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PREPARATION OF PAINTS FROM PASTE AND DRY PIGMENTS

This is primarily a digest of section of Bureau of Standards Circular No. 69 (November 17, 1917), "Paint and Varnish";¹ and Technologic Paper No. 274 (December 15, 1924), "Use of United States Government Specification Paints and Paint Materials",² by P. H. Walker and E. F. Hickson; dealing with proportions of pigment and oil in some paste paint pigments, preparation of paints from paste and dry pigments, and color blending.

The following papers contain additional information relative to paint pigments, oil paints, and water paints:

- TIBM - 30 "Paint Pigments--White"
- TIBM - 31 "Paint Pigments--Black, Red, and Lakes"
- TIBM - 32 "Paint Pigments--Yellow, Brown, Blue, Green, and Bronze"
- TIBM - 33 "Federal Specification Paint Pigments and Mixing Formulas"
- TIBM - 34 "Federal Specification Ready-Mixed Paints, Semi-paste Paints and Mixing Formulas"
- TIBM - 36 "Preparation of Paints from Semipaste Paints, Thinning Ready-Mixed Paints, and Preparation of Water Paints"
- TIBM - 43 "Aluminum Paints"

¹Out of print. May be consulted in Government depository libraries.

²Available from Superintendent of Documents, Government Printing Office, Washington, D. C. (Price 10 cents).

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Paint is "a mixture of pigment with vehicle, intended to be spread in thin coats on surfaces for decoration or protection, or both."¹

The principal distinction between paint and varnish is that paint contains an appreciable amount of pigment in suspension, substantially insoluble in the vehicle; while varnish is a liquid in which any resins or waxes contained therein are mostly in solution.

Pigments are "the fine solid particles used in the preparation of paint, and substantially insoluble in the vehicle."¹ Pigments are prepared for commercial use in two forms, dry and paste, the latter being ground in oil, Japan, or other vehicles to a stiff consistency. Paste pigments are generally preferred, as the incorporation of dry pigments into the vehicle to form a paint of desirable properties is a tedious and unsatisfactory process unless suitable machinery is available. While there is some tendency for pigments in paste form to separate from the vehicle, this tendency is greater in thinner mixtures of painting consistency than in the paste form. Basic carbonate white lead in linseed oil is the most widely used paint paste pigment. In general, it may be assumed that pigments composed of very fine particles, having high refractive indices, provide the greatest covering power and opacity.

Vehicle is "the liquid portion of a paint."¹ The vehicle usually contains a number of substances which for convenience may be divided into two classes, volatile thinner and nonvolatile vehicle.

Volatile thinner is "all that portion of a paint, water excepted, which is volatile in a current of steam at atmospheric pressure."¹ Turpentine, the most important of the volatile thinners used in paints and varnishes, is added to provide proper flowing consistency, penetrating power and, in some cases, to dissolve resinous matter in the wood being painted. As a thinner, one volume of turpentine is as effective as approximately two volumes of oil. Substitution of turpentine for a portion of the oil in the vehicle causes paint to dry "flat".

Nonvolatile vehicle is "the liquid portion of a paint, excepting its volatile thinner and water."¹ Linseed oil, the principal nonvolatile vehicle, is added to furnish a binder for pigments. A small proportion of oil to pigment gives the paint a "flat", rather than glossy, surface.

Proportions of Pigment and Oil in Some Paste Paint Pigments.

White Lead Paste Pigment: The most used paste paint pigment is basic carbonate white lead in linseed oil. That known to the trade as keg lead contains one hundred pounds dry white lead to eight pounds linseed

¹Quoted from "Standard Definitions of Terms Relating to Paint Specifications", American Society for Testing Materials (1933). pp. 735-739.

oil. A standard grinding formula is 92 1/4 pounds dry white lead to 1 gallon of linseed oil weighing 7 3/4 pounds. One hundred pounds of this paste occupies about 2 3/4 gallons, weighing about 36 pounds per gallon. Soft paste or semipaste white lead is usually ground in the proportion of 100 pounds dry basic carbonate white lead to 10 pounds linseed oil and 2 pounds turpentine. One hundred pounds of the soft paste occupies about 3 gallons, weighing about 33 1/3 pounds per gallon. For Federal Specifications, see TT-W-251a "White Lead; Basic Carbonate, Dry, Paste-In-Oil, and Semipaste containing Volatile Thinner."¹

Zinc Oxide Paste Pigment is usually ground in the proportion of 37 3/4 pounds zinc oxide to 1 gallon linseed oil, producing about 1.83 gallons of paste, containing about 83 percent zinc oxide, weighing about 24 pounds per gallon. Commercial products are sometimes marketed which contain as low as 73 percent zinc oxide. For Federal Specifications, see TT-Z-301 "Zinc Oxide; Dry and Paste-In-Oil."¹

Other Opaque White Pigments, Extenders, and some Colored Body Pigments are not commonly sold in paste form.

Indian Red and Venetian Red Paste Pigments contain about 80 percent pigment.

Yellow Ocher and Chrome Yellow Paste Pigments contain about 75 percent pigment.

Raw Sienna and Raw Umber Paste Pigments contain about 60 percent pigment.

Prussian Blue Paste Pigments contain about 50 percent pigment.

Lampblack Paste Pigments seldom contain more than 35 percent pigment.

Preparation of Paints from Paste Pigments

In preparing paint, the order in which the ingredients are added is important. Each ingredient should be thoroughly incorporated in the paint before adding the next.

Preparation of Paste: The first step is to break up the paste, which is quite stiff. Transfer it to a vessel of sufficient size to hold considerably more than the volume of paint to be mixed, add a small amount of linseed oil (not more than 1 pint per 100 pounds paste), and mix thoroughly with a stout wooden paddle or spatula until a homogeneous softer paste is formed. The gradual addition of oil,

¹ Copies of all Federal Specifications mentioned in this digest may be obtained from Superintendent of Documents, Government Printing Office, Washington, D. C. (Price 5 cents each).

a smaller amount each time, followed by thorough mixing should be repeated until the paste is thin enough to be easily stirred and can be poured, but is still too thick to be used as paint. To prevent the paste from sticking to the sides of the mixing vessel and to facilitate stirring, the inside of the vessel should be swabbed with oil. The addition of a very little turpentine to the paste will cause it to break up more readily.

Better oil paint will be produced if the broken up paste is allowed to stand for a day before finishing the mixing so that the oil may form a smooth uniform liquid by softening the many small lumps that escape the paddle.

Addition of Color Pigments or Tinting Colors: If any color pigments or tinting colors are to be added, they should first be broken up and thinned separately to the same consistency as the main body of thinned paste, and added in very small quantities and mixed thoroughly. When adding colors, especially tinting colors which are usually very strong, it is better to add too little than too much, as very small amounts of color are required. Where too much color is added the fault can only be remedied by breaking up more of the main body paste and adding it to that already mixed. This may produce more finished paint than is desired.

Addition of the Drier: When the paste has been broken up and properly colored or tinted, the drier should be added and stirred in thoroughly.

Final Steps: With constant stirring, work in the rest of the oil, then the turpentine or mineral spirits until the paint is of proper consistency for painting. To insure freedom from lumps, the paint should be strained shortly before using by pouring it through a paint strainer, a piece of fly screen, or coarse muslin.

Addition of Spar Varnish to Oil Paints: In any formula calling for the addition of spar varnish to oil paint, such as floor, porch, or deck paint, add varnish to completed paint just before application. Generally one pint of varnish to one gallon of paint is ample for top coat work. In general, varnish should not be added to oil paint and then allowed to stand several days before using, as some varnishes, even overnight, may thicken paints containing zinc oxide.

Preparation of Paints from Two or More Paste Pigments

In mixing paint containing two or more pigments, as, for example, white lead-zinc oxide paint or zinc oxide-titanium pigment paint, each paste should be broken up separately, as recommended above, to the point where the drier is added. The drier should then be added

in portions to each partially broken down paste. The broken down pastes should then be thoroughly mixed together and the rest of the oil and volatile thinner added.

Preparation of Paints from Dry Pigments

When necessary to use dry pigments, they should first be ground to a paste. This may be accomplished by wetting the pigment with a little turpentine and working it on a smooth marble slab, a piece of glass, or smooth board, with a stone muller, a spatula, or flexible knife until a stiff paste is formed. Oil may then be added in small amounts mixing constantly until a smooth paste results. This paste may then be mixed with any similar paste for the making of paint.

Caution: Under no circumstances should dry color be added to a paint until it has been worked up into a smooth paste, as it will form small masses of dry powder causing streaks under the brush regardless of the amount of stirring. In general, with the one exception of dry red lead, it is difficult to get a good smooth paint by using dry pigments.

Color Blending

In blending colors it should be remembered that different samples of the same color vary considerably in strength and tone. The same quantity will not always produce the same result. The names used by different manufacturers for their pigments vary so much that directions given to produce a certain tint may give entirely different results with different brands.

Subduing Bright and Glaring Colors: Colors in paste form that are too bright and glaring may be corrected by adding small amounts of their complimentary colors. Yellow is made less intense by adding a little blue and red; blue, by adding a little red and yellow; and red, by adding a little yellow and blue.

Caution: Except in rare instances, the addition of black to dull a bright color causes a muddy appearance.

Production of Tints: The following illustrations are given as a guide to the production of tints by mixing pastes of different colors:

Gray: White lead mixed with lampblack will produce gray from the lightest shade to the darkest, depending upon the proportions of each pigment used. One percent of lampblack will produce a strong "cold", "steel-gray" tint. A strong warm gray tint may be obtained by adding a little yellow ocher or sienna to the cold gray tint. If burnt umber is used instead of the ocher or sienna, a series of gray drabs will be obtained.

Buff is obtained by tinting white lead with yellow ocher. Cream color results from adding a touch of Venetian red to light buff. Ivory, a tint closely related to cream, is produced by using a very little medium chrome yellow to white lead. Drab "stone" color is obtained by mixing together about five parts white lead paste, two parts yellow ocher or chrome yellow in oil, and one part burnt umber in oil. Yellow drab will result if the proportions for producing the drab "stone" color are varied.

Brown Shades may be produced by mixing in varying proportions about three parts Indian red in oil or Venetian red, two parts lampblack in oil, and one part yellow ocher in oil. Umber may replace the lampblack and ocher. Brown drabs may be obtained by adding white lead in oil to the brown shades.

Pink is produced by tinting zinc oxide with madder lake, carmine, or crimson shades of English vermilion. Purple or lilac is made by tinting white lead with dark Indian red. A small amount of light Indian red may improve the purple effect.

Brick Reds are secured by mixing about two parts yellow ocher, one part Venetian red, and one part white lead, the exact color depending upon the proportions used.

"Sapphire Blue" is obtained by tinting zinc white with ultramarine blue. "Sky Blue" of various depths is produced by adding Prussian blue to white lead.

Chrome Green, a mixture of Prussian blue and chrome yellow, is obtainable in many varieties, which may all be further modified by the addition of white, black, or some other color. Pea green is white lead tinted with medium chrome green (1 part to 100). Apple green is pea green tinted with a little chrome yellow. Bronze green is obtained by adding lampblack to a dark chrome green. A richer effect may be obtained by using a medium chrome green as a base and adding ivory black and a small amount of raw umber. "Quaker Green", a dull green, is produced by darkening white lead and yellow ocher with lampblack and burnt sienna.

Matching Colors: With practice a very good match of a given paint can be made, although exact matching requires much skill. Therefore, sufficient paint to cover all surfaces for final coat painting should be made up at one time.