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ADDITIVES THAT INFLUENCE FLOW

The rheological properties of coatings (that is, their ability to flow) are critical for their preparation, storage, and application, and the primary factor affecting rheology in fluids such as coatings is the fluid's viscosity.

In some cases, the viscosity of the polymer, pigments, and solvent combination is sufficient to achieve the desired coating viscosity. However, in some instances, specialty additives are required to achieve precise viscosity control. These materials are frequently referred to as thickeners, and when added in small amounts, they increase the viscosity or thickness of a coating. In nonaqueous coatings, treated attapulgite clays, fine-particle silica aerogel-type pigments, and ultrahigh-molecular-weight polymers are used as thickeners, whereas in aqueous systems, modified cellulosic polymers, carrageenan (a natural polymer derived from seaweed), high-molecular-weight water-soluble polymers (e.g., polyacrylic acid), and so-called associative thick Thickeners are polymers that dissolve in and increase the viscosity of the coating's solvent or carrier liquid.

Pigmentary materials used to increase viscosity do so by interacting with the solvent or carrier fluid and forming connected networks or chains of particles. Another type of thickener, associative thickeners, are low-molecular-weight polymers that, due to their surfactant-like properties, form networks in primarily aqueous systems.

These materials have enabled latex coatings for the retail market to provide flow and leveling characteristics previously reserved for solvent-based coatings.

Activators and driers

Catalysts and driers are another critical component of low-concentration coatings because they aid in the acceleration of the film-formation reaction. Catalysts for curing were discovered by chance when it was discovered that the presence of lead oxide pigments such as red lead caused oil-based coatings to cure more rapidly and thoroughly than when they were not present. This reaction is initiated by the Pb2+ ion, which reacts with the fatty acid components of the drying oil to form organic salts. The lead–fatty acid salt catalyzes the decomposition of organic hydroperoxides formed when oxygen from the air reacts with unsaturated fatty acids found in drying oils. As a result of the hydroperoxides' free radical decomposition products, chain reactions known as oil drying occur. While lead-based pigments and driers are no longer available due to their toxicity, alternative organometallic driers such as cobalt and zirconium naphthenate are frequently used in alkyd and oil-based coatings.

Catalyzed reactions are also used to catalyze the majority of cross-linking reactions, such as the polyol-polyisocyanate reactions that occur during the formation of polyurethane coatings. Dibutyltin dilaurate (DBTDL) is frequently used as a catalyst to accelerate the urethane reaction in this reaction class. Other cross-linking reactions utilize specific catalysts that accelerate the reaction sufficiently to result in the formation of a film within a reasonable amount of time after application.

Wetting of solid surfaces by the fluid phase is required for both the production and application of coatings. Wetting agents are chemicals that alter the surface properties and surface tension of the coating fluid. (In fact, these ingredients are very similar to those found in dishwashing liquids, hand soaps, and shampoos and are classified as surfactants.) Wetting agents assist the fluid phase in wetting pigment particles during the pigment dispersion process (see below), and they also assist the coating in reducing its surface tension, allowing it to properly wet the substrate upon application.

Agents diffusion

To perform optimally, pigment particles must act independently of one another in the coating film and must therefore remain well dispersed throughout manufacturing, storage, application, and film formation. Unfortunately, colloidal dispersions, such as those used in liquid coatings, are inherently unstable and must be stabilized to avoid the flocculation that occurs in unstabilized systems. To accomplish this, dispersing and wetting agents are added to coating fluids during the pigment dispersion process used in the manufacture of coatings. Dispersing agents, alternatively referred to as dispersants, are typically relatively low-molecular-weight materials that strongly adsorb onto pigment particles and act as a repellent barrier to the positive forces of interaction that exist between all particulate materials. While a portion of the film-forming polymer may serve as a dispersant in many solvent-based coatings, separate dispersants are typically added in aqueous systems (particularly latex coatings).

Defoamers

A disadvantage of specialty additives is that they frequently contain surfactants, which stabilize foam in the liquid coating. Additionally, portions of the coating polymer are surfactant-based, contributing to the foam's stability. Foam frequently creates issues during the manufacturing and packaging processes, and it frequently results in film defects such as bubbles and subsequent thin spots during application. Defoamers—substances that destabilize or break foams—are frequently added to coatings to address this issue. Although the mechanism of defoamer action is not fully understood, the agents appear to act by destabilizing bubble surface films or by spontaneously spreading on the surface of these films as they form and breaking the bubbles. Defoamers are frequently composed of silicone oils with the addition of fine silica particles as a carrier for the silicone.

Antifungal, antibacterial, and other specialized additives

Antimicrobial agents are frequently added to aqueous latex coatings to stabilize them for long-term storage. Similarly, latex coatings for exterior architectural applications frequently contain fungicides that aid in the prevention of mildew growth on exterior surfaces. Additionally, the pH of the majority of water-based coatings must be controlled. When coatings are manufactured with hard water, sequestrants (additives that prevent precipitation reactions) such as tetrapotassium pyrophosphate are used to help stabilize the coating. Additives such as ethylene glycol and propylene glycol, the primary ingredients in automobile antifreeze, are used to provide freeze-thaw stability for latex coatings stored in garages in cold climates.

Organic coatings: properties

Properties of light

Optical properties are one of the primary characteristics of coatings. The major optical properties of coatings are opacity, or the ability to conceal a substrate; color, or the ability to reflect and absorb specific wavelengths of visible light; and gloss, or the ability to act like a mirror when light is reflected directly. These three optical properties are critical for topcoats, and coatings manufacturers closely control them due to the human eye's sensitivity to optical performance. Consumers' primary concerns with automobile paints are color and gloss, while their primary concerns with house paints are opacity and color.

Optical properties are one of the most well-defined and controllable characteristics of coatings. Almost every large retailer who sells paint directly to consumers has a computer-controlled color measurement or color matching system.

Adhesion properties and thermomechanical properties

The way a coating reacts to mechanical and thermal stress is critical to understanding the behavior of the coating film. Hardness, elastic modulus, glass transition temperature, toughness, and abrasion resistance are all properties that are frequently considered in this area. Adhesion to substrates is a characteristic of organic coatings that is frequently discussed in detail. Although there are numerous empirical tests for adhesion, such as peel and scribe tests, the mechanisms underlying adhesion remain poorly understood and characterized.

Resistant to chemicals and corrosion

Numerous substrates, such as metals and composites, have unique mechanical properties but lack inherent chemical or corrosion resistance, necessitating the use of protective coatings in environments containing chemicals or causing corrosion. Coatings provide protection against the environment for bridges, aircraft, pipelines, washing machines, and automobiles, among other things. For instance, coatings are expected to protect automobiles against corrosion and aggressive chemicals for a period of ten years; refrigerators and dishwashers are expected to last even longer. This safeguard is critical to the sales and performance of a large number of products.

Durability at the exterior

Exterior durability—that is, the ability of coatings to protect substrates from external exposure—is frequently regarded as a unique performance property. Durability encompasses many of the above-mentioned aspects of chemical and corrosion protection, but is frequently thought to be primarily concerned with resistance to and protection from solar radiation. Numerous natural polymeric substrates, such as wood, and numerous synthetic polymers are susceptible to damage and degradation when exposed to sunlight on a continuous basis. Degradation occurs as a result of radiation in the near-ultraviolet and blue regions of the visible spectrum containing enough energy to break chemical bonds within a variety of polymers. As a result of radiation-induced degradation, a coating's ability to provide chemical and corrosion protection deteriorates as well, resulting in chalking and delamination of the coating. Coatings used on the exterior surfaces of automobiles, road signs, houses, airplanes, and commercial buildings are particularly susceptible to degradation caused by ultraviolet radiation. In each of these instances, the coatings must incorporate an internal solar protection layer.