С Интрованное масло Олеат алюминия	1,5 7,5 0,5	1	1	1	4	I	5
s	V Окисленный церезий	3	5	_	4	4	3	3
9	Скисленный церезии Всретенное масло	3 20	2	2	1	2	1	1
10	• Окисленный церезин . • Петролатум	3 30	5	5	5	5	2	3
11	у Присадка — нигибитор коррозии Акор	10	0	1	0	0	1	1
12	t Хромат гексаметилен- глимента	2	.1	7	0	0	1	1
13	• Вазелиновое масло . • Октадечиламии	63 3	0	1		_	1	1
! 1	Бласлинорге масло в Безарат моноутанола- нога Стризтан гламил Оленторая каслота	17 1 1	2		4	-	5	_
;5	. С Винеличовое масло . 12. Питекс	63 3	1		_	-	1	

Key:

- a. Number b. Paraffin additive
- c. Concentration, %
- d. State of surface, points
- e. Steel
- f. .Copper
- g. Brass
- h. After 60 days
- i. After 120 days
- j. Control (paraffinned paper)
- k. Oxidized petrolatum
- 1. Spindle Oil
- m. Petrolatum
- n. Oil solution of calcium sulfonate

- o. Nitrated oil
- p. Pyropolymers
- q. Aluminum oleate
- r. Oxidized ceresin
- s. Additive, Akor corrosion inhibitor

1

- t. Hexamethylonediamine chromate
- u. Mineral oil
- v. Octadecylamine
- w. Monoetha clamine benzoate
- x. Triethanolamine
- y. Oleic acid
- z. Latex

-12-

1

1 СКитроль (бумага парафинированная, лабора- торные образцы) 2 44 2 Филосенный петролатум 3 29 3 Окисленный петролатум 3 20 4 Окисленный петролатум 3 20 5 Окисленный петролатум 30 12 6 Масляный петролатум 1.5 58 6 Исполный петролатум 1.5 58 7 Окисленный петролатум 1.5 57 1 Антрованное масло 7.5 50 1 Опаст алюминия 30 45 9 Юкисленный церзин 3 30 45 10 20 55 55 50 10 20 55 55 50 11 Эваслинове масло 10 20 20 20 Уромат гексаметилециланина 1 57	Ø. №N n/n	Ь Добавки в парафии		е Концент- рация, %	Парбпро- инцае- мость, <i>е/м²</i>
торные образцы)	1	Контроль (бумага парафинированная, лабо	opa-	[
2 OKACCENHAN RETPORTYM 3 29 3 OKACCENHAN RETPORTYM 3 1 9 Beperenhoe Macho 30 12 4 OKACCENHAN RETPORTYM 30 12 5 Ackannak Retportym 30 12 6 Ackannak Retportym 1.5 58 7 FOKACENHAN RETPORTYM 1.5 53 7 FOKACENHAN RETPORTYM 1.5 51 1 Appoint Retport 3 55 7 FOKACENHAN RETPORTYM 1.5 53 6 FOKACENHAN RETPORTYM 1.5 53 7 FOKACENHAN RETPORTYM 3 30 8 MOKACENHAN RETPORTYM 3 31 9 ROKACENHAN REPORTYM 33 31 <tr< td=""><td></td><td>торные образцы)</td><td></td><td>2</td><td>44</td></tr<>		торные образцы)		2	44
3 Окнолники петролатум 3 51 4 Окноленный петролатум 30 12 5 Окноленный петролатум 15 30 12 5 Окноленный петролатум 15 36 58 6 Окноленный петролатум 15 3 55 7 Окноленный петролатум 15 3 55 7 Окноленный петролатум 15 3 35 7 Окноленный петролатум 15 15 16 1 Интрованное масло 7.5 10 20 55 1 Окноленный церезин 3 30 9 90	2	• Окисленный петролатум	• •	3	29
 J Depende Macholin, J. J.	3	Варатенное масло	•••	20	51
Image: Strain	4	+ Окисленный петролатум	•••	3	51
5 Нокисленный петролатум 15 15 • Масляный петролатум 15 58 6 Окисленный петролатум 15 1 15 15 1 15 15 1 15 15 1 15 15 1 15 15 1 15 15 1 15 15 1 15 15 1 15 15 1 15 15 1 15 15 1 16 15 1 16 15 1 17 16 1 10 20 12 0 20 14 PBaschinobace Macho 63 14 PBaschinobas Kuchora 1 15 1 87 20 20 1 14 PBaschinobas Kuchora 1 15 1 87 20 1 1 14	1	h Петролатум		30	12
i Масляный раствор сульфоната кальция '8.5 58 f Окисленный петролатум '1.5 '1.5 f Парополимеры '3 55 f Парополимеры '1.5 '1.5 i Нарополимеры '1.5 '1.5 i Нарополимеры '1.5 '1.5 i Парополимеры '1.5 '1.5 i Масланый петролатум '1.5 '1.5 i Масланый церезин '3 '3' g Deperennoe масло '20 '55 i М Окисленный церезин '3 '3' g Beperennoe масло '10 '20 i M Присака Акор '10 '20 o Xpowar гексаметиленднамина '2 '46 g Octrageциламин '3 '11 g Destant монозтаноламина '1 '1 g Dasannonoce масло '17 '1 g Basennoose масло '1 '1 g Dotrageциламин '1 '1 g Cotrageциламин '1 '1 g Dasannoose масло '1 '1 g Dotragetunament '1 '1 <td< td=""><td>5</td><td>4 Окисленный петролатум</td><td></td><td>1,5</td><td></td></td<>	5	4 Окисленный петролатум		1,5	
6 #ORECREMENT TO PORTYM 1.5 1 HERDOBARNOE MACRO 5.5 1 Therposathoe Macro 7.5 2 Oreat алюминия 0.5 32 3 0 0.5 32 4 Herposathoe Macro 7.5 30 5 1 0.5 32 7 #ORECRENHA LEPSON 3 30 9 WOKHCRENHA LEPSON 30 45 10 Peperennoe Macro 20 55 10 WORECRENHA LEPSON 30 45 11 Terporatym 30 45 12 OKNERCENHA LEPSON 20 55 10 20 20 55 11 PErporatym 30 45 12 OKNERCENHANA LEPSON 10 20 12 OKARA ANOP 10 20 20 13 PBaschinoboe Macro 17 7 7 7 FEBASCHINOBOE MACRO 17 7 7 7 FEBASCHINOBOE MACRO 1 1<		• Масляный раствор сульфоната кальция .		8,5	58
 Hurponanhoe Macho Hurponankeps Hoponankeps Hoponankeps<td>6</td><td>FОкисленный петролатум</td><td>• •</td><td>1,5</td><td>1</td>	6	FОкисленный петролатум	• •	1,5	1
 Пирополимеры) Нитрованное масло	• •	5,5	
 Provide the fight of the fight of	7	Пирополимеры	•••	3	55
Innposance масло 0,5 32 8 Мокисленный церезин 3 30 9 МОкисленный церезин 3 30 10 20 20 55 10 20 20 20 11 MIpucanka Akop 10 20 2 46 9 33 115 12 ØKMARAMANNHA 3 115 115 9 Baseлиновое масло 17 1 87 11 PBaseлиновое масло 1 1 87 ey: 1 87 ey: 1 87	1	У Нитрокачное масто	•••	75	
8 Юккленный церезин 3 30 9 Юккленный церезин 3 30 9 Юккленный церезин 3 30 10 Усоронатия 30 45 11 и Присака Акор 10 20 12 Оккленный церезин 30 45 11 и Присака Акор 10 20 12 О Хромат гексаметилендилимина 2 46 13 Рвазслиновое масло 63 115 14 Рвазслиновое масло 17 1 r Бензоат моноэтаноламина 1 1 87 ey:		Олеат алюминия	•••	0.5	32
9 МОКИСЛЕННЫЙ ЦЕРЕЗИН 3 3 9 Верегенное масло 20 55 10 МОКИСЛЕННЫЙ ЦЕРЕЗИН 3 45 11 Петролатум 30 45 11 N Перислака Акор 10 20 12 О Хромат гексаметиленднамина 2 46 13 Рвазслиновое масло 63 15 4 Рвазслиновое масло 63 15 4 Рвазслиновое масло 17 7 5 Беноват моноэтаноламин 1 87 ey: 2 1 87 ey: 1 1 87 ey: 2 1 1 . Yaparationamut 1 87 <	. 8	МОкисленный церезин		3	30
Beperennoe масло 20 55 10 MORUCACHINAN QEPENH 3 45 11 N Присадка Акор 10 20 12 O Xpowar reксаметилендиамина 2 46 13 PBaschinoboe масло 63 46 14 PBaschinoboe масло 3 115 14 PBaschinoboe масло 3 115 14 PBaschinoboe масло 1 57 15 PBaschinoboe масло 1 57 14 PBaschinoboe масло 1 57 15 PBaschinoboe масло 1 57 14 PBaschinoboe масло 1 57 15 PBaschinoboe масло 1 57 14 PBaschinoboe масло 1 57 15 PBaschinoboe масло 1 57 15 PBaschinoboe масло 1 57 16 PBaschinoboe масло 1 57 15 Paschinobas Kucлота 1 57 16 Concentration, % modulatis ceresin 0	9	WOКИСЛЕННЫЙ ЦЕРЕЗИН		3	
10 МОкисленный церезин 30 45 11 Петролатум 30 45 12 Охромат гексаметилендиамина 2 46 13 РВазелиновое масло 63 46 14 РВазелиновое масло 63 115 14 РВазелиновое масло 17 6 г Бензоат моноэтаноламина 1 37 14 РВазелиновое масло 17 г Бензоат моноэтаноламина 1 57 ey: 1 87 ey: 1 1 . 1 87 ey: 1 1 . 1 87 ey: 1 1 87 . 2 1 1 . 30 1 87 . 2		Э Веретенное масло		20	55
11 Переолатум	10	МОкисленный церезин		3	45
12 и присилка якор				30	40
13 P Вазслиновое масло 63 115 14 P Вазслиновое масло 17 63 115 14 P Вазслиновое масло 17 1 87 14 P Вазслиновое масло 1 1 87 14 P Вазслиновое масло 1 1 87 14 P Вазслиновое масло 1 1 87 15 Tpustanonamun 1 1 87 15 Tpustanonamun 1 87 ey:	12	АХромат гексаметилендиамина		10	46
14 Эвазелиновое масло	13	РВазелиновое масло		63	
14 рВазелиновое масло 17 г Бензоат моноэтаноламина 1 з Триэтаноламин 1 ц Оленновая кислота 1 к Оленновая 1 к Оленновая кислота 1 к Оленновая 1		о Октадециламни		3	115
 Г Бензоат моноэтаноламина	14	рВазелиновое масло		17	
 S Тризтаноламин		СБензоат моноэтаноламина	• • •		
 Number Paraffin additive Concentration, % Vapor permeability, g/cm² Control (paraffinned paper, o. Hexamethylenediamine chromather in the spindle of 1 Oxidized petrolatum Spindle of 1 Oil solution of calcium sulfonate t. Oleic acid 		У Гриэтаноламин	• •		87
 Number Number Paraffin additive Concentration, % Vapor permeability, g/cm² Control (paraffinned paper, laboratory samples) Oxidized petrolatum Spindle cil Petrolatum Oil solution of calcium sulfonate t. Oleic acid 			• •		
 Number Number Paraffin additive Concentration, % Vapor permeability, g/cm² Control (paraffinned paper, o. Hexamethylenediamine chromather laboratory samples) Oxidized petrolatum Spindle cfl Petrolatum Oil solution of calcium sulfonate t. Oleic acid 	Key				
 Paraffin additive Paraffin additive Concentration, % Vapor permeability, g/cm² Control (paraffinned paper, laboratory samples) Oxidized petrolatum Spindle cil Petrolatum Oil solution of calcium sulfonate t. Oleic acid 	а.	Number	k.	Pyropo	lymers
 Concentration, % m. Oxidized ceresin Vapor permeability, g/cm n. Akor additive Control (paraffinned paper, o. Hexamethylenediamine chromat laboratory samples) p. Mineral oil Oxidized petrolatum q. Octadecylamine Spindle cil r. Monoethanolamine benzoate Petrolatum sulfonate t. Oleic acid 	э.	Paraffin additive	1.	Alumin	um oleate
 Vapor permeability, g/cm² Control (paraffinned paper, laboratory samples) Oxidized petrolatum Spindle cil Petrolatum Oil solution of calcium sulfonate t. Oleic acid 	с.	Concentration, %	m -	Oxidiz	ed ceresin
 Control (paraffinned paper, laboratory samples) Oxidized petrolatum Spindle cil Petrolatum Oil solution of calcium sulfonate t. New additive Reconstruction of the second second	1.	Vapor permeability g/cm ²		Akam -	dditius
 control (parafrinned paper, o. Hexamethylenediamine chromatilaboratory samples) oxidized petrolatum Spindle cil Petrolatum Oil solution of calcium sulfonate t. Oleic acid 	_	Control (noroffinned none-	11.	AKOT A	duitive
Laboratory samples)p. Mineral oil. Oxidized petrolatumq. Octadecylamine. Spindle cilr. Monoethanolamine benzoate. Petrolatums. Triethanolamine. Oil solution of calcium sulfonate t.Oleic acid	- •	lalante la	ο.	Hexame	thylenediamine chromat
 Oxidized petrolatum q. Octadecylamine Spindle cil r. Monoethanolamine benzoate Petrolatum sulfonate t. Oleic acid 	-	laboratory samples)	p.	Minera	l oil
 Spindle cil Petrolatum Oil solution of calcium sulfonate t. Oleic acid 		Oxidized petrolatum	q۰	Octade	cylamine
 Petrolatum s. Triethanolamine Oil solution of calcium sulfonate t. Oleic acid 	3.	Spindle of1	r.	Monoet	hanolamine benzoate
. Oil solution of calcium sulfonate t. Oleic acid	n.	Petrolatum	s.	Trieth	anolamine
Nitrated oil		011 solution of calcium sulforete	+	Oloic	and
		Nitrated oil	6.	Uterc	aciu

TARTE 6. VADOD DEDMEADILITY OF DADADDINNED DADED

The investigations conducted demonstrated that introduction of corrosion inhibitors into the paraffinning compound considerably increases the protective anticorrosion effect of paraffinned wrapping paper.

Samples of metals wrapped in paraffinned paper containing Akor additive, hexamethylenediamine chromate (nonferrous metals) were not corroded over a

period of four months of testing under severe conditions. Oxidized petrolatum, combined with other additives, also has good protective properties.

For conduct of natural tests, the following compositions of the protective layer of the wrapping paper can be recommended:

For Steel and Nonferrous Metals

- A. 1. Paraffin 90%
 - 2. Akor additive 10%
- B. 1. Paraffin 30%
 - 2. Mineral Oil 63%
 - 3. Octadecylamine 7%

For Copper and Brass

A. 1. Paraffin - 98%

2. Hexamethylenediamine chromate - 2%

For Copper

- 1. Paraffin 67%
- 2. Petrolatum 30%
- 3. Oxidized petrolatum 3%

For Steel

- 1. Paraffin 90.5%
- 2. Nitrated oil 7.5%
- 3. Oxidized petrolatum 1.5%
- 4. Aluminum oleate 0.5%

Conclusions

1. The possibility of producing a single-layer anticorrosion wrapping paper for metal parts was investigated.

2. The possibility of effective protection of ferrous and nonferrous metal parts from atmospheric corrosion was demonstrated, using paraffinned wrapping paper containing corrosion inhibitors.

3. It was determined that introduction of certain additives to the protective layer of paraffinned wrapping paper reduces its vapor permeability.

4. A formula for the protective layer of paraffinned wrapping paper for metal parts was developed.

5. The comparative effectiveness of the protective action of wrapping paper, impregnated with various atmospheric corrosion inhibitors, was investigated.

6. It was determined that, in preservation of metal parts with inhibitor paper, additional wrapping of them in paraffinned paper increases the corrosion resistance of the paper to only a negligible extent, in the majority of cases.

It was noted that the protective properties of certain samples of inhibitor paper (ammonium benzoate and hexamethylenediamine chromate inhibitors) is sharply reduced by isolating them from the external medium with paraffinned paper.

BIBLIOGRAPHY

- Balezin, S. A., L. V. Babich, in the collection <u>Ingibitory korrozii metallov</u> [Metal Corrosion Inhibitors], Sudostroyeniye Press, Leningrad, 1965.
- Balezin, S. A., Collection No. 2 <u>Ingibitory korrozii</u> [Corrosion Inhibitors], VSNTO, Profizdat Press, 1957.
- 3. Golyanitskiy, O.I., scientific-technical collection Zashchitnyye pokrytiya [Protective Coatings], Issue 1, Moscow, 1962.
- Shekhter, Yu. N., <u>Zashchita metallov ot korrozii</u> [Protection of Metals from Corrosion], Khimiya Press, 1964.

-15-