

WHAT IS PAINT?

Since the basic premise of this book is on how to choose and use paints, we thought we would write a section on just "what is paint?" We realize that everyone knows what paint is, but we thought we would get to the meat and potatoes (so to speak) of paint, the "Technical Perspective." For this we went to our Technical Director and resident paint expert, Dave Licht. Dave has been with Testor for more than 25 years, and was more than happy to share with us the following *technical perspective for the nontechnical*. We have broken down the information into two main categories, both solvent-based (alkyd) enamel and water-based (acrylic) enamels.

I. Basic Composition (what is it?)

In general, all paint products (whether water-based or solvent-based) are made up of four essential components (raw materials).

1.) Binder (vehicle or resin)

2.) Solvents

3.) Pigments

4.) Additives

1. The principal *binder* in most Testor/Model Master enamels is a specially modified alkyd. The binder is a polymer which forms the final dry film and "binds" the paint to the substrate and the other paint components.
2. *Solvents* in the enamels are a blend of various organic solvents. The blend chosen (different for gloss and flat colors) is one that maximizes desired evaporation rate, dry time, proper flow, level and anti-sag properties and also promotes excellent adhesion to polystyrene and other materials used in model construction.

3. Pigments include organic and inorganic.

Organic pigments are primarily the bright and clean yellows, oranges, reds, blues and greens. Inorganic pigments are represented by white (Titanium Dioxide), black, yellow and red iron oxides, umbers, siennas and similar "dirty-shade" pigments. Although not exclusively true, the cleaner organic pigments are used primarily for car model colors, while military paints use mostly inorganic pigments.

4. *Additives* include many key components of paint such as driers, anti-skinning agents, plasticizers, viscosity modifiers, wetting agents, defoamers, anti-settle agents, and more. While, even when taken collectively, these additives comprise a small percentage of the final paint formulas by weight, they are critical components that will "make or break" the final performance and appearance of the paint when put into the hands of the end user.

II. How paint is produced

The raw materials briefly identified above and used in Testor paints are acquired in quantities ranging from 5-gallon pails and small packets to 6,000-gal. tank wagons and truckloads of palletized stock.

The raw materials come in many forms including dry powder, flakes, beads, granules, as well as liquid forms such as solvents, resin solutions, plasticizers and many other additives.

The process of producing paint from raw materials varies widely depending on the desired physical and performance properties of the finished product.

1. The first and most critical step in the entire process is the dispersion of the dry color (pigments) into a proper liquid vehicle. Sometimes this vehicle is the same resin that is the primary binder for the paint. It may also be other resins, plasticizers, or solvent /additive combinations

This important step (referred to commonly as "the grind") is done by one of the three methods for MM enamels:

a. Steel Ball Mills

b. 3-Roll Roller Mills

c. High-Speed Dispersion

Regardless of the method used, the goal is to produce a superfine dispersion of the pigment in the liquid vehicle. This fine grind optimizes gloss, color strength, coverage (hiding power), and the general smoothness and uniformity of the final paint film.

In general, darker pigments are dispersed in steel ball mills, and lighter pigments on roller mills or high-speed dispersers. Very tight controls are held on pigment grinds, because as any paint formulator will tell you, "You can't make good paint from bad grind."

The fineness of dispersion is measured with a Hegman gauge having a 0-8 scale. Testor dispersions are typically and consistently 7-7 1/2, which is a very fine grind.

2. Once all the pigment grinds have been made and approved, they are then "let down" while mixing into finished paint by a predetermined order of addition of the remaining components. These components include all remaining vehicle (binder), appropriate solvents, and necessary additives as mentioned above. Final batch sizes range from 5 to 50 gallons.

III. Quality Controls

The process of producing paint from original raw materials to finished product obviously involves many quality assurance tests and controls at all key stages of the process. A detailed description of all these tests and parameters is not possible within the space limitations of this book. However, regardless of the paint batch size, and without exception, Q.C. lab technicians carry out a minimum of the following quality control tests:

1. Fineness of grind (dispersion of pigment)

2. Color match

3. Gloss (at 60° incident light angle)

4. Viscosity

5. Density

6. Coverage (hiding power)

7. Visual appearance of final dry film

All of these tests are conducted to ensure a final product that is consistent from batch to batch in all respects and to provide the consumer with the finest quality hobby paint available anywhere.

IV. Stability and Packaging

Anytime new paint product lines or colors are developed, lengthy compatibility and stability tests are conducted on the product in its final formula and package configuration. The tests are done at ambient (normal) conditions, low temperature (-50°F) and elevated temperatures (120°F and/or 140°F) for predetermined time periods. New formulas must pass all tests conducted. This assures that the product arrives in the hands of the consumers as quality material regardless of prior shipping and storage conditions.

V. *Compatibility Considerations*

1. Most solvent-based hobby coatings are classified as either enamels or lacquers.
2. Enamels and lacquers should never be wet-mixed at any time.
3. All Model Master enamels (both pigmented and clear products) are wet-mix compatible. They can be combined in any ratio in order to produce a finish which produces the final color and gloss desired by the modeler.
4. When thinning solvent-based hobby finishing materials (for brushing or air-brushing application), it is essential to select and use correct thinners. In general, the best thinners for enamels are those which contain petroleum distillates. These thinners are primarily blends of aliphatic hydrocarbon solvents such as mineral spirits, naphtha, or stoddard solvents. Occasionally these thinners also may contain small amounts of aromatic hydrocarbons (such as toluol or xylol) to enhance certain application and performance properties of the paint. Lacquers, on the other hand, usually contain little, if any, hydrocarbon solvents. Instead, they usually contain what is often referred to as "active" or oxygenated solvents. These include ketones (such as acetone, MEK, and MIBK), esters (isopropyl acetate, butyl acetate) and sometimes alcohols (isopropyl alcohol, butyl alcohol), and occasionally small amounts of aromatic hydrocarbons.
5. Most modelers are familiar with the general rule, "Never apply lacquer over enamel." This is generally a good rule of thumb. However, Testor has developed a line of custom-formulated clear lacquers (available in gloss, satin semigloss and flat) which are specifically designed to do just that. They may be brushed or

airbrushed over our dry enamels or unpainted polystyrene surfaces to produce smooth, transparent overcoats. They will not lift or wrinkle previously enamel-painted surfaces or decals, nor will they craze clear polystyrene parts such as windshields or canopies.

6. When in doubt, always follow manufacturer's directions when mixing or thinning any hobby finishing enamel or lacquer.

WATER BASED (ACRYLICS)

In coating technology circles, acrylic coating is used in both water- and solvent-based paints. However, in the craft and hobby industries, the term "acrylic paint" has become known as or referred to as any water-based paint. As with solvent-based paints, the ingredients of acrylic paint are divided into four categories:

1. *Vehicle or Binder*
2. *Solvents*
3. *Pigments*
4. *Additives*

I. *Vehicle or Binder*

Vehicles used in water-based paints can be divided into two separate classes:

a. *Latex or Polymer Emulsions*

Latex is a stable dispersion of a polymeric substance in water. Strictly speaking, an emulsion is a two-phase liquid system in which very fine droplets of one liquid are suspended or dispersed in a second liquid. Conversely a latex is a solid dispersed in water and therefore is not a true emulsion. In the paint industry, the terms latex and emulsion are often used synonymously.

b. Water-Soluble Resins

These are resins which can be diluted (or reduced) with water, water cosolvent mixtures and sometimes with alkali. This type of resin is produced in water-soluble form by incorporating acidic groups, e.g., carboxyl, in the molecular structure. These groups are then neutralized by bases such as ammonia or amines to form products soluble in water.

II. Solvents

a. Water

Water is the carrier phase of latex coating. It normally constitutes about half of the content of a latex paint on a per-weight basis.

b. Coalescing Agents

Next to the polymer vehicle and water, coalescing solvents are the most important components in the water-based coating. In latex paint, the film is formed when the polymer particles coalesce. To coalesce properly, the polymer particles must be sufficiently fluid in order to coalesce to a continuous film. To reach this condition the temperature of the film must be at or above the "minimum film-forming temperature" of the polymer. This is generally the "Glass Transition Temperature" (T_g) which is the temperature at which polymer or resin changes from a brittle solid to a viscous fluid condition, or vice versa. Addition of small quantities of certain slow-evaporating solvents can assist in film formation at lower temperatures. These solvents, which are called coalescing agents, temporarily soften the resin and then slowly evaporate after the film has formed.

III. Pigments

In general, the term embraces not only the primary hiding and coloring pigments but also the extenders used as low-cost inorganic fillers to supplement expensive pigments.

a. Prime and Coloring Pigments

The most commonly used pigment for hiding in latex coatings is Titanium Dioxide. The coloring pigments used in latex paints consist of organic and inorganic pigments usually supplied as aqueous dispersion by most suppliers.

b. Extenders

The most commonly used extenders in latex paints are Calcium Carbonate, Calcium Silicate, Silica, Mica and Talc.

IV. Additives

Most latex pigments contain the following additives:

a. Dispersants

A surface active agent that aids in breaking down pigment agglomerates when the paint is mixed. It also prevents re-agglomeration in storage.

b. Wetting Agents

An addition that helps a paint to wet the substrate. It also aids in color development and mechanical stability.

c. Defoamers

An agent to minimize foaming during mixing and application.

d. Plasticizers

Plasticizers are required with hard resins to produce durable films with necessary flexibility.

e. Glycols

Glycols are used to improve freeze/thaw stability and to modify the rate of drying, which is important in wet-edge retention.

f. *Thickeners*

A material added primarily to control viscosity. Usually one material serves as both protective colloid and thickener.

g. *Preservatives*

A chemical added to protect the paint against microbiological attack during storage. Usually, the same additive functions as a mildewcide to prevent mildew formation on the applied film.

h. *Amines*

Amines are responsible for activating the vehicle's thickening mechanism. In water-soluble resins, amines are used to neutralize the carboxyl group present in the resin in order to make the resin soluble in water.

Water-based paints have many similarities to the solvent-based paints in the production procedures. Both require:

1. *Grind Phase*

Dry pigments are dispersed into a carefully selected vehicle with some additives until the desired fineness is obtained. The quality of dispersion is checked by using a Hegman gauge.

2. *Let down Phase*

Once the pigment grind is obtained, the grind is then let down by adding the remaining ingredients with good mixing. In water-based paints, the letdown phase is more sensitive than with solvent-based paints. The addition of ingredients should strictly follow the recommended sequence. Any deviation from the recommended sequence can sometimes "shock" the formulation, i.e., causing the mix to gel or resulting in grit in the mix.

Water-based paints and solvent-based paints have similar quality assurance tests and controls. Since latex emulsions are more sensitive to low temperature (below freezing) and elevated temperature (120° F), thorough stability tests are conducted at these two temperatures for our water-based products. These assure that the product arrives in the hands of the consumer in top quality, regardless of what time of the year the paints have been shipped. As with any paint product, whether solvent or water based, the best storage condition for paint is a cool to ambient (room temperature) environment. This will help enhance shelf life and promote long-term stability.

We hope this brief overview has given you, the consumer, better insight and knowledge of our product. The following glossary will help you with those "big" words in the previous perspective, and as general information, if you ever get into a conversation about paint formulations or chemistry.

GLOSSARY OF PAINT FORMULATION TERMS

Additives – Any one of a number of special chemicals added to paint to bring about special effects. Examples are plasticizers, driers, fungicides, anti-setting and anti-skinning agents.

Agglomeration – Merging of dispersed particles into aggregates that adversely affect smoothness, hiding, color and gloss.

Anti-Skinning Agents – Chemicals added to paint to help prevent the formation of a surface film.

Base Coat – A highly pigmented color coat applied prior to a clear coating that gives the system the desired color.

Binder – The paint material which forms the film. So called because it binds the pigment and any additive present into a solid durable film.

Bleeding – A defect in which pigment from a lower coat of paint diffuses into an upper coat and discolors the latter.

Blistering – Formation of dome-shaped projections in paints or varnish films resulting from local loss of adhesion and lifting of the film from the underlying surface.

Blocking – The undesirable sticking together of two painted surfaces when pressed together under normal conditions.

Blushing – Usually caused by condensation of moisture during the drying period. The film becomes cloudy or translucent.

Chalking – Formation of a pigment layer on the surface of weathered paint. Promotes self-cleaning of white paint but causes fading in colored paints.

Coalescence – Merging of latex particles to form the coating film as the latex or latex paint dries.

Colloid, Protective – A water-soluble gum, protein or cellulose derivative used to obtain mechanical stability and improve brushing, leveling and package stability.

Crazing – The formation of a surface crack, often as a fine network, which does not penetrate to the underlying surface. Crazing is sometimes caused by the softening effect of solvents from successive paint coats as in lacquer operations.

Critical Pigment Volume Concentration – The volume percent of pigment in a paint film at which the particles pack together and contact each other.

Deflocculation – Dispersion of pigment or extender in water. Chemical and mechanical aids are used.

Degreaser – Combination of solvents for the purpose of removing grease and oil from the surface in preparation for painting.

Diluent – (1) A volatile liquid which, while not a solvent for the nonvolatile constituents of a coating or printing ink, may yet be used in conjunction with the true solvent, without causing precipitation. (2) An inert solid or liquid used to increase the bulk of another substance.

Dispersing Agent – Additive that increases the stability of a suspension of pigments in a liquid medium.

Drier – A catalyst added to speed the cure of oil base paints. Driers are often metal salts of naphthenic acids obtained from petroleum.

Drying Time – The expected time for a paint film to harden. Varying by product, temperature or atmospheric conditions, drying time is usually expressed as dry-hard, dust-free, set-to-touch time, tack-free, or dry-to-recoat time.

Dry Spray – Sprayed paint which loses so much solvent in the air that it becomes too dry to flow over the surface. Dry spray has a lower gloss than the normally sprayed surface.

Durability – The lasting of a paint film. The wearability of paint under conditions for which it was designed.

Enamel – A very confusing term as it has several meanings: (1) Topcoat which is characterized by its ability to form a smooth surface; originally associated with a high gloss, but may also include lower degree of gloss, i.e., flat enamels. (2) In shop terminology, any paint which is not a lacquer.

Extender – White or light-colored inorganic filler. Supplements expensive prime pigments in building up the pigment volume concentration.

Filler – A paint or paste applied to fill holes or other irregularities in a surface prior to painting.

Fish Eyes – Paint defect which manifests itself by the crawling of wet paint into a recognized pattern resembling small “dimples” or “fish eyes.”

Flaking – The paint film separates from the substrate and flakes off. A paint failure.

Flash Point – The temperature at which the vapor of a thinner or solvent will ignite in the presence of sparks or open flame.

Flattening Agent – The ingredient used in lacquers and varnishes to give a flat or hand-rubbed effect. Calcium, aluminum or zinc stearate are used. Silicate flattening pigments give better product than those metallic soaps.

Floating – The tendency of some pigments to separate and float to the surface. Also called flooding and results in a streaked or spotty application.

Flocculation – To form masses of particles either by settling out or forming a gel.

Gloss – The degree to which a surface reflects light. Glossy surfaces are generally very smooth.

Gloss Meter – An instrument that measures the degree of gloss of film by its reflectance. Most commonly used in a 60-degree meter, which measures gloss at an angle of 60 degrees.

Hiding Power – The ability of a paint to mask the color or pattern of a surface. Usually expressed as square feet per gallon or square meters per liter.

Hue – The name of a color. The property of a color by which it can be distinguished. Red, Blue, Yellow, etc.

Kick-Out – The precipitation of dissolved binder from solution as a result of solvent incompatibility.

Lacquer – A finish or protective coating consisting of a resin and/or a cellulose ester dissolved in a volatile solvent. Sometimes pigment is added. Dries when solvents evaporate.

Latex Paint – A paint containing colloidal binder particles formed by emulsion polymerization. Generally applied as a water-base coating which dries by evaporation and coalescence.

Matte – A surface with minimal reflectance. The opposite of gloss.

Mil – Unit of measuring film thickness. One mil is one thousandth of an inch (0.001 inch).

Mildewcide – Paint additive used to prevent growth of mildew in painted surfaces.

Nonvolatile – (Solids) Does not evaporate.

Orange Peel – An irregularity in the surface of a paint film resulting from the inability of the wet film to “level out” after being applied.

Paint – A material which, when applied as a liquid to a surface, forms a solid film for the purpose of decoration and/or protection. Generally, a paint contains binder, one or more solvents, and pigments. Often other materials are present to give special properties to the paint film. Examples of such additives are wetting and dispersing agents, corrosion inhibitors, thickeners, plasticizers, anti-skinning and anti-setting agents.

Peeling – The failure of a paint film to adhere to its substrate. Peeling results when contaminated surfaces are painted or when there is an excessive difference between paint and surface polarity or thermal expansion characteristics.

Percent Solids – The present mass of a paint due to its non-liquid components.

pH Value – The chemical symbol that together with a number describes the alkalinity or acidity of a solution. Seven is neutral. Below 7 indicates acidity. Above 7 indicates alkalinity.

Pigment – Finely ground, natural or synthetic, inorganic or organic insoluble dispersed particles which, when dispersed in a liquid vehicle to make paint, may provide, in addition to color, many of the essential properties of a paint: opacity, hardness, durability, and corrosion resistance.

Pin-Holing – Tiny round breaks in a paint film giving the appearance of a pinhole. Caused by rapid solvent loss. They may or may not have raised edges.

Plasticizer – A low molecular weight substance added to polymeric materials such as paints, plastics, or adhesives to improve their flexibility.

Preservative – Paint additive used to prevent microbiological attack with resulting loss of viscosity and/or putrefaction during storage.

Primers – Undercoats which bind topcoat to substrate.

Retarders – A solvent added to a paint to slow down its evaporation rate.

Sealer – A primer which does not allow succeeding coats to penetrate. Also seals in material that might otherwise bleed through the surface.

Shelf Life – The length of time a paint product may remain on the shelf or be stored and still be usable.

Skinning – The formation of a thin tough film on the surface of a liquid paint film. Usually due to reaction with the air or to rapid solvent evaporation.

Solids – The pigment and nonvolatile vehicle components of paint. Material which remains on surface. Can be measured by weight or volume.

Solvent -The liquid or blend of liquids used to dissolve or disperse a paint.

Surfactant -Contracted from surface-active agents, these are additives which reduce surface tension and may form micelles and thereby improve wetting (wetting agents); help disperse pigments (dispersants); inhibit foam (defoamers); or emulsify (emulsifiers). Conventionally, they are classified as to their charge: anionic (negative); cationic (positive); nonionic (no charge) to amphoteric (both positive or negative).

Thermoset -Materials in which catalysts are used to cross-link and polymerize the final product. Includes phenolics, polyesters, alkyds, and *some* acrylics. Cannot be reformed simply by heating and melting.

Thermoplastic -Materials which are polymerized and formed by a heating and cooling process. Includes polystyrene, PE, PP, nylon, PVC polycarbonate (Lexon), and *some* acrylics. Generally, thermoplastics can be reheated, melted, and recooled without significant chemical or physical changes. The material simply recrystallizes again when it cools.

Thinner - (1)The portion of a paint, varnish, lacquer or related product that volatilizes during the drying process. (2)Any volatile liquid used for reducing the viscosity of a paint mixture; may consist of a simple solvent or diluent, or a mixture of solvents and diluents.

Thixotropy -The tendency for the viscosity of a liquid to be shear rate dependent. When the liquid is rapidly shaken, brushed or otherwise mechanically disturbed, the viscosity decreases rapidly.

Tint -The color produced by the mixture of white pigment with absorbing colorants.

Tinting Strength -The relative ability of a unit quantity of colorant to alter the color of another colorant to which it is added. In popular usage, tinting strength is an index of the effectiveness with which a chromatic colorant imparts color to a standard white pigment.

Topcoat -Usually the final paint film applied to a surface.

Varnish -An unpigmented binder-solvent solution applied to protect or decorate a surface.

Vehicle -The liquid portion of paint, in which the pigment is dispersed; it is composed of binder and solvents.

Viscosity -The property of liquid which enables it to resist flow. Often measured by the time required for a given volume of liquid to flow through a small hole in the bottom of a cup with controlled conditions.

VOC -Volatile Organic Compound.

Wet-Edge Retention -Time after application during which fresh paint has sufficient flow and rewettability to permit lapping.