MAINTENANCE CHEMICAL SPECIALTIES

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by

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To those of my colleagues who have helped along the way, and to the one who makes it all worthwhile, my wife, "Ceil".

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Foreword

If the following foreword were to be titled, "Glossiness is Next to Godliness" would certainly be most appropriate. To those involved in the formulation, manufacture and sale of polish and polished products, the title assumes an almost Biblical overtone. There can be no question that, almost without exception, the gloss and gloss-influencing properties of a polish product are of greatest concern and importance during the preparatory stages, as well as the consumer-use stages. Sacrifices are quite often made in other important polish properties in order to achieve optimum gloss, while the reverse situation almost never occurs.

The consumer's reverence for gloss is evidenced by the wide spread usage of a host of terms that connote, or relate to, the value of a reflective surface, e.g., glisten, gleam, sparkle, burnish, glow, smooth, radiance, polish, sheen, shine, luster, reflection, glare, sleek, glint, glitter, patina, etc. While the exact psychological reasons for the value ascribed to glossy surfaces have not been fully defined, it certainly could be said that gloss bespeaks quality, respectability, wealth, a state of repair, suggested newness and, of course, cleanliness. If cleanliness is next to Godliness, then too must glossiness be next to Godliness. In subsequent chapters, which will occasionally deal with a variety of polish products, the gloss property, and its achievement, will be considered specifically within the framework of each type of product. The following will briefly and generally discuss certain of the technical aspects of the gloss property as the reasons for its being elevated to an Olympian plane in the chemical specialties field, and will illustrate the surprisingly many interdependent formulation considerations that must be balanced during the compounding of a typical gloss producing product.

Detailed definitions of gloss and its related terms are beyond the scope of this foreword. Suffice it to say that the gloss of a surface is determined by the behavior of light that strikes the surface and the manner of its specular reflection. The attainment of gloss is always a matter of achieving surface smoothness and subsequent reflectivity. Surely we are all familiar with the sensation of gloss when observing a pool of undisturbed water. At certain viewing angles, the liquid film appears to act as a perfect reflector. The sensation is broken, however, when the surface is disturbed, thus reducing, or eliminating its reflective powers. Other contributing factors include the internal light absorption and dispersion characteristics of a film. Any absorption or dispersion of light will prevent its full specular reflection and thereby reduce gloss. Light that penetrates a transparent surface is sometimes internally dispersed due to the non-homogeneous nature of the film, or to substrate irregularities. If the angle of the dispersed light exceeds the critical angle for light in the film, the film will be illuminated, giving it a luminous appearance. Coatings of materials possessing high refractive indices can, once past a critical angle, aid in deflecting light and in a sense thus increases gloss by enhancing reflection. An illusion of depth, which contributes to greater awareness and appreciation of mirror images, is created in this way. These two aspects of gloss-distinctness of image gloss and depth of gloss are then related.

The distinctness of image and depth of gloss characteristics are of utmost importance in our current world of highly polished surfaces. A wide consumer preference is exhibited for those products that are superior in producing or enhancing these characteristics, notwithstanding that there will be no consensus as to why. It is interesting to note that while we can actually measure specular gloss and depth of gloss separately, we do not have an instrument that will measure both simultaneously. Only the human eye can integrate and evaluate the total result. The reason for a lack of ability of the consumer to define or explain a preference is because in making a decision as to what is glossy or glossiest, the consumer is in reality visually evaluating both of the above properties at the same time, as well as a parallactic effect in which one sees a surface through, or behind, another. If our space-age technology can not duplicate the workings of the human eye, how then can mortal man adequately define his thoughts and preferences in regard to the Great God Gloss?

A variety of psychological reasons for consumer demand for superior gloss-producing polishes have already been mentioned. A considerably more important reason has been variously referred to as the physical factor, or the reward factor. The user of a floor, furniture, or automobile polish must be rewarded by an attractive, high-gloss appearance after investing the time, effort and labor involved in its application. The person waxing his automobile encounters something of a physical work-out, since he must first wash the car and then hand-apply and buff the wax to its optimum gloss. Similarly, the housewife physically washes and strips a floor of its previous polish and then applies the fresh product. Industrially this polish might also be power buffed. It is reasonable for these people to expect some immediate reward for their efforts. The immediate reward is gloss and a subsequently renewed appearance. It is entirely possible that if a product does not offer such reward value, it will receive no further trial, despite the fact that it may be an exceptional product in all other regards. Conversely, it is possible that an exceptionally glossy product will enjoy considerable and continued popularity even though it is weak in one or more other performance properties.

Most specialty polishes can be said to develop, or produce gloss by cleaning and smoothing a surface and/or (additionally) depositing a still smoother coating or film upon that surface. This film may be produced in a variety of ways. Some of the more important film forming mechanisms are:

(1) Deposition of films from aqueous, or solvent systems (solutions or fine particle size dispersions), which by virtue of the inherent film forming natures of the ingredients, or high degrees of built in coalescence, self-develop the smooth reflective state upon drying. Typical examples of specialty polish products in this category include water-emulsion floor polishes, gymnasium finishes, varnishes, etc.

(2) Deposition of films from aqueous or solvent systems that are not sufficiently coalesced or capable of self coalescence, and which require either manual or mechanical buffing (frictional heat) in order to develop smoothness and gloss. Typical examples include paste shoe polishes, paste floor waxes, polymer gels, and automobile liquid and paste products.

(3) Formation of a film through interaction of polish ingredients with the surface being polished. Examples include aluminum cleaner-polish products, as well as silver polishes. In the instance of the aluminum polish, an aluminum soap is deposited over the surface from reaction with fatty acid components released during the rubbing operation. This protective coating also contributes to a pleasant mellow gloss. Similarly, silver, when polished with certain sulfur-containing compounds, is thought to form a silver-sulfur bond that acts primarily as an anti-tarnish

mechanism and also contributes to gloss and gloss retention.

It should be noted that abrasive polishing action is sometimes a necessary supplemental aid in the achievement of adequate gloss, particularly in the automobile and metal cleaner-polish areas.

All chemical specialty polish products can be thought of as attempts at balanced products. That is to say, products that are balanced so as to optimize advantageous performance properties and minimize disadvantageous properties. Similarly, a balanced product is one in which a compromise has been made between two related advantageous properties, whereby the fullest development of one property would diminish the other. That the gloss property is an "untouchable" and is considered to be apart from this balancing-compromising aspect of formulation has already been mentioned. The achievement of the all important high gloss property itself is, however, a study in the balancing of a great variety of interdependent formulation considerations, which vary from one type of product to another.

An abrasive-type automobile paste-polish will be chosen for illustration, since it involves the supplemental aid of abrasive components.

An automobile paste wax exhibiting gloss achievement properties must provide the following:

1 – Complete removal of oxidized or weathered paint film.

2 – Complete removal of road soils.

3 – Easy buffability.

4 – Lack of smeariness in buffed film.

5 – Easy removal of dried abrasive.

6 – Durable gloss.

The four major ingredients of a paste auto polish are solvents, abrasives, silicones and waxes. The relation of each to the final gloss result is discussed below.

The abrasive system is the most important cleaning ingredient or ingredients in that the proper balancing of types, particle size, and amounts produces rapid cutting and removal of oxidized paint film and stubborn road and insect soil (not removed by solvent components). Non-removal, or partial removal, of oxidized or weathered paint produces light dispersion and reduces reflectance. Care must, of course, be taken not to build in abrasivity to the point where the paint film becomes scratched.

The solvent system is chosen and employed at different levels of concentration for its balance of cleaning properties, solvency characteristics and its drying rate. Cleaning efficiency would include its ability to soften or dissolve oily road residues and previous wax film. Solvency characteristics need to be considered as to capacity to hot dissolve the film forming ingredients and later form the proper paste consistency while maintaining a uniform distribution of the abrasive system. The drying rate should be such as to contribute to easy buffability.

Carefully controlled small amounts of paint solvents are sometimes employed to soften the oxidized paint film in order to accelerate abrasive removal.

Silicones contribute to the gloss property in a number of ways once the proper type, viscosity, and amount have been balanced. Its film forming nature contributes to the final gloss. As important are the facts that it acts as a buffing lubricant and also acts as a release agent for the dried abrasive. Easy removal of the dried abrasive prevents scratching of the paints or the wax film, which would necessitate still more buffing. Use of the wrong type of silicone, or too much silicone, can produce smeary films.

Waxes are the major film forming ingredients and are coalesced into the final glossy film by the buffing operation. The wax component is usually a blend of soft waxes and hard waxes. The soft waxes are selected because they are easily buffed and contribute to the easier buffing of the harder wax components. If too high a level of certain soft waxes, e.g., paraffin, are employed, buffability will be impaired in that excessive buffing will be needed to eliminate the smeariness. The hard waxes are more durable and contribute to the longer life of the gloss condition, as well as some measure of long-term rebuffability. Employing an overbalance of hard wax components can similarly produce the need for extra buffing action. The waxy ingredients are also chosen for their solvent retention properties. It is possible that neglect of any one of the above considerations, even where all else is expertly formulated, can result in non-consumer acceptance. Only the balancing of all gloss considerations can produce the superior polish product.

It is reasonable to assume that our quest for gloss producing maintenance products will continue to center about ways and means to achieve unusual and greater depth of gloss properties. Recent innovations in manufacturing techniques should permit the incorporation of unique gloss-producing materials into polishes. The continued march toward the manufacture of ultra-smooth, highly-polished surfaces and substrates will create greater demands for polishes that will enhance and preserve an already very high level of gloss. Greater depth of gloss may very well be the most important factor.

Previous and recent interest in "Wash and Wax" products may eventually result in the development of the ultimate product of its type – a cleaner product that would efficiently clean a surface and deposit a film with at least that level of bright-dry gloss our current technology is capable of providing and a film that would also be an entirely functional polish in all else.

Unusual gloss effects might also be developed in the area of films exhibiting rainbow or iridescent characteristics.

Whatever the future direction, it is quite certain that polish formulations will still need pay obeisance to the Great God Gloss.

I

Polymer-Based Floor Finishes

I-1 FORMULATION GUIDELINES FOR IMPROVING FLOOR FINISHES

When one considers that modern water-emulsion, polymer-based floor finishes are formulated with a minimum of seven and as many as ten different types of ingredients, and that these ingredients interdependently influence 15 or more different and sometimes opposing performance properties, it is no wonder that a neophyte formulator may feel overwhelmed. The following presents a useful set of general guidelines that are designed to be helpful in instances where an improvement in a specific floor finish performance property is desired. Similar guidelines for wax-based floor polishes will be discussed in Chapter II.

The neophyte should be forewarned that not every recommendation will prove successful in every instance. The complex nature of modern polishes and their individual components mitigates against formulation absolutes. Care must also be exercised to consider and maintain a balance of properties when seeking to improve a given performance area. If, for instance, removal ease is greatly improved, it is possible that water-spot resistance may be impaired.

Similarly, if too high a degree of detergent resistance is achieved, then easy and complete removal of the film may be impossible, even with the use of significant amounts of ammonia, unless an abrasive pad is employed. If a film has been softened in order to produce greater anti-slip properties, soil and scuff resistance properties may be adversely influenced.

Many of the other performance compromise situations may be handled on a common sense basis and all will become quickly evident to the beginning formulator during the necessary period of learning through trial and error. Use of the following may shorten the learning period.

To Achieve Higher Bright-Dry Gloss

Increase emulsion polymer level. Employ more film forming polymers.* Increase solids of polish formulation. Employ higher ratios of plasticizer to polymer solids.* Use combination of plasticizers. Increase coalescent content. Vary type and concentration* of alkali soluble resin fraction. The resin must be completely solubilized and may also be preplasticized. Employ finer particle size wax-dispersion fractions. Control polish pH within ranges suggested for particular polymer system.

To Improve Depth of Gloss

Add or increase polystyrene concentration. Generally employ high refractive index ingredients. Investigate use of Pyrrol plasticizers. Increase plasticizer and/or coalescent level.*

To Improve Leveling

Employ more film forming emulsion polymers.* Increase plasticizer content and particularly tributoxyethyl phosphate, as well as coalescent content.* An exception would be phthalate plasticizers whereby decreased levels are sometimes beneficial. Use combinations of plasticizers and coalescents. Increase concentrations of alkali soluble resin.* Employ higher acid value rosin ester resins, rather than low acid value resins. Employ additive amounts of surfactants, wetting-leveling agents, e.g., fluorocarbons, Igepals, etc.* Where odor is no problem, incorporate small amounts of n-octanol. Incorporate small amounts of plasticizer or coalescent-synergistic emulsifiers in wax dispersion fraction.*

To Improve Water-Spot Resistance

Reduce alkali soluble resin. Employ low acid value resins. Fully or partially substitute rosin ester resins for styrene-maleic anhydride resins. Investigate the use of cross-linked polymers, acrylic polymers, styrene-acrylic copolymers and styrene polymers in that order. Increase coalescent and plasticizer levels.* Reduce wax content. Employ more volatile amines in wax dispersion. Avoid use of fixed alkali in wax dispersion. Vary type and amount of emulsifier system in wax dispersion.

To Improve Recoat Properties

All of the suggestions for improving water-spot resistance. Restrict use of surfactants and other water-sensitive materials. Increase pH (if practical).

To Improve Removability

Increase alkali soluble resin content.* Employ high acid value resins. Investigate use of styrenes, ammonia removable polymers, styrene-acrylics and acrylics in that order. Increase wax content.* Employ more permanent or fixed alkali in wax dispersion fraction.*

To Improve Color

Avoid use of shellac or dark resin supported polymers. Reduce alkali soluble resin fraction. Substitute styrene-maleic anhydride resin or bleached alkali soluble resins for darker counterparts. Use only low color waxes for wax fraction. Substitute lighter colored emulsifier systems in wax dispersion. Avoid prolonged or excessive heating of molten waxes during preparation of wax dispersion.

To Improve Slip Resistance

Reduce hard polymer content. Incorporate small amounts of soft, film forming polymers.* Increase plasticizer and/or coalescent levels.* Substitute "soft" waxes, e.g., oxidized low-molecular-weight polyethylene for "harder" waxes. Increase emulsifier content in wax dispersion.* Increase concentration of "soft" wax dispersion in polish system. Employ Ludox A.M. Plasticize wax and resin fractions.*

To Improve Detergent Resistance

All of the suggestions for improving water resistance properties. Investigate use of cross-linked polymers, cross-linkable polymers, amino-functional polymers and high acrylonitrile polymers in that order.

To Increase Resistance to Powdering

Reduce styrene content. Increase levels of plasticizers and coalescents.* Investigate use of humectant plasticizers.* Reduce wax content. Limit use of non-oxidized polyethylene or oxidized high-molecular-weight polyethylene fractions to 15% or less.

To Improve Heel Mark Resistance

Employ harder styrene-acrylate, as well as styrene polymers. Fully or partially substitute styrene-maleic anhydride resins for other alkali soluble resins. Reduce or eliminate soft wax dispersions employed.* Employ high-molecular-weight polyethylene dispersions or latices.* Maintain plasticizer contents at minimum levels.* Substitute for tributoxyethyl phosphate.

To Improve Soil and Scuff Resistance

All of the suggestions for improving heel mark resistance, with particular emphasis on the wax dispersion considerations. Maintain level of wax dispersion emulsifier at a minimum. Where possible, employ solid or semi-solid emulsifiers.

To Improve Stability

Formulate in the 8.9–9.5 range for all polymer products except high acid number acrylics (pH 7–8). Adjust with ammonia where necessary. Employ only prechecked compatible ingredients. Employ fine particle size, stable wax dispersion fractions. Reduce level of alkali soluble resin.* Filter product. Add preservative. Employ high-molecular-weight polyethylene latices. Reduce solids of polish, where practical.

To Improve Freeze-Thaw Stability

Investigate use of styrenes, styrene-acrylics, and acrylics in that order. Increase pH. Reduce plasticizer content. Increase coalescents and particularly use ethylene glycol.* Add small amounts of lower alcohols, morpholine or surfactants.*

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