Kirk-Othmer Encyclopedia of Chemical Technology.

POLISHES

Polishes are used to maintain a glossy finish on surfaces as well as to prolong the useful lives of these surfaces. Appearance enhancement provided by polishes generally results from the presence of components that leave a glossy coating, and/or materials that smooth and clean surfaces. Furniture, shoe, and most floor polishes rely on the deposition of a film. The exception in the case of floor polishes is in certain treatments for marble, which involve recrystallization of the surface rather than application of a film. In addition to providing glossy protective films, car polishes contain abrasives (qv) to remove weathered paint (qv) and soils. Metal polishes are based on either abrasive smoothing and cleaning or tarnish-removing chemicals, and sometimes deposit materials that retard future tarnishing (see Coatings; Metal surface treatments).

The terms *polish* and *wax* have been used almost interchangeably. Film formers not based on wax are used increasingly (see Waxes). Change to synthetic polymer-based films was motivated by the promise of more consistent quality, greater durability, and greater convenience in the total product experience, as well as changes in the surfaces being protected. Buffing is necessary to achieve gloss for natural wax-based formulas. Most modern polishes are self-polishing. Even buffable products have been formulated to reduce buffing effort. Some modern formulations clean and remove previous polish films as well as leave a new film, all in one operation. Thus, periodic stripping of polish film buildup is not required. Polymeric film formers, which can be synthesized to provide specific properties, have been the basis of most polish formula advancements, even though the technology involved in modifying natural waxes has also progressed. Products employing reduced levels of volatile organic compounds (VOCs) to meet environmental requirements have been developed. The nature of the surfaces that are polished has also changed over the years. Polymers are widely used as construction materials and are thence polished (see Building materials). For example, whereas wood (qv) floors are popular in households, the most common hard-surface floor covering in the industrial and institutional market is vinyl polymer. Synthetic resins are commonly used to coat natural surfaces, eg, of wooden furniture.

1. Furniture

Modern furniture polishes are designed for a wide variety of surfaces, eg, plastics, metals, and synthetic and natural resin coatings. Furniture polishes impart shine and provide protection from abrasion, marring, and spills. The formulations clean well in many cases. In common with most other polishes, furniture polishes are characterized by ease and speed of application and of buffing, and by either the absence of objectionable odors or the addition of pleasing ones.

Reviews of furniture polish formulations are available (1–3). Furniture polishes contain one or two classes of film-forming ingredients, solvents, and various stabilizers. Natural and synthetic waxes are the main film formers in many formulations. Most natural waxes protect plants against water loss and microorganism entry (4). Typically, these waxes are long-chain molecules that do not evaporate easily. They contain few polyunsaturated compounds that might be susceptible to atmospheric degradation, and the waxes may be immune to enzymatic breakdown by microbes. Other modern waxes include paraffins derived from petroleum;

montan, a fossil vegetable wax; and synthetic materials, eg, polyethylene [9002-88-4], polypropylene [25085-53-4], and Fisher-Tropsch products. For polish use, the basis for referring to these materials as waxes is the similarity between their physical properties and those of natural waxes. Wax blends used in furniture polishes are not as hard as those used for automobile or floor polishes, but the blends must not be so soft that the resulting coating can be smeared easily.

Chemical modification of the wax can improve smear resistance (5). Silicones, which do not harm furniture finishes (6), are incorporated as film-forming ingredients in furniture polishes. The lubricant properties of silicones improve ease of application of the polish and removal of insoluble soil particles. In addition, silicones make dry films easier to buff and more water-repellent, and provide depth of gloss, ie, ability to reflect a coherent image as a result of a high refractive index (7). Wax-free polishes, which have silicones as the only film former, can be formulated to deliver smear resistance (8). Another type of film former commonly used in oil-base furniture polishes is a mineral or vegetable oil, eg, linseed oil.

Solvents facilitate oil-borne detergency, provide the solvency required for a stable formulation of the desired consistency, and control the film drying rate after its application. For furniture polishes, the nonaqueous solvents generally are aliphatic hydrocarbons (qv) that do not attack finishes. Because its use reduces cost and toxicity, and because it aids detergency against waterborne soils, water is increasingly used as a carrier. Emulsion polishes can be either of two types: oil in a continuous water phase (o/w), or water in a continuous oil phase (w/o). Generally, o/w emulsions provide better cleaning properties for water-soluble soils but poorer gloss. For o/w emulsions, ethoxylated, nonionic emulsifiers having high levels of ethoxylation are used. For w/o emulsions, sorbitan oleates [1338-43-8] commonly are used (1). The advantages of using cationic emulsifiers for w/o-emulsion furniture polishes have been described (9). It is possible to formulate shear unstable emulsions of silicones. These break when the liquid emulsion is sheared during polishing and thereby deposit a uniform silicone film (10).

The different types of furniture polishes include liquid or paste solvent waxes, clear oil polishes, emulsion oil polishes, emulsion wax polishes, and aerosol or spray polishes (3). Nonwoven wipes impregnated with polish ingredients have been targeted at consumers who do not wish to expend the time to dust before polishing (11). Compilations of representative formulas are given in References 3, 4, 12, and 13. Paste waxes contain ca 25 wt % wax, the remainder being solvent. Clear oil polishes contain 10–15 wt % oil and a small amount of wax, the rest being solvent. Aerosol or spray products may contain 2–5 wt % of a silicone polymer, 1–3 wt % wax, 0–30 wt % hydrocarbon solvent, and ca 1 wt % emulsifier. The remainder is water.

Evaluations of furniture polish application properties, gloss, uniformity, film clarity, smear and mar resistance, film healing, buffability, cleaning, water spotting, gloss retention, and dust attraction are all described in ASTM D3751-79. Federal Specification P-P553B (1977) includes some standard test methods for the evaluation of liquid furniture polishes.

2. Floor

There are two basic segments in the floor care market: the household market which has been declining as a result of changing lifestyles and no-wax floors, and the industrial and institutional (I&I) market. Whereas trends in the former have stressed convenience, the I&I market, which has been holding fairly steady, has focused on labor saving, either through increased durability or faster maintenance.

Floor polishes are subject to more mechanical abuse than other polish films and, therefore, should be resistant to abrasion, soiling, water, and detergents. Polymers, which generally are of higher molecular weight than natural waxes, can be formulated to provide films having these properties. In addition, the ability to tailor the properties of synthetic polymers has produced self-polishing aqueous formulations. These formulations result in the deposition of films having high gloss, low color, durability, little tendency to powder, and built-in mechanisms for easy removal.

Reviews of floor polish formulations are given in References 3, 13, 14, and 15. Aqueous, self-polishing, polymeric formulations generally contain two or three polymeric film formers, coalescing agents, leveling aids, plasticizers, zinc complexes, ammonia, and wetting and emulsifying agents. The polymer generally is a styrene–acrylic copolymer or an acrylic copolymer (14, 15). The monomers used are styrene [100-42-5]; acrylic acid [79-10-7]; acrylic acid esters, eg, butyl acrylate [141-32-2]; methacrylic acid [79-41-4]; and methacrylic acid esters. Polyurethanes are used in some products as well (16). The polymer may be used in the formulation as an emulsion, but if sufficient acid monomer is incorporated and base is added, the emulsion particles swell and, in some cases, the polymer dissolves. This dissolved form is used in water-clear floor polishes (17, 18). Polymer usually is the principal film former. Resins, which are low molecular weight and high acid content polymers, form clear dispersions of low viscosity at high solids content (14). They may be styrene–maleic anhydride copolymers, various styrene–acrylic copolymers, rosin maleates, or terpene–phenolics. In an emulsion product that otherwise might be low viscosity, resins are used to increase the application viscosity and thereby provide a thicker film.

Waxes are added to formulations in the form of emulsions. The trend of the latter twentieth century has been to use low molecular weight polyethylene, made somewhat polar by oxidation or by copolymerization with carboxylic acid monomers to make them readily emulsifiable (19). Waxes provide buffability to polish films and increase abrasion resistance. Plasticizers are used in emulsion products to lower the minimum film-forming temperature (MFT) below which the coating is applied. Below MFT, polymer emulsion particles do not coalesce to provide a coherent film. The plasticizer can be a phthalate ester, phosphate ester, glycol ether, or glycol (20). Phosphate esters, particularly tris(butoxyethyl)phosphate [78-51-3], are plasticizers but are more important as leveling agents (21). Glycol ethers are classed as coalescing agents and differ from plasticizers in that they are fugitive (22). These reduce MFT but evaporate when the film dries, yielding a hard film.

Zinc may be added as a fugitive ligand complex, eg, zinc ammonium carbonate (23). During film formation, the ligands evaporate and zinc complexes with carboxylate groups on the polymer, forming a cross-linked network (24). Zinc hardens the film and imparts detergent resistance to it. Nevertheless, the ammonia in a floor wax stripper can complex the zinc, thereby breaking the cross-link and allowing the polymer to redissolve (see Zinc compounds). Alternatives to zinc complexes are also possible (25, 26). Aqueous polymeric floor polishes contain the emulsifiers, wetting agents, and stabilizers needed to give a stable homogeneous product that wets out on the surface to which it is applied. Liquid, solvent-based products for wooden floors are solutions or dispersions of waxes in aliphatic hydrocarbons. Water and oil emulsion products for wooden floors also can be formulated using proper selection of emulsifiers and waxes (27). These are rapidly replacing solvent-based products.

Formulas for representative floor polishes are listed in References (3, 12, 13), and 25. An aqueous formula may contain 0–12 wt % polymer, 0–12 wt % resin, 0–6 wt % wax, 0.3–1.5 wt % tris(butoxyethyl)phosphate, 1–6 wt % glycol ether, and 0–1 wt % zinc, with water filling the rest. Water-clear floor finishes contain little or no wax, whereas buffable products contain relatively large amounts of wax. Sealers contain little wax and relatively large amounts of emulsion polymers (28). For industrial use, sealers are applied to porous substrates to fill the pores and prevent polishes that are used as topcoats from soaking into the floor.

One-step clean-and-shine products have become popular in the household market. These products are applied to the floor with a sponge mop and their detergent action removes and suspends soil, which collects on the mop and is removed when the mop is rinsed with water. The formulation, which remains on the floor, dries to a polish film. An earlier product of this type was dispensed from an aerosol as a foam. Formulas as of this writing (ca 1995) are applied as liquids (29, 30). In one product, the dried film obtained from the formulation is soluble in the formulation, which includes low molecular weight, high acid polymers and a fairly large amount of ammonia (31). Repeated use does not contribute to a buildup of polish.

Industrial and institutional floor care demands polishes that accommodate the needs of machine-centered maintenance. The development of machines that buff or burnish with rotational speeds from 1000 to 2000 rpm has produced polish formulations that are balanced to accommodate the process (32–36).

Marble crystallizing does not involve a coating, rather it is a process whereby the stone gets a new surface. A heavy rotary machine is used with oxalic acid-based formulations to yield a highly reflective surface. The formulations can include hardening and curing agents that render the surface both harder and more stain-resistant (37). A machine-applied treatment for marble, wood, and stone floors involving silicone copolymers that penetrate and bond to the surface has been marketed (38).

Floor polishes typically are evaluated for gloss, application and leveling properties, discoloration, slip resistance, scratch resistance, heel-mark resistance, scuff resistance, damp-mopping and detergent resistance, repairability, lack of sediment, and removability (3). Recoatability and formula stability are also important. A review of test methods is available (35). More than 20 ASTM test methods for floor polishes exist. From the standpoint of product safety, slip resistance is a particularly important variable and many test methods are available (39).

3. Automobiles

Automobile polishing is designed to remove road film and oxidized paint, and to lay down a continuous, glossy film, which resists removal by water and car-wash detergents (7, 40–42). Much of the market is represented by one-step products which generally contain four functional ingredients. Abrasives are the principal cleaning ingredients but must not be so aggressive as to scratch the paint film. Representative types are fine grades of aluminum silicate, diatomaceous earth, and silicas (see Abrasives; Diatomite; Silica; Silicon compounds). Modern acrylic automobile paints, in contrast to older alkyd or nitrocellulose types, do not oxidize as rapidly and so reduce the need for highly abrasive polishes.

Straight- and branched-chain aliphatic hydrocarbons are used to facilitate detergency toward oil-based traffic soils, provide the solvency characteristics needed to produce a stable formula, and control the drying rate of the overall formulation. Other types of solvents, eg, aromatics, which attack paint films, are not employed. The solvent content of these polishes is generally being reduced (43). Waxes are used as one of the two principal film-forming ingredients. They are spread and leveled to produce a high luster by buffing. Blends of soft wax and hard wax, which provide ease of buffing and durability, respectively, generally are used. Many combinations have been used, including paraffin and microcrystalline petroleum waxes, carnauba and candelilla vegetable waxes, montan waxes derived from coal (qv), and synthetic polymer waxes, eg, oxidized polyethylene. Colored car waxes are liquids that hide minor scratches and enhance the color of the vehicle (44).

Silicones comprise the other type of film-forming ingredient. They also serve as lubricants for easy application and buffing and as release agents for dried abrasives. Silicones spread easily, providing a uniform high gloss as well as water repellency. Dimethylsilicone fluids are the most common, but amino-functional silicones are being used increasingly, particularly in premium quality products (45–47). Amino-functional silicones provide films with increased resistance to detergent removal because of the ability of the silicones to plate out on a paint surface and cross-link and bond to that surface. Furthermore, films containing amino-functional silicones in conjunction with corrosion inhibitors, eg, phenylacetic acid, inhibit surface corrosion (46). Acrylic polymers may also be used with the silicones (48). In addition to the functional ingredients, car polish formulas contain the emulsifiers, thickeners, and stabilizers needed to produce a homogeneous, stable product of the desired consistency.

Car polishes can be solid, semisolid, or liquid. They can be solvent-based or emulsions. In either case, liquid and solid forms are possible. Compilations of suggested formulas are given in References 3, 12, and 44. A representative liquid emulsion product may contain 10–15 wt % abrasive, 0–30 wt % solvent, 2–12 wt % silicone, and 0–4 wt % wax; an emulsion paste product may contain 3–15 wt % wax with other ingredients at similar levels. Vinyl-top waxes and dressings contain no abrasives and some are similar to water-based floor polishes (49). Federal Specifications P-W-120C (1975) and P-P-546D (1975) describe laboratory tests for gloss, smear resistance, weatherability, cleaning ability, and stability. Some of the standard laboratory tests pertaining to silicone polishes are described in Reference 7. Methods for the evaluation of automotive polishes are described in ASTM D3836 and D4955. Other evaluations required in the formulating process are depth of gloss, ease of application and buffing, film stability, and resistance to water and detergent.

4. Metal

In industrial metal finishing, polishing is an abrading operation involving the use of coarse abrasives, which remove significant amounts of metal from a surface and leave visible line patterns (50). Buffing is the smoothing of the resultant surface and involves the use of fine abrasives to reduce the dimensions of the polishing patterns. The only requirement for a metal surface to reflect light is that the surface roughness be small compared to the wavelength of incident light (51). Nonindustrial polishing does not remove large amounts of metal, but cleans and buffs to remove tarnish, oxides, and stubborn soils. The exposed metal is buffed to a high luster. Metal polishing is reviewed in Reference 3.

Formulated metal polishes consist of fine abrasives similar to those involved in industrial buffing operations, ie, pumice, tripoli, kaolin, rouge and crocus iron oxides, and lime. Other ingredients include surfactants (qv), eg, sodium oleate [143-19-1] or sodium dodecylbenzenesulfonate [25155-30-0]; chelating agents (qv), eg, citric acid [77-92-9]; and solvents, eg, alcohols or aliphatic hydrocarbons.

A problem associated with the use of abrasive metal polishes is that the fresh metal, which has been exposed by the cleaning, rapidly oxidizes or tarnishes. Thus, many modern polishes contain inhibitors. Sulfur compounds, eg, alkyl benzyl thiols, commonly are used, as are mercapto esters such as lauryl thioglycolate [3746-39-2] and dialkyldisulfides (52–54).

Metal polishes may contain emulsifiers and thickeners for controlling the consistency and stabilization of abrasive suspensions, and the product form can be solid, paste, or liquid. Liquid and paste products can be solvent or emulsion types; the market for the latter is growing. Formulas for metal polishes are listed in Reference 12. A representative liquid emulsion product may contain 8–25 wt % abrasive, 2–6 wt % surfactant, 0–5 wt % chelating agents, and 0–25 wt % solvent, with the remainder being water. The abrasive content in an emulsion paste product is greater than that in a solvent product.

Although abrasive polishing is the most common metal polishing operation, other forms of polishing and chemical brightening are used in industrial operations. Aluminum truck trailers often are cleaned and brightened by treatments with strong acids or alkalies, which chemically remove oxides. Chemical methods can also remove tarnish from other metals (55, 56).

Federal specifications that pertain to metal polishes include P-P-566D (1964), metal polishes; A-A-105, brass polishes; P-P-580A (1975), silver polishes, cleaners, and tarnish preventers. Specification P-P-556D provides test methods for polishing capability, tarnish removal, metal weight loss resulting from polishing, chemical activity toward the metal, and gloss retention. The formulation process involves evaluation of ease of use, cleaning capability, product stability, and the efficacy of tarnish inhibitor.

5. Shoe

Use of a shoe polish imparts high gloss, maintains the supple hand of the leather (qv), and increases the weather resistance of the leather (3, 57–59). Three general types of polishes are produced: solvent pastes, self-polishing liquids, and emulsion creams. Solvent pastes represent ca 60% of the market (58). They are similar to the paste furniture and floor polishes, except that the former contain higher wax-to-solvent ratios and high levels of dye. The resulting film dries to a dull finish and must be buffed to a high shine. Liquid self-polishing products contain a soft polymer, which provides a more flexible coating, and coloring agents. The latter may be dyes or, in scuff-coat polishes, pigments. Shoe creams can be made in any consistency. They are emulsions of waxes, solvents, and water. Formulas for shoe polishes are listed in References 3 and 57. Silicone waxes can also be used in shoe polishes (60). The evaluation of shoe polishes is reviewed in Reference 3. The evaluation of paste shoe polishes is reviewed in Federal Specification P-P-557B (see also Leather; Leather-like materials).

6. Health, Safety, and Environmental Factors

Liquid polishes and waxes containing 10 wt % or more petroleum distillates must be contained in childproof packaging (61). General experience indicates that natural waxes and polyethylene waxes are nontoxic (62). Although nonsolvent floor polishes are relatively nontoxic, concern for floor waxes continues to be slip-resistance (63, 64).

Under Section 183 of the Clean Air Act Amendments of 1990, the Environmental Protection Agency is required to study volatile organic compound (VOC) emissions from consumer and commercial products. The goal is to (*1*) determine the potential of the VOCs to contribute to ambient ozone levels; (*2*) establish criteria for regulating consumer and commercial products; and (*3*) submit a report of this study to the U.S. Congress (65). As of this writing, this report has not been submitted. Although it remains unclear what the exact nature of regulation will be, VOC reductions in polish formulations are underway. The State of California Air Resource Board has imposed limits on the content of volatile organic compounds in products sold in its jurisdiction (66). Much of the work described herein pertains to reductions in VOC content in polish formulations.

7. Economic Factors

According to U.S. Census Data, the value of polishing preparations and related products shipped from U.S. factories in 1987 was $798 million in factory sales, a 23% increase from 1982 (67). These sales included $155.3 million in furniture polish, $245.2 million in floor polish, $185.1 million in automotive polish, $81.1 million in metal polish, and $42.8 million in shoe polish. Industry estimates for retail sales as of 1994 involving furniture polish were that this category remained flat at $197 million (68). Retail shoe polish sales remained constant at $200 million; household floor polish sales declined about 7% in 1993, whereas institutional floor wax and polish sales have grown at an annual rate of 2–2.5% to $370 million (69). In 1992 and 1993, automotive polish sales increased about 40% a year with the advent of colored car polishes to $240 million, but were flat in 1994.

The leading manufacturers in the polish categories are S. C. Johnson & Son, Inc., Reckitt & Coleman, Sara Lee, Scotts Liquid Gold, Turtle Wax, and Alberto Culver for furniture polishes; S. C. Johnson & Son, Inc. and L & F Products for household floor polishes; S. C. Johnson & Son, Inc., Pioneer-Eclipse, Spartan Chemical, Hillyard Chemical Co., and Butcher Co. for industrial and institutional floor polishes; Turtle Wax, Armor All, First Brands, Kit Products of Northern Labs, Meguires, Blue Coral, and Nu-Finish for automotive polishes; and Kiwi for shoe polishes (68–72).

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Related Articles

Leather; Leather-like materials; Waxes; Coatings; metal surface treatments