M.I.C.I.
Midwest Industrial Coatings, Inc.

Powder Specifications

For More Information Call
1-952-252-2000

Powder Coatings

Powder coatings are unique among all present-day compliance coatings in that they are dry, solid coating materials in contrast to the liquid materials of other coating technologies. Prior to baking, powder coatings are finely pulverized, plastic compositions; consequently, the resins used in powder coatings are different from those in liquid paints. Liquid paints require resins that are soluble or miscible with solvents and/or water, whereas powder coatings require resins that are solid materials. These solid materials must be solid at ambient and elevated storage temperatures, but must be capable of melting sharply to low viscosities when heated. Powder coatings are available as thermoplastic and thermosetting resins.

In the early 1970s, the number of solid resin systems available to the powder coatings manufacturer was somewhat restricted, as a result, powder coatings were limited in their ability to meet the diverse needs of the finishing industry. However, with the growth of powder coatings, the technology has rapidly expanded, resulting in many new resin systems and other compositional components. There are now available a wide range of powder coatings that will meet and often exceed the properties of most present-day solvent-borne and water-borne baking enamels.

Like all other industrial surface coatings, powder coatings are individually formulated to meet the industrial user's specific finishing needs. Individual formulation means matching color and film performance requirements, all within the particular restrictions of the finisher's operation. As with the selection of any industrial finish, a close relationship must be developed between the user of the coating and the coatings supplier so that exacting requirements are thoroughly understood and the correct type of finishing material is supplied.

Thermoplastic Powders

A thermoplastic powder coating is one that melts and flows with the application of heat, but maintains the same chemical composition when it solidifies on cooling. Thermoplastic powder coatings are based on thermoplastic resins of high molecular weight. These tough and resistant resins tend to be difficult and also expensive to grind into the very fine particles necessary for the fusion of thin paint-like film thicknesses.

Consequently, thermoplastic resin systems are used more as thick-film functional coatings and are applied mainly by the fluidized-bed application technique. Typical film thicknesses are 5-12 mils (0.13-0.30 mm) when applied by the fluidized-bed technique and 3-5 mils (0.08-0.13 mm) when applied using electrostatic spraying techniques.

The most commonly used thermoplastic powders are polyvinyl chloride (PVC), nylon, polyester, polyethylene, and polypropylene. Some of these powders require a primer to be applied to the substrate surface prior to coating. Table 1 summarizes the physical and coating properties of the common thermoplastic powders.

Thermosetting Powders

Thermosetting powder coatings are quite different from thermoplastic powder coatings in that they are based on lower molecular-weight solid resins, which on melting and flowing, chemically crosslink within themselves or with other reactive components to form a higher molecular-weight reaction product. The coating film formed by this reaction is heat stable and will not soften back to a liquid on further exposure to heat. Powders based on these thermosetting resins can be ground into fine particle sizes, in the range of 0.001 to 0.0015" (0.03 to 0.038 mm) diameter. Due to the rheological characteristics of thermosetting resins, thin paint-like surface coatings 1 to 2 mils thick (0.03 to 0.05 mm) can be produced, and their properties are usually better than the properties of liquid coatings. The main types of resins used in thermosetting powder coatings are epoxy, polyester, and acrylic. Table 2 summarizes typical physical and coating properties of these powders.

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Table 1
Physical & Coating Properties of Thermoplastic Powders

Property	PVC	Nylon-11	Polyester	Polyethylene	Polypropylene
Primer Required	Yes	Yes	No	Yes	Yes
Melting point	266-300ºF	367ºF	320-338ºF	248-300ºF	329-338ºF
Typical Preheat/ Post Heat	446-544ºF	482-590ºF	482-572ºF	392-446ºF	428-482ºF
Specific Gravity	1.20-1.35	1.01-1.15	1.30-1.40	0.91-1.00	0.90-1.02
Adhesion (1,2)	G-E	E	E	G	G-E
Gloss (60º meter)	40-90	20-95	60-95	60-80	60-80
Hardness-Shore D	30-55	70-80	75-85	30-50	40-60
Flexibility (3)	Pass	Pass	Pass	Pass	Pass
Resistance (1)					
Impact	E	E	G-E	G-E	G
Salt Spray	G	E	G	F-G	G
Weathering	G	G	E	P	P
Humidity	E	E	G	G	E
Acid (4)	E	F	G	E	E
Alkali (4)	E	E	G	E	E
Solvent (4)	F	E	F	G	E

(1) E = excellent; G = good; F = fair; P = poor
(2) With primer where indicated.
(3) No cracking, 1/8" diameter mandrel bend.
(4) Inorganic, dilute.

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Table 2
Physical & Coating Properties of Thermosetting Powders

Property	Epoxy	Polyurethane[a]	Polyester[b]	Hybrid	Acrylic[a]
Film Thickness	1-4 mils	1-3.5 mils	1-10 mils	1-10 mils	1-2.5 mils
Cure Type [c]	L,N,Q	N,Q	L,N	N	N
Adhesion [d]	E	G-E	G-E	G-E	G
Gloss (60° meter)	5-95	10-95	40-95	30-95	80-95
Pencil Hardness	H-4H	H-4H	H-2H	H-2H	H-5H
Flexibility [d]	E	E	E	E	F
Resistance [d]					
Impact	E	G-E	G-E	G-E	F
Salt Spray	F-G	G-E	E	E	G
Weathering	P	G-E	E	P-F	G-E
Humidity	E	G	G	G	F
Acid [e]	G	F	F	G	G
Alkali [e]	E	G	F-G	F	F
Solvent	E	E	E	E	E

(a) Hydroxy functional - blocked isocyanate cure.
(b) TGIC (triglycidyl isocyanurate) cure.
(c) L = Low; N = normal; Q = quick.
(d) E = excellent; G = good; F = fair; P = poor
(e) Inorganic, dilute.

GLOSSARY OF TERMS

The following painting terms are abstracted from the glossary of Understanding Paint and Painting Processes

acetone A powerful ketone-type lacquer solvent.

acrylic A coating based on a polymer containing short-chain esters of acrylic and methacrylic acid. Acrylics are widely used as automotive topcoats. Their physical properties can be con-trolled in part by the choice of the alcohol used to make the ester.

active solvent A liquid that can dissolve a paint binder when used alone.

additive Any one of a number of special chemicals added to a paint to bring about special effects. Examples are plasticizers, light stabilizers, and fungicides.

adhesion The phenomenon by which one material is attached to another by means of surface attraction.

agglomerate Clumps of pigment crystals that have formed loose clusters containing entrapped air. Usually undesirable in paint, as they tend to settle out and have poor optical properties.

aliphatic solvent A type of solvent comprised mainly of straight-chain hydrocarbons Examples are gasoline, kerosene, hexane, and naphtha.

alkyd A coating based on a polyester binder. The polyester binders are chemical combinations of molecules that contain more than one acid or alcohol group. Alkyds are widely used in water-based house paints and automotive primers.

anhydride A reactive form of dicarboxylic acid containing a monomer that has one mole of water removed. The major anhydride used in the synthesis of alkyds is phthalic anhydride.

anti-skinning agents Chemicals added to a paint to help prevent the formation of a surface film on the paint.

aromatic A type of solvent based on benzene ring molecules. Aromatics are often used as diluents in acrylic lacquers Typical examples are ben-zene. xylol. and toluol.

benzoic acid An aromatic monocarboxylic acid used in terminating chain growth in polyester or alkyd polymers. Also used in the manufacture of plasticizers.

beta rays Beams of electrons that can be used to cure certain kinds of paint.

binder The paint material that forms the film, so called because it binds the pigment and any additives present into a solid durable film. Also referred to as the resin.

branched polymer A polymer that has some branching along its backbone chain. An example is low-density polyethylene.

catalyst A chemical used to change the rate of a chemical reaction. Differs from a curing agent in that the catalyst is not itself chemically consumed in the reaction, while a curing agent is. Technically, catalysts that increase reaction rates are called accelerators; those that decrease reaction rates are called inhibitors or retarders.

cathodic protection The prevention of corrosion of a metal by electrically connecting it to a sacrificial anode. The anode is itself decomposed, and the object of interest is protected. The sacrificial anode must be replaced periodically.

coalescence The fusing or flowing together of liquid or solvent particles.

colloids Aggregates of molecules in solution (dispersion) resulting in particles having dimensions in the 0.001 milli micron to 1000 micron range.

condensation cure Any crosslinking process that liberates water and other simple molecules during the reaction.

conjugated double bond Two double bonds in alternate posi-tions as indicated by the formula -CH-CH-CH-CH-.

copolymer A polymer comprised of two or more different monomer units.

critical pigment volume concentration (CPVC) The volume percent pigment in a coating in which the pigment parti-cles are surrounded by resin so that no free surface pigment exists cure. The process by which paint is converted from the liquid to the solid state.

Desmodur N® An aliphatic-type polyisocyanate commercially available from Mobay Chemicals.

diluent A liquid that extends a solution but definitely acts to weaken the solvent power of the active solvent.

double bond An unsaturated hydrocarbon of the type CnHn with the formula -C=C-, indicated by the suffix -ene.

drier A catalyst added to speed the cure of oil-based paints. Driers are often metal salts of carboxylic acids.

drying oil A water-insoluble liquid, usually obtained from a plant source, that reacts with oxygen (from the air) to form a crosslinked polymeric film.

electrocoating (E-coat) See ìelectrodeposition.î

electrodeposition The process by which electrically charged paint is plated on conductive surfaces of the opposite charge.

electrolyte A substance that dissociates to some extent into two or more ions in water and other polar solvents. Solutions of electrolyte conduct electrical current and can be decomposed by it (electrolysis).

electron beam curing A system for curing paint films using the energy of an electron beam. The process lends itself to high-speed curing of paint on flat surfaces. Special paints must be used and personal shielding is required.

electron beam radiation Radiation generated from high-energy electrons that is used in crosslinking coating systems.

electrostatic spray The process by which paint particles are electrically charged and attracted to a substrate bearing an opposite charge.

emulsion polymerization The formation of a polymer in which the growing polymer molecules form droplets in the reaction medium This situation arises when the solvent can dissolve the monomer, but not the polymer.

emulsion A class of colloidal dispersions containing two or more immiscible liquids such as oil in water. Emulsions are usually unstable and will separate into their components unless a stabilizing agent is present.

enamel A broad classification of free-flowing clear or pig-mented varnishes, treated oils, or other forms of organic coat-ings that usually dry to a hard, glossy or semi glossy finish.

epoxy Synthetic resins formed by the condensation of epi- chiorohydrin and bisphenol-A.

exempt solvents Solvents that are not subject to air pollution legislation. Many alcohols, esters, some ketones, and mineral spirits are exempt. Aromatic and some ethylenic compounds are not exempt, and their use as solvents is there-fore subject to regulation.

flash time The time between paint application and baking. Usually a considerable quantity of solvent is lost during this interval, and this solvent loss prevents popping problems in the oven.

functionality Ability of a compound to form covalent bonds.

gamma radiation High-energy radiation, similar to X-ray radiation, that is emitted by radioactive substances.

glass transition temperature The temperature at which polymer molecules are able to move fairly freely in the solid state.

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.

high-solids paint Paint containing 35-80% solids. These pro-ducts have become popular because of the reduction in solvent emissions associated with their use.

homopolymer A polymer containing only one kind of monomer.

inhibitor A chemical added to retard some particular reaction. Examples are antioxidants and anti-skinning agents.

interfacial free energy The minimum amount of work required to create an interface between two immiscible materials.

latent solvent A liquid that cannot itself dissolve a binder but increases the tolerance of the paint for a diluent.

linear polymer A polymer containing little or no branching Examples are high-density polyethylene and nitrocellulose or acrylic lacquers.

molecular weight The relative mass of a molecule in relation to that of a hydrogen atom, It is obtained by adding together the atomic weights indicated in the formula of the substance.

monomers Low-molecular-weight reactive materials that are used in the synthesis of polymers.

nonconjugated double bond Double bonds that are not in the relationship outlined under conjugated double bonds. They are indicated by the formula -C-C=C-C-C=C-C.

oil-based paints Paints with films that form solids by the air-induced crosslinking of certain unsaturated plant oils known as drying oils. Oxygen is consumed in the process.

paint A material that when applied as a liquid to a surface forms a solid film for the purpose of decoration and/or protection. Generally, a paint contains a binder(s), solvent(s), and a pigment(s). Often other materials are present to give special properties to the paint film. Examples of such additives are rust inhibitors, light stabilizers, and softening agents (plasticizers).

percent solids The percent mass of a paint due to its nonliquid components.

pigment Small particles added to the paint to influence properties such as color, corrosion resistance, and mechani-cal strength.

pigment volume concentration (PVC) The percent volume of a paint film occupied by the pigment.

plasticizer A low-molecular-weight material added to polymeric materials such as paints, plastics, or adhesives to improve their flexibility.

polyamides Polymeric compounds synthesized by the reaction of amine and carboxylic-containing compounds. They are sometimes amine terminated and used in the crosslinking of epoxide polymers.

polymers Large molecules built up by the combination of many small molecules.

primer A type of paint applied to a surface to increase its compatibility with the topcoat or to improve the corrosion resistance of the substrate.

refractive index The ratio of the velocities of light in a medium and in air under the same conditions. The result is that light passing from one medium to another is bent to some degree.

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 loss.

styrene An unsaturated reactive monomer used extensively in the synthesis of polymers. It can also be used to thin out reactive polyesters with subsequent crosslinking in the ethylenic groups.

thermoplastic A type of polymer that softens and melts when heated and then resolidifies upon cooling. Thermoplastics generally have linear or branched structures.

thermosetting A type of polymer that does not soften appreci-ably when heated. Thermosets may char when heated in air. They are generally crosslinked polymers.

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. Thixotropic behavior is the result of molecules or particles in the liquid forming weakly associated structures that break apart when agitated.

throwing power The ability of an electrodeposition resin to coat recessed areas, usually measured by noting the coating distance up a cylindrical tube that is coated in an electro-deposition bath.

topcoat Usually the final paint film applied to a surface.

ultraviolet radiation High-energy short-wavelength radiation used in coatings to crosslink primarily acrylic and methacrylic systems by means of free-radical reactions.

UV stabilizers Chemicals added to paint to absorb the ultra-violet radiation present in sunlight. Ultraviolet radiation decomposes the polymer molecules in a paint film, and thus UV stabilizers are used to prolong paint life.

vehicle The combination of binder and solvents or diluents, which are used to put the binder in a liquid, usable form.

vinyl cure A curing process involving the crosslinking of vinyl groups.

vinyl toluene An unsaturated, aromatic monomeric compound reacted into oil-modified alkyds to modify its drying properties.

viscosity The property of liquid that 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 under controlled conditions. A thick liquid-like molasses has a high viscosity.

volatile organic compounds (VOC) Volatile organic materials, such as solvents, that are present in many coating products.