WAXES IN COATINGS

1 INTRODUCTION

Waxes are frequently used as additives in coating formulations. Trecoraõs range of Polyethylene waxes can be used in a number of coating types, particularly in:

- Powder coatings
- Can Coatings
- Coil Coatings
- Wood/furniture coatings

2 PROPERTIES OBTAINABLE FROM WAXES

2.1 Abrasion, rub and mar resistance

Waxes are used to protect a coating and/or its substrate from cosmetic and physical damage. The hardness of the wax will determine the effectiveness in improving abrasion resistance. The wax in an exterior topcoat for beverage cans must help protect the decorative aspect of the container, i.e. the ink. Additionally, the use of wax in the coating formulation prevents physical damage to the topcoat caused by contact with another can. Trecoraõs CWP400 or CWP400E can be used to obtain this property.

2.2 Coefficient of friction

Many applications require the coated surface to slide against a stationary surface, which can occur during manufacturing or end use. Assuring that the coefficient of friction of the coating is at a low value facilitates the process. Waxes reduce the coefficient of friction of the system. Harder waxes are more efficient in reducing the coefficient of friction.

2.3 Chemical resistance

Waxes can aid in the resistance properties of a coating. Salt spray resistance of an exterior coating that will be exposed to severe weathering can be improved by adding a barrier enhancing wax.

2.4 Block resistance and release properties

Waxes impart a non-stick character to a coating that decreases the tendency for blocking. Unwanted transfer or adhesion of coating to a contacted surface is thus prevented.

2.5 Influence on Gloss

Waxes can be used to control gloss to achieve a desired matt effect. An example of this is satin finish coatings for wood.

3. METHODS OF WAX PROCESSING

Wax is introduced into the coating in the form of discrete microfine particles. The form in which the wax is incorporated into the coating formulation is an important factor to consider. Several processes are used to reduce waxes to the required particle size.

3.1 Compounding

The production of a wax compound involves dissolving the wax in a solvent and then rapidly cooling the solution with cold solvent. This process of ñshock coolingò can produce wax dispersions with extremely fine particle size. This process is very difficult to control and is used where the very special properties of dispersions made by this method are required. In the case of pigment dispersion, wax can act as a spacer to reduce settling. The gel structure created by the compounding method assists in reducing settling.

3.2 Emulsifying

A true emulsion is a dispersion of a liquid in an immiscible liquid. A wax emulsion is in reality a very fine particle size dispersion of a solid wax in water with the addition of some surfactant or emulsifying agent. It is referred to as an emulsion because the molten wax is dispersed in water in the presence of emulsifier and then recrystallises into fine dispersed particles. Polar (oxidised or modified) waxes are more easily emulsified. Trecoraôs OX7 or OX18 can be used in this application.

Wax emulsions provide the smallest particle size. The average wax particle size in an emulsion is often less than one micron. The fine particle size can result in a lack of efficiency as a coating additive. Since the wax must protrude through the coating surface in order to have any effect, smaller particles are less likely to project beyond surface irregularities, especially in pigmented coatings.

3.3 Dispersing

Solid waxes can also be ground into a vehicle (oil, solvent or water) by the use of different media mills. The standard procedure would be to ball or pebble mill the wax into an appropriate solvent or solvent/vehicle blend. The advantages of this method are that any friable wax can be used and that the wax can be dispersed in any liquid in which it is not soluble at the dispersing temperature. When dispersing waxes in strong solvents, care must be taken to control process temperature as elevated temperature may cause partial solution and uncontrolled recrystalliation of the wax.

The finished wax dispersion can be sufficiently coarse to allow adequate penetration through the surface in ambient cured coatings, or dispersed to a fineness that approaches that of an emulsion.

Solvent/vehicle selection is important to ensure the wax dispersion can be used in various coating applications. Dispersing the wax in a different solvent will sometimes provide an effect that could not otherwise be achieved. A series of dispersions of a given wax in a variety of solvents will increase the potential range of usefulness of that wax. The solvent alters the surface characteristics of the wax. This can change the degree of compatibility of the wax with the coating, and increase the amount of wax that rises to the surface of the coating. In extreme cases this can be the difference between success and failure. This is of greatest significance in baking finishes, where the mobility of the wax during the bake cycle is critical to the function of the wax. The predispersion of a wax in a solvent will allow it to function in coatings where direct addition may yield no benefit.

Another advantage of wax dispersions is that they are thixotropic. In varnish and paint systems the wax particles form a network which reduces the settling of matting (anti-gloss) agents, and therefore improves their matting effect. The particle size of the wax dispersion also affects the gloss of the coating. A combination of wax dispersions with silicas gives effective matting, scratch resistance and surface slip.

Other physical and application factors that have a major influence on the efficiency of the wax in the coating system include:

- the density of the wax particles in the coating system
- the polarity of the wax
- the particle size, the particle size distribution and the particle shape of the wax
- the dosage of the wax dispersion
- the film thickness of the coating
- the drying or reactivity of the coating system

3.4 Micronizing

3.4.1 Grinding

Waxes can be reduced to a useable particle size in the solid state by a process referred to as jet milling. Granulated wax is blown into a chamber at very high speed. The particles fracture through contact with the walls of the mill and through particle to particle impingement. These particles are classified resulting in fine particles with a very narrow particle size range.

3.4.2 Spraying

Liquid waxes can be sprayed to a very fine particle size. By using the correct pressure and die configuration spherical particles are formed which are then classified to a narrow particle size distribution. The spherical form of the sprayed particle enhances rub resistance and slip.

3.4.3 Incorporation

The ground or sprayed micronised product is incorporated into the coating by means of precompounding or direct incorporation. Precompounding involves putting the wax into the vehicle under high-speed agitation, or putting it into the higher viscosity portion of the mix and dispersing it thoroughly. Since a micronized wax has already been optimised for particle size and range, no further grinding is necessary.

4 SPECIFIC TYPES OF COATINGS

A typical breakdown of the paint and coating industry can be done by looking at market categories. Using this criteria coatings can be divided into three categories, namely;

1) architectural (decorative) coatings
2) speciality (maintenance) coatings, and
3) OEM(original end manufacturers)/product (industrial) coatings.

The architectural market represents the market category that includes all paints, varnishes and lacquers sold for the direct application to either interior or exterior surfaces of residential, commercial, institutional and industrial buildings.

The speciality/maintenance market represents coatings that can withstand unusual exposure to high abrasion/wear, corrosion or temperature conditions as well as prolonged exposure to either hazardous chemicals or water.

The OEM/product market represents the market category that includes coatings formulated to specific customer specifications and applied to original, durable equipment within the confines of an established manufacturing process. Typical products to which coatings are applied include appliances, automobiles, industrial machinery, ships, metal containers, aircraft and wood furniture. The use of hard waxes as surface additives in coatings by far finds its main application in these types of coatings. A number of different types are discussed below.

Table 1 : Three main categories breakdown

Architectural coatings	OEM coatings	Special-purpose coatings
Exterior house paints Interior house paints Stains Undercoaters, primers & sealers	Appliances Automotive Electrical insulation Factory-finished wood Film, paper & foil Machinery & equipment Marine Metal containers Metal furniture & fixtures Pipe Sheet, strip & coil Wood furniture & fixtures Miscellaneous consumer & industrial products Toys & sporting goods	Aerosols Arts & crafts Bridge maintenance High-performance maintenance Metallics Multicolored Roof Swimming pool Traffic marking

4.1 Powder Coating

Powder coatings are similar to other types of coatings or paints but are applied in a powder in stead of liquid form.

The manufacture of powder coatings starts with a recipe, on the basis of which resins, hardeners, pigments and additives are combined. A typical powder coating contains 50 - 60 % binder, resin and hardener, 40 - 50 % pigments and fillers and 1 - 2 % additives. These ingredients are mixed in a mixer of a suitable size and results in what is called a base compound. The mixing process can be described as a tumbling action.

This base mixed compound is then extruded. During this process the raw materials melt and are fused into a homogenous mass. When the material, after a few seconds, has passed through the extruder, it has reached a temperature of about 100 °C. During the extrusion process the wax acts as a lubricant to lower the pressure and increase the throughput. The wax also assists by increasing the wetting capacity of the resin mixture for pigments and fillers.

The paste is pressed through a pair of cooled rollers and cools on a cooling belt. When the material has been cooled and crushed, it is ground to the correct particle size. Since the plant and application technology of every final user is unique, the parameters of the mill must be adjusted so that the final powder particle size suits each user. Because the wax is crystalline, it adds to the efficiency of the grinding stage.

After grinding the powder is sifted to remove any remaining coarse particles from the final product. The product is packaged and is now ready for delivery.

At the customerȷs manufacturing facility, the item to be powder coated is cleaned and a pre-treatment is applied. The powder coating may be applied directly to cleaned, treated metal or to a primed surface. The powder is fluidised or mixed with compressed air so that it can be pumped into spray guns and is then given an electrical charge. The piece to be coated is electrically grounded, so that the charged powder will adhere to it. During application, wax reduces the risk of caking and in this way ensures troublefree coating. At the same time the nozzles do not wear so quickly.

Once coated, the piece is transferred to an oven and heated until the powder particles cure and fuse into a tough, solid coating. In the final application of the powder coating the wax acts as a flow additive. It lowers the viscosity of the system and hence the flow of the resins, resulting in a more even surface with higher gloss. This is very important in decorative applications, i.e. those applications where the coating serves an aesthetic purpose and where gloss, colour and appearance are of prime importance. It is important to know the application, as a more flexible system is needed if post-formation of the final product has to be done, for example stretching. The recommended product in this case would be OX18.

The main purpose of wax addition is to influence the gloss and improve the surface hardness, scratch resistance, scuff and mar resistance of the finished coating film. Wax addition levels vary between 0.2 and 1.5%.

A powder coating has several advantages compared with traditional liquid coatings. The paint is solvent-free, does not run, has very little waste and is durable. It has a higher rate of transfer efficiency, i.e. the ratio of the coating usefully deposited on the substrate to the total amount sprayed. Powder overspray can be recovered and recycled which reduces the amount of time needed for clean up and minimises the cost of waste disposal.

4.2 Can Coating (Two-piece aluminium can)

An important consideration here is that waxes used in can coatings normally require food approval e.g. F&DA.

The can body is formed using a drawn and iron process. A slug of aluminium is stretched and formed into the appropriate shape. Afterwards, an aqueous coating is sprayed on the interior surface of the can and heat cured. The purpose of the wax as an additive to the aqueous coating is to promote product release, maintain product integrity and flavour and to protect the coating from fracturing during minor bending of the can edge when sealing. Waxes are minor components of this coating since the can was formed prior to the application of the coating, and therefore, the coating is subjected to minimal physical stress.

The manufacture of the end piece (top) offers an example of an application that puts severe flexibility and surface lubricity requirements on the coating. In this process the aluminium discs are punched out of a precoated flat stock, shaped into ends that have a scored area and a tab attached by a rivet drawn from the disc. The stress on the coating at this point is tremendous, as the metal may elongate as much as 300% while in contact with the forming dies. The wax must protect the coating from abrasion by the dies and provide release from the dies after forming. At the same time the waxes must not affect the film barrier integrity of the coating as it stretches with the metal. The primary mechanism of protection in this application is reduction of the coefficient of friction by the wax. High coefficient of friction leads to increased fracture of the coating and subsequent failure.

4.3 Coil coating

In precoat recoil applications, the metal coil is coated, cured and then rewound for storage and handling prior to being used for part formation. In the recoil process, wax in the coating significantly reduces or eliminates marring and blocking.

Post formation of the coil involves stamping, bending and subsequent handling. In the stamping and bending process, the wax in the coating aids in surface lubricity and causes less wear on the forming equipment. During these operations metal-to-coated surface contact can result in metal marking and scuffing.

In the subsequent handling of the finished product, abrasion resistance is important. When in transit, abrasion can occur from corrugated packaging. The wax in the coating minimises these conditions.

The property of recoatability requires the selection of a wax that does not contribute to poor intercoat adhesion.

4.4 Wood finishes

The role of the wax is to act as an anti-weathering agent, prevent watermarking, lower the MVTR, and beautify the wood, preservation and texturing. The wax migrates to the surface to give a matt effect as well as a satin surface finish.

4.5 Marine Coating

Wood, fibreglass and metal hulls of seagoing vessels are coated to protect against fouling and corrosion. Fouling leads to additional maintenance and the increased drag results in higher fuel consumption. Biocidal antifouling coatings contain toxins, such as cuprous oxide or tributyl tin compounds. These coatings are environmentally unfriendly and are restricted in many areas.

Wax is used as a non-stick or release additive in the topcoat layer for marine applications. The low surface energy of the wax reduces the ability of organisms to adhere to the surface of the coating. As a vessel moves through the water, organisms more readily lose their grip and fall off.

Another benefit is a substantial reduction in the difficulty of hull cleaning and maintenance. A coating formulated with wax minimises the need for extensive scraping and blasting. Due to the lowering of the need for maintenance, the coating has an extended useful life.

4.6 Automotive Coating

The wax lowers the viscosity of the coating and thereby adding to increased orientation of the metal pigment in metallic paints.

4.7 Paints

Waxes give rub and slip resistance to decorative paints. A factor that should be taken into consideration here is the particle size. A particle size of around 40 microns should be used, because of the film thickness.

5. GENERAL

The best choice of wax and method of dispersion depends on factors including type of resin, film thickness and gloss level. The porosity of the substrate is often overlooked. On a non-porous substrate such as metal or plastic, the wax particles will remain on the substrate. On a porous substrate such as wood or paper, the wax particles will tend to penetrate into the substrate. Thus, an extremely fine particle size material such as an emulsion may be very effective on a non-porous substrate. A larger or micronised size particle may be required on a porous substrate.

Trecora Grades Recommended

Grade	Description	Physical form
CWP400/ CWP400E	Unmodified	Pastilles/ Micronized powders
OX 7/ OX18	Oxidised	Pastilles