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#28. Synthetic Coatings for Ships' Hulls
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Author: None

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Code 1

Paints and varnish materials are the basic means for protecting ships' hulls from corrosion and the underwater sections from being fouled by marine organisms. The boot topping, bow wave and stem rake areas are exposed to the greatest corrosion.

The synthetic coatings employed in the outer plating of ships' hulls can be divided in terms of function into the following groups: 1) primers; 2) anticorrosive; 3) antifouling. The use of synthetic paints on ships in the majority of cases helps to reduce the painting time, extends the period of utilization of the ship (before requiring maintenance), and successfully replaces paints made from vegetable oils. In order to obtain a paint-varnish coating which is stable under operating conditions of the ship, it is necessary to carefully prepare the surface to be painted beforehand.

One of the advanced methods for such preparation is the mechanized blasting of ships' hulls. In order to clean the outer plating of ships, (both at the slip and at the dock), mobile towers can be employed which are equipped with blasting apparatus and articulated or telescoping "arms" with cleaning heads. The vacuuming of the shot guarantees dust-free operation of the apparatus. Television is employed to control the quality of cleaning.

For all Soviet ships, depending on their area of operation, specific systems* for painting the underwater section of the boot topping and the

* Departmental Standards MVN-51-57 and MVN-52-57

external above-surface surfaces of hulls were established effective 1 July 1958.

Below the procedures for painting the underwater sections and the boot toppings with paints based on synthetic materials are given (Arabic numerals denote procedures for painting the underwater sections and Roman numerals for the boot toppings).

A. For ships with unlimited sea and ocean navigating ranges, sailing in various latitudes, including 50°N. Lat. and within the Black and Far Eastern seas.

Procedure I

4 coats of EKZhC-40
5 coats of KhS-79t*
6 coats of KhS-79s*

"t" denotes dark shade

"s" denotes light shade

Procedure 9

1st coat of primer VL-02
2nd coat - paint KhS-78t or KhS (green) s

3rd coat paint KhS-78t or KhS (green):
4th coat paint KhS-78s or KhS (green)s
5th coat paint KhS-79t
6th coat paint KhS-79s

B. For ships of unlimited sea and ocean navigating range, sailing no further south than 50°N. Lat. and within the Baltic, Caspian, Azov and Arctic waters.

Procedure 3

4 coats of paint EKZhS-40
2 coats of KhS-79t or s

Procedure 9 is given in Section A.

C. For ships sailing in port waters and the roadsteads of the Baltic, White, Caspian, Azov seas, the Arctic oceans and fresh waters.

Procedure 8

4 coats of paint EKhKS-40

Procedure 10

1st coat - primer VL-02
2nd coat - paint KhS-78s or KhS (green)s
3rd coat - paint KhS-78t or KhS (green)t
4th coat - paint KhS-78s or KhS (green)s
5th coat - paint KhS-78t or PhS (green)t

For boot toppings

Procedure III

3 coats of paint EKXhS-40
2 coats of mixed primer No. 83

Procedure IV

3 coats of paint EKZhS-40
2 coats of green cinnabar No. 33 or No. 34

Procedure V

3 coats of paint EKZhS-40
2 coats of paint EPKK-69 or EPKK-67

Procedure VI

3 coats of paint EKZhS-40
2 coats of EPKZ-62 or EPKZ-60

Procedures VII and VIII are employed in painting the boot roppings when painting the underwater sections according to procedures 9 and 10.

Procedure VII

1st coat-primer VL-02
2nd coat-paint KhS-78t
3rd coat-paint KhS-78s
4th coat-paint KhS-78t
5th coat-paint KhS-78s

Procedure VIII

1st coat-primer VL-02
2nd coat-paint KhS (green) t
3rd coat-paint KhS (green) s
4th coat-paint KhS (green) t
5th coat-paint KhS (green) s

Primer coatings EKZHS-40, VL-02 and others:

Any primer should be applied to a surface which has been prepared by degreasing and removing corrosion products. Corrosion products should be removed with special care from weld seams.

The basic component of ethinol paint is ethinol varnish (a brown liquid). It is a solution of a polymer of divinylacetylene (a homologue of acetylene) in xylol, i.e., the basic source material is the waste from the production of synthetic rubber. Iron oxide red paint is added to the varnish as a pigment. The brand of paint usually employed in shipbuilding and ship repair as a primer is EKZHS-40. In 100% prepared EKZHS paint the content of iron oxide red paint is 40% and the remaining 60% is ethinol varnish. Thus the number in the name of the paint indicates the percentage of pigment in its composition.

Ethinol paint has a number of positive characteristics. It can be used the year round at a minimum temperature of -25° and under high humidity conditions. The first coat of primer is applied by brush, while the second and subsequent layers can be applied by paint sprayer. The drying time in summer is from 2 to 12 hours, and up to 48 hours in winter. The paint can be stored satisfactorily up to two years. The approximate consumption of EKZHS-40 in applying by brush is $100\text{g}/\text{m}^2$, and $120\text{g}/\text{m}^2$ when applying with a sprayer. The thickness of a coat ranges from 12 to 15 μ .

Paint EKZHS-30 should not be used for painting surfaces subject to prolonged heating above 50° or directly in the sun. If the hull is painted near the hot well or dirty condensate tanks, then before painting with EKZHS-40, these sectors should first be primed with red lead.

Ethinol paint must be prepared directly before use in order to avoid thickening. White spirit serves as a thinner.

Of great significance at the present time are paints based on synthetic vinyl resins, including a primer compound. Such primer compounds are widely used in the U.S. with the name "wash primer". The Soviet compound is called VL-02. Primer compound consists of two components: the primer itself and an acid thinner. The first component, in the form of a viscous paint based on polyvinyl butyral, is thinned 5 minutes before beginning priming operations, with an acid thinner which includes phosphoric acid, ethyl alcohol and water, for which reason it is called a phosphatizer. The ingredients of the primer are mixed in the following ratio: 1 part weight of acid thinner to four parts of primer base. Primer VL-02, which has the appearance of a green liquid, is applied to the surface to be painted in one coat and dried in summer for 15 -30 minutes, and in winter for two hours at a temperature of -10° .

Paint operations using primer VL-02 are not permitted in the open air at temperatures below -10° , in strong sunlight, at a temperature in the shadows above $+30^{\circ}$, in a strong wind, during rain or snowfall. The approximate specific consumption of phosphatizing primer VL-02 per coat is 60 g/m^2 . The thickness of the primer coat is 10 microns.

Mixed primer No. 83 consists of equal parts of zinc and iron oxide red paint (35% per weight) and linseed oil (30%). The thickness of the coat of primer No. 83 is 25 microns.

In addition to the above, primers of various brands based on perchlorovinyl and alkyd resins KhSG, phenol ash varnish FL-08 and others are employed, in which case an obligatory condition is that they subsequently be covered with the appropriate paints.

In the point of seam welding of metals, the film of primer should, after welding, evenly fill the gaps between the weldable parts. For this purpose varnish primers ALG (for priming the surfaces of aluminum alloys) and VKHGM are used. VKHGM primer, which is made on a base of vinyl chloride and vinylidenechloride, should be modified with oil pastes in order to retard excessively rapid drying.

Primers V-329 and D-329 based on butyl-phenol resin and oils are used in painting the above-surface sections of hulls with vinylidene chloride paints type SKHV. Primer paints are produced abroad under various names, as, for example, Vinyflex-100, Vinyflex-100W and others.

Anticorrosive coverings: The basic anticorrosive paints used for covering phosphatizing primers are vinyl paints which are distinguished by the resistance of the film. Brand KHS vinyl paints are used for the underwater part of the outer plating of ships' hulls. A number of additional components, e.g., toluol, butylacetate, etc., as well as pigments are included in brand KHS-78 and KHS (green) anticorrosive paints based on a copolymer of vinyl chloride with vinyl acetate. Xylol, solvent, and brand R-4 thinner are used for thinning the paint.

KHS-78 and KHS (green) paints should be applied in three or four coats on primer VL-02 (see procedures 9, 10, VII and VIII) and the welded and

riveted seams and seam areas are coated with an additional coat of paint. The total thickness of the film of dried paint should be about 150 microns.

KHS paints are applied by paint sprayer with an air pressure of 1.5 to 2.5 atm. The approximate consumption of paint in one coat when using the paint sprayer is 120 g/m². The coat thickness is 18 to 20 microns. The drying time for each coat depends on the temperature at which the painting is done. Paints dry at a temperature of 0 to -10° in four hours, and in one hour from 0° and above. As with painting with primer VL-02, painting operations must not be carried out with KHS paints at temperatures lower than -10°, in a strong sun, etc. The coats of dark and light KHS paint may be alternated in reverse order, in opposition to procedures 9 and 10. KHS paints may be applied to a dry or moist surface.

A number of vinyl paints are also employed in foreign countries. For example, paint 119 is applied in two or three layers, the drying time for one coat of paint at a temperature of +20° being one hour. Novoplast paint ASP is applied in one coat and dries in several hours. Kromokarena paint is applied in two coats and dries in 3 - 4 hours etc.

For painting the boot toppings type, EPK Soviet ethinol perchlorvinyl paint is used. Five brands of EPK paint are produced which differ from each other in the percentage composition of ethinol varnish (20-28%), perchlorvinyl varnish (34-42%) and pigments (20-45%). EPK* paints are applied

*In the procedures and specifications, a fourth letter is added to the designation of EPK paints to indicate the color of the paint: Z-green; K-red, etc., E.g. EPKZ, EPKK.

on a surface primed with EKZHS-40 according to procedures V and VI. The expenditure of paint applied by brush is 150 g/m², and 200 g/m² by paint sprayer.

EPK paints should be prepared in a quantity not exceeding two days' needs. The thickness of each coat is 12 to 15 microns. The drying time for EPK paints is not more than 6 hours at a temperature of 20 -25°.

New anticorrosive paints based on epoxy resins are employed within USSR and abroad in painting the tank of tankers. Due to the development of the chemical industry, it would be suitable to employ epoxy coatings on a broader scale on the outer plating of ships' hulls. Under the effects of sea water, this coating undergoes no changes and protects steel from corrosion. At the present time industry is producing paints based on epoxy resins E-40, E-41 and others. Epoxy paints are applied on primer E-402, first thinning them with thinner R-40. The painting should be done on a passivated surface at a temperature of not less than 10 -15°. This limits the use of epoxy paints at low temperatures.

In foreign countries, epoxy paints of various brands, which are similar to Soviet types are employed, for example: Artouex and others.

Experimental anticorrosive paints for boot topping were tested. They

made it possible to draw the conclusion that the use of polyethylene in powder form is feasible. After drying the primer, organic solvents are applied to the surface. R-4 is the solvent (GOST 7827-55).

#31. Synthetic Coatings under Conditions of Tropical Climate

The problem of coatings for the outer plating of ships' hulls, equipment and parts operating under tropical conditions is of urgent significance in connection with the voyages of ships that entail stopovers in ports in the tropical and subtropical regions. The basic phenomena which have a harmful effect on paint and varnish coatings are high temperature (60-75° on the surface of constructions) and high air humidity (90 -99%). Paints based on synthetic resins are most stable under these conditions. Painting procedures 9, VII and VIII are recommended for the outer plating of ships' hulls.

In addition to protection against corrosive damage, a significant role is played by the stability of the paints against the formation of molds and the action of microorganisms and the effects of types of insects (termites, for example) which destroy the insulation of electric cables and pipes. In order to obtain coatings which will withstand tropical conditions, it is necessary to apply inhibiting primers to a carefully prepared surface, and to use moisture resistant coatings to which fungicides have been added.

Pentaphthal based enamels containing powdered aluminum as a pigment are used most extensively for painting equipment. Copper compounds are used as fungicide additives (copper oxyquinolate). The equipment is painted with three or four coats of enamel, which is applied by paint sprayer with subsequent drying under natural conditions.

Metal coating with polyamides and polyethylene applied by spraying are also used. The surfaces of electrical equipment are coated with primer V-329 based on phenolformaldehyde and painted with glyphthalic enamel No. 138.