TECHNICAL INFORMATION ON BUILDING MATERIALS

TIBM - 47

FOR USE IN THE DESIGN OF LOW-COST HOUSING

*****

THE NATIONAL BUREAU OF STANDARDS
UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

June 4, 1937

VARNISH AND LACQUER

This is chiefly a digest of sections of applicable Federal Specifications, and the following publications of the National Bureau of Standards dealing with varnish and lacquer, raw materials used, manufacturing methods, required properties, and practical tests.

Circular C69, "Paint and Varnish", (November 17, 1917).[1]

Technologic Paper T274, "Use of United States Government Specification Paints and Paint Materials", (December 15, 1924),[2] by P. H. Walker and E. F. Hickson.

Varnish: In general, varnish may be defined as any liquid, not containing suspended matter (pigment), used for decoration or protection and capable of being spread in a thin homogeneous film which will dry to a hard coating.

Lacquer: Any thin spirit varnish containing shellac or other resins, can be considered a lacquer.

---

[1]Out of print and not available by purchase, but may be consulted in Government depository libraries.

[2]Available from Superintendent of Documents, Washington, D. C. (Price 10 cents)

Classes and Special Types

Oil Varnishes are more important and numerous than other types. They embrace such kinds as spar, interior, floor, gear, and rubbing varnishes which contain a fixed or fatty oil, in addition to a volatile solvent and usually resin.

Spirit Varnishes, such as dammar, shellac, lacquers, asphaltum, etc., contain only resin (or some other similar substance) and a volatile solvent.

Special Types, such as the following, have a somewhat specialized and technical use. "Flat" varnish, which gives a dull, lusterless coat; insulating varnish, which is used chiefly for insulating tape; dipping varnishes, in which articles are dipped and allowed to dry; and certain "baking varnishes", some of which contain no metallic driers and are entirely dependent on baking for accelerating the drying process. The film obtained when a varnish is dried by baking; that is, by heating to a suitable temperature in an oven, is generally considered more durable than one dried at room temperature.

Other special types are lithographic and patent-leather varnishes, the black asphaltum varnishes, black jacket enamels, and many kinds of lacquers.

Raw Materials - Fatty Oils

Linseed Oil,[1] used for varnish, is practically always refined or treated in various ways and called "varnish oil", "borate oil" (boiled oil prepared by heating with manganese borate), etc.

Tung Oil,[2] another fatty oil used in the manufacture of varnish must be treated to remove or prevent gelatination (formation of a jelly-like mass) which ordinarily occurs when the oil is heated at 250-300°C. A common method for treating tung oil is to add rosin, which has a solvent action on the jelly-like material. Gelatination may also be prevented by other means.

---

[1] See TIBM - 44, "Paint Drying Oils - Linseed".

[2] See TIBM - 45, "Miscellaneous Paint Drying Oils and Paint Driers".

These and other TIBM's mentioned in this digest may be obtained, free of charge, from the Division of Codes and Specifications, National Bureau of Standards, Washington, D. C.

Volatile Paint and Varnish Thinners[1]

The chief volatile thinners used in the manufacture of varnish are turpentine, and mineral spirits. Many spirit varnishes, especially shellac varnish, contain either grain (ethyl) alcohol, wood (methyl) alcohol, or denatured alcohol (a mixture of grain alcohol with such materials as wood alcohol, acetone, pyridine, benzine, etc.).

Metallic Driers[2]

Practically the same metallic compounds, namely, those of lead, manganese, and cobalt, used in the manufacture of paint, are also used in the preparation of varnish.

Resins

Copals, including "fossil gums",[3] are formed by exposing to the air and aging the exudation of certain trees, indigenous to New Zealand and various parts of the tropics. Amber is generally considered a fossil resin. Although Zanzibar is considered the hardest and most valuable of the copals, Kauri is the one most used. Copals are graded commercially according to color, freedom from foreign matter, etc. The grades are classified according to size, as "bolds", "nubs", "seeds", and "dust". As the supply of copals is limited, it has been necessary to find substitutes, the most promising of which are nitrocellulose esters, and the condensation products of phenol and formaldehyde.

Dammar Resin, formed from the exudation of certain trees, is generally classified according to place of shipment, as Singapore dammar, Batavia dammar, etc. It is used chiefly in the preparation of spirit varnish.

Rosin, the residue left in the still after distillation of turpentine, is graded according to color. The light-colored varieties are considered to be the most valuable. Rosin, when used as a varnish material, is generally, but not always, hardened by the addition of lime. Resinates of the heavy metals, such as zinc, are also used to a limited extent. Prolonged heating, or treatment with zinc or calcium oxides not only hardens rosin but also lessens its acidity. As the

---

[1] See TIBM - 46, "Volatile Paint and Varnish Thinners".

[2] See TIBM - 45, "Miscellaneous Paint Drying Oils and Paint Driers".

[3] Zanzibar, Kauri, Pontianak, Sierra Leone, etc.

addition of too much oxide to rosin makes the product too hard and insoluble, the amount of oxides added (usual ratio, 1 part lime to 20 parts rosin) is not nearly sufficient to completely neutralize the rosin acid (abietic acid).

Rosin has generally been considered an improper material for use in high grade varnishes; since, when present in considerable amounts, it causes varnish films to be brittle, to turn white with water, and generally lowers the wearing qualities. Very fine varnishes are now made, however, which contain small amounts of rosin; and for interior use some of the tung oil-rosin varnishes, which contain considerable rosin, may be considered as high-grade products.

Shellac,[1] a resinous material, is also used as a raw material in varnish.

Manufacture of oil Varnish

Without Resin: Oil varnish free from resin, is produced from "bodied"[2] fatty oil, chiefly linseed oil. Driers and volatile thinners may or may not be added, according to the purpose for which the varnish is used. Varnishes of this type, such as lithographic varnishes, patent-leather varnishes, etc., have a more or less limited and special use.

With Resin: Oil varnish containing resin is frequestly produced by adding heated fatty oil to resin which has been previously heated in a kettle until it is completely melted. Driers may be added separately or they may be incorporated with the oil. This mixture is heated until, in the judgment of the varnish maker, it is ready to be cooled and thinned. Heating must be continued until no separation of the ingredients occurs on cooling. After thinning with a volatile thinner, the varnish is filtered and stored. Some of the best grades are stored for a long time before marketing, in which case filtration may be omitted. Sometimes different varnishes are mixed and the blend marketed under a certain name. By varying mixing and heating methods, it is possible to prepare varnishes from the same proportions and amounts of raw materials, even though they differ greatly in properties and qualities.

Manufacture of Spirit Varnishes

Dammar Varnish is prepared by treating dammar resin with turpentine or light mineral oil, with or without the application of heat.

---

[1]See TIBM - 48, "Shellac".

[2]See TIBM - 44, "Paint Drying Oils - Linseed".

The usual proportions are five to six pounds of resin to one gallon of solvent. "Cold process" dammar varnish is generally believed to be better. As the resin is only partially dissolved, commercial dammar varnishes always show more or less turbidity.

Shellac Varnish, a spirit varnish, is discussed in TIBM - 48, "Shellac".

Lacquers are usually clear or nearly clear solutions. Some lacquers are made by dissolving nitrocellulose, sometimes with the addition of resin, in such solvents as amyl acetate, wood alcohol, acetone, or mixtures of these and other liquids. They are frequently colored by the addition of soluble coloring matter.

Asphaltum Varnish and other similar products are, in some cases, oil varnishes containing in place of part or all of the resin, a prepared asphalt or pitch, and in other cases spirit varnishes made by dissolving coal-tar pitch in coal-tar naphtha.

Insulating Varnishes: As all resins, bitumens, and oils have rather good insulating properties, any varnish made of these materials, which dries with a reasonably impervious film, may be considered as an insulating varnish.

Flatting Spirit Varnishes contain such materials as shellac, glycerin, and galipot,[1] with various solvents.

Required Properties

Properties required in a varnish are "flowing and drying", "appearance", and "durability", which naturally depend upon how it is to be used.

Exterior Exposures: Although the modern, quick-drying, four-hour type spar varnish is used extensively for exterior exposures, other varnishes for outside use are of the "long-oil"[2] type, which generally dry more slowly than those for indoor exposures. These varnishes must be elastic and waterproof. Therefore, a better and more expensive varnish is usually required.

---

[1]Crude Turpentine resin formed as an exudation upon the bark of the cluster pine in Southern Europe.

[2]Usually contain from 25 to 50 gallons of oil per 100 pounds of gum. They are generally heated for a considerable time to increase the viscosity or "body".

Interior Exposures: For general inside use, an elastic varnish film is not so essential. A good grade interior varnish should not turn permanently white with water, and the very best grades do not turn white even while wet. For some inside work a very hard film, although it dusts, is more suitable than a softer, elastic film. In the manufacture of varnish, hardness, usually obtained by the addition of resins, is produced at the expense of elasticity. However, due to the advent of modern synthetic resins, hard-drying and elastic varnishes may now be obtained.

Floor Varnish should dry hard in at least three days; although with the use of the new, synthetic resins, floor varnishes dry hard overnight.

Color: When it is desired to retain the light color of certain woods, or of white or tinted color coats, a light-colored varnish is essential.

Practical Testing of Varnishes and Lacquers

Dammar and Shellac Varnishes: The practical testing of these varnishes is limited to color, consistency, and smoothness of film.

Lacquers: Aside from special requirements, the parctical testing of lacquer is limited to color, consistency, drying, and whether or not it dulls a polished metal surface.

Black Varnishes may be tested by applying them to metal panels, and noting the time of drying and nature of the film.

High Temperature Varnishes: If the varnished surface is to withstand high temperatures, a baking test should be made to ascertain whether the film retains its gloss, elasticity, and adhesive properties at the necessary temperature.

Insulating Varnishes should be tested principally to ascertain their adhesive properties, and resistance to oil and water.

Simple Methods for Testing Varnishes

First note whether or not the sample has the desired color, clearness, and flowing properties. Then, any or all of, the following simple tests may be made.

Panel Test: Apply a coat of the varnish to a metal or wood panel, which has been painted a dull black. Drop-black in oil, thinned with

turpentine and drier, gives a good undercoat for this purpose. Note the time required for the film to dry hard; that is, when the finger pressed firmly against the surface leaves no impression.

Let the coat dry for two days or more, and rub with steel wool or powdered pumice and water. Note whether or not the sample has good rubbing properties; that is, whether or not a smooth, dull surface, suitable for the application of a second coat, is obtained. Also note whether or not the rubbed surface "sweats"; that is, whether glossy patches form on the panel after twenty-four hours.

Apply a second coat of the varnish and let the film dry for three days after it has become hard. The relative luster of different samples may be noted at this point.

Let a stream of cold water run over the varnished surface over night, and in the morning note whether the film is unaffected, dulled, or whitened. Then let a stream of boiling water flow over the varnish for fifteen minutes and note the effect on the film.

Finally, any other desired tests, such as the application of soap and water, or household ammonia, may be made.

Glass Plate Test: Flow some of the sample on a clean glass plate, allow it to drain and dry in a vertical position, and note the time required for the film to dry "free from tackiness" (the point at which the film no longer feels sticky when touched lightly with the finger), and to dry hard.

After five days, run the point of a knife blade through the film at the top of the plate, and note whether it is elastic; that is, whether it comes off as a ribbon from a clean cut, or whether it "dusts" (breaks into small pieces).

Service Test: The most satisfactory and reliable information regarding varnish is naturally obtained by actual use, but such information can be collected only after several months. While service tests give useful information regarding certain brands, which are of uniform quality, it is necessary to assume or to actually prove that such brands remain uniform in composition and properties. In service tests of outside varnishes, it has generally been found that a difference in climatic conditions causes a greater variation in the length of service of any brand of good quality varnish, than is obtained with different brands under the same climatic conditions.

Federal Specifications[1]

Water-Resisting Spar Varnish: Specification TT-V-121a, "Varnish; Spar, Water-Resisting", is intended to meet the needs for a general utility varnish, suitable for both outside and inside exposure, where durability is the chief requisite and high gloss or initial hardness of the film are not required. This varnish should be used for all exterior work and for interior floors when several days can be allowed for drying before using. When this can not be done it may be best to use interior varnish on the floor.

Interior Varnish: Specification TT-V-71, "Varnish; Interior", covers a varnish suitable for general interior use for both rubbed and unrubbed finishes, including floors. This varnish may be used when it is desired to rub the film a short time after applying, but generally, a water-resistant spar varnish is preferred.

Shellac Varnish: Specification TT-V-91, "Varnish; Shellac", is intended to cover all needs of the Government for light, medium, or heavy body shellac varnish; both orange, Type I and II, and bleached, Type I and II. Light, medium, and heavy body varnishes correspond to 3.5, 4.0 pound "cuts" of shellac, respectively.

Orange Shellac Varnish: In general, Type I will include the rosin-free material and the lighter colored varnishes, while Type II is intended for use where the presence of small percentages of rosin (not over 3%) is not objectionable, and where lightness of color is not an essential factor.

Bleached Shellac Varnish:[2] In general, Type I will fulfill all needs for a white shellac varnish. Type II will only be used in cases where a clear bleached varnish (practically free from wax or other suspended matter) is necessary.

Asphalt Varnish: Specification TT-V-51, "Varnish; Asphalt" covers two grades; namely, Grade A - Normal asphalt varnish, and Grade B - Asphalt varnish resistant to mineral acids. Asphalt varnish is very commonly used on interior ironwork, and on both interior and exterior surfaces subjected to high temperatures. It should never be applied under or over oil paints.

Mixing Varnish for Aluminum Paint: Specification TT-V-81, "Varnish; Mixing (For) Aluminum-Paint" covers a mixing varnish designed for use in the preparation of aluminum paint but not for use as a clear varnish.

---

[1]Specifications adopted by the Federal Specifications Executive Committee and approved by the Director of Procurement, Treasury Department, for use of all departments and establishments of the Government. Copies of these specifications may be obtained from the Superintendent of Documents, Washington, D. C. (Price 5 cents each)

[2]Sometimes known as white shellac varnish.