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CHAPTER VIII

ROSIN

THE history of the production and uses of rosin can be traced to the earliest times; it has been produced in France for the past several centuries and Richard II is said to have given grants for conducting rosin markets.[1] It is also said that one of the reasons for establishing an English colony at Virginia, U.S.A., was to obtain a source of pine pitch which would make them independent of Dutch and Swedish supplies.[2]

Rosin is obtained by distillation of the exudation products of many species of *Pinus*; the American variety is obtained from *pinus palustris* while *pinus maritima* is the source of the French grade.

The genus *Pinus* is widely distributed throughout the world, but the chief producers of rosin are the United States of America, France, and Spain. Other countries producing rosin, given in the order of their production are Portugal, Greece, Mexico, India, Austria, Russia, Poland, Sumatra, Germany and China.

METHODS OF PRODUCTION

The total world production of rosin exceeds that of any other resin. It is the cheapest resin and economically there is no competition.

Gum Rosin

The *Pinus* tree on incising, exudes an oleoresin which is collected in open cups. The fresh oleoresin is a clear viscous solution of rosin in turpentine but soon becomes opaque and very viscous due to evaporation of the easily volatile turpentine and crystallisation of the rosin. Its composition is usually 68 per cent. rosin, 20 per cent. turpentine and 12 per cent. water.[3] The oleoresin may become contaminated with bark of the tree, leaves, dust, insects, etc., and the use of the closed cups has been suggested to prevent such a contamination as well as to reduce the evaporation of turpentine.[4, 5]

[illegible] methods [illegible] may [illegible]

[illegible] is not [illegible]

[illegible] A, the greater the [illegible] Wood rosin is usually more [illegible]

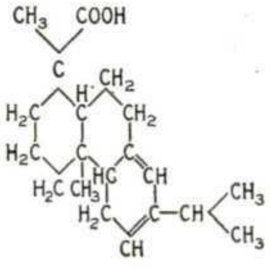
Chemistry

A comprehensive bibliography of the scientific literature on rosin from 1808–1922 has been compiled by C. E. Soane,[16] but much of the earlier work is of historical interest. Fieser[17] has also written an excellent review of the chemistry of rosin up to 1936. The true nature of rosin acids has been established only recently and even then a method is not available to identify quantitatively the different acids present in gum or wood rosin.

Approximately 80 per cent. of rosin consists of unsaturated isomeric acids, the most important of which are abietic and pimaric acids. They belong to the terpene family and their structure can be divided into isoprene units.

Some investigators consider that the different behaviour of various rosins is due to the presence of different isomers. For example, the main constituent of most European rosins is believed to be pimaric acid, while the American and other rosins contain chiefly abietic acid.[18]

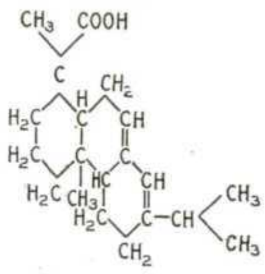
For the properties and structure of rosin acids reference should be made to the original papers. Rosin on refluxing with acetic acid yields abietic acid which can also be obtained by dissolving rosin in alcohol containing a little hydrochloric acid. Ruzicka[19] has suggested that abietic acid, $C_{20}H_{30}O_2$ has the structure shown in the diagram (*h*).



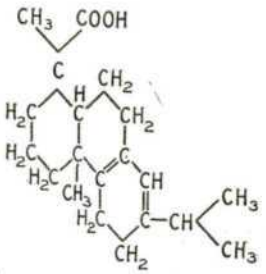
(*h*)

Some doubt exists not only as to the position of the conjugated double bonds, but whether such a conjugated system occurs at all.[20] A more recent suggestion is that of Fieser and Campbell[21] to the effect that the unsaturated bonds in abietic acid are located in separate rings as seen in (*j*).

According to these authors, the double bonds in *l*-pimaric acid are located in the same ring (*k*).



(*j*)



(*k*)

Approximately one tenth of gum rosin is unsaponifiable matter which is believed to be a diterpene derivative.[22] The same diterpene together with other hydrocarbons is also present in the unsaponifiable matter of wood rosin.

Physical and Chemical Properties

Rosin is a brittle resin that can be crushed easily by hand. When rolled between the fingers, the body temperature is sufficient to make it sticky. Various properties of rosin are detailed below.

Melting Point (Ball and Ring method)	72–86° C.
Specific gravity at 20° C.	1·089
Specific heat at 20–67° C.	0·453
Latent heat of vaporisation	105 B.T.U./lb. or 58·4 calories / g.
Heat of fusion	nil.
Vapour pressure at 198° C.	3·6 mm. Hg.
at 273° C.	37·6 mm. Hg.
Refractive index at t° C.	1·5496–0·00038t
Specific refraction at 25° C.	0·2935
Ash	0·01–0·06
Acid value	163–170
Sap. value	165–176
Unsaponifiable matter	5–10%

Crystallinity of Rosin

One of the chief defects associated with most rosins is their tendency to crystallise. This tendency appears to depend upon abietic acid content of the rosin. Gum rosin crystallises less readily than wood rosin unless it has been heated for a prolonged time. The abietic acid content of wood rosin is usually more than that of gum rosin and is further increased by heating it at 100–150° C.

Crystallisation can be prevented or retarded by the addition of alkalis,[23] fatty soaps,[24] or a small quantity of a synthetic resin.[25]

Deterioration of Rosin

Rosin, particularly when in a powdered form deteriorates rapidly on exposure to air. Oxidised rosin is insoluble in petroleum ether and can thus be readily detected. It has been stated[26] that exposure of rosin to air leads to the formation of unstable peroxides which are insoluble in aliphatic hydrocarbons.

CHEMICAL MODIFICATIONS OF ROSIN

Due to its high acidity, rosin is seldom used alone or without further processing. Most of the rosin-derivatives are obtained by neutralisation or esterification of the carboxyl group but more recently new modification have been obtained by reacting the unsaturated linkages.

Rosin Soaps

The earliest modifications of rosin were intended to increase its hardness and also to improve the tackiness of varnishes by reducing its acidity. The carboxyl group of rosin can readily be reacted with alkalis or metallic oxides to form soaps. The first modification was limed-rosin which may be considered as the first synthetic resin. Liming of rosin results in a hardened product depending upon the amount of lime used. In the case of wood rosin, slightly more lime is required than with gum rosin in order to obtain a product with the same melting point. Generally 5–6 per cent. hydrated lime (with low carbonate and magnesia content) is used; with larger quantities of lime, a neutral soap is obtained which is insoluble in drying oils and solvents.

According to Schantz,[27] the physical condition of abietic acid influences the reaction with lime. Crystalline abietic acid does not react with hydrated lime at 160° C. and even at 300° C. the reaction is slow and incomplete. Calcium acetate promotes and magnesia retards, the reaction. Lime is usually added at 200° C. and the temperature raised somewhat to complete the reaction. Liming can also be conducted in petroleum solutions of rosin. The temperature is kept at about 150° C. to facilitate removal of the water formed in the reaction.

Zinc oxide instead of lime may be used when zinc resinates are obtained. Considerable improvement has been made in their manufacture and their properties have been described.[28] During the war, zinc resinates have played an important part as substitutes for various resins in short supply. Zinc resinates are much less sensitive to water than calcium resinates.

Sodium-soap of rosin is soluble in water and is widely used as a paper-size. It is obtained by heating mixtures of rosin and sodium carbonate or sodium hydroxide solutions. In conjunction with soaps of fatty acids, the sodium soap of rosin finds considerable outlet in laundry and toilet soaps.

Lead, cobalt and manganese soaps of rosin, commonly known as metallic resinates are used as driers while mercury and copper soaps find an outlet in ship-bottom paints.

Rosin Esters

Rosin esters have received considerable attention, the glycerol ester, commonly known as "ester gum," being the most important ester.

The preparation of ester gum was described in 1886 by Schaal[29] and the expanding use of tung oil in the paint industry gave the product a merited impetus. The advantages of using ester gum instead of rosin in drying oil varnishes are mainly better durability and resistance to water and alkalis, and the possibility of pigmentation with basic pigments without livering.

Ester gum is obtained by reacting rosin with glycerol at 280–290° C. The quantity of glycerol used is 11–12 per cent. on the weight of rosin, i.e. about 30–33 per cent. more than the theoretically required weight.[30] It is not necessary to use an esterifying catalyst although aluminium,[31] zinc,[32] and succinic acid[33] have been suggested.

A harder resin than ester gum is obtained when polyglycerol is used.[34]

Rosin has also been esterified with mono-, di-, and triethylene glycol, the melting point of the ester decreasing with the increasing molecular weight of the glycol. These esters have high refractive index and are neutral, sticky, adhesive, non-hygroscopic and water insensitive. They are compatible with most film forming materials, and are miscible with both hydrophilic and hydrophobic colloids.

Other polyalcohols used for the esterification of rosin are pentaerythritol,[35] mannitol, sorbitol,[36] or their ethers.[37] Only three hydroxyl groups of mannitol or sorbitol react with rosin. The pentaerythritol esters have achieved considerable success during war years and their use in the paint and allied industries is now well-assured. Their outstanding features are hardness, ability to " dry " soft oils and stability when cooked in oils at high temperatures.

Many mono-alcohols have also been successfully employed for the esterification of rosin. The higher alcohols including cetyl, menthyl and bornyl alcohols give solid esters[38] while with lower alcohols, liquids are obtained which can be distilled under reduced pressure.

Vinyl chloride and sodium soap of rosin react to form vinyl abietate[39] which can be polymerised to polyvinyl abietate.[40]

Polymerised Rosin

Improved properties such as higher melting point, increased solubility and improved colour retention is obtained when rosin is polymerised. The polymerisation can be effected by treating a solution of rosin with boron triflouride[41] or sulphuric acid.[42] The acid value of the product is unaffected by polymerisation, but the degree of unsaturation is reduced and the melting point is considerably increased.

Oxidised Rosin

In the oxidation of rosin an unstable peroxide is first formed which helps to oxidise more abietic acid.[43] Rosin can be oxidised by blowing air or ozone through molten rosin. Metal resinates catalyse the reaction while phenols retard it. Oxidation changes the properties of rosin and darkens its colour. The acid value and saponification values are reduced and the product becomes more and more insoluble in petroleum ether with increasing degree of oxidation.

The oxidised rosins are dark reddish-brown in colour, have higher melting point and can be incorporated in tung oil. They

exhibit strong anti-oxidising properties so that when used with drying oils, a larger amount of drier must be employed. They are brittle but can be plasticised with castor oil. They are used as shellac-substitutes for air-drying insulating spirit-varnishes and have also found an outlet in petrol resisting lacquers,[44, 45] nitrocellulose lacquers, spirit varnish stains, spirit chassis blacks, asphalt emulsions, cement roads, etc.

Hydrogenated Rosin

The tendency of yellowing and discoloration of rosin which is associated with the presence of unsaturated linkages is reduced by hydrogenation. Hydrogenation is carried out by passing hydrogen under pressure at elevated temperatures in the presence of catalysts. Temperatures employed range from 125° C. to 250° C. the pressures may vary from 200 to 15,000 lbs. per sq. inch and the catalysts usually used are nickel[46] or copper chromite.[47] Hydrogenation can also be carried out at room temperature when palladium is used as a catalyst and has been recommended as an analytical method. Under these conditions, only one double bond is hydrogenated.[48] Hydrogenation at higher temperatures, for example at 450° C. leads to the removal of the carboxyl group[49] and formation of tetrahydronaphthalene.

Various grades of hydrogenated rosins are now available. An almost colourless grade is obtained by vacuum distillation.[50]

Esters of Hydrogenated, Oxidised and Polymerised Rosins

Like rosin, the modified rosins can also be esterified with various alcohols to yield corresponding esters. Methyl, glycol and glycerol esters of hydrogenated rosin have shown promise as softeners and tackifiers for rubber, as modifiers and transparentising agents for tracing papers, as plasticisers for ethyl cellulose and polyvinyl acetate chloride and as binders for wool, glass and cellulose fibrous insulation materials. Their use in asphalt laminating adhesives has also been suggested. These esters differ from rosin ester in being essentially non-oxidising. For example, when held under oxygen at 300 lbs. per sq. inch for 160 hours, less than 1 per cent. oxygen is absorbed.

Other Modifications of Rosin

Treatment of rosin with maleic anhydride[51] or maleic acid[52] results in a product having improved properties. It is believed that this involves the formation of an adduct by Diene synthesis. The adduct on esterification with glycerol or other polyhydric alcohols gives alkyd resins which have proved very useful in certain fields of application, particularly in cellulose lacquers, and in metal lacquers.

Products of high melting point and viscosity are obtained by reacting rosin with formaldehyde or hexamine at 120–150° C. and subsequent heating at 230° C. in an inert atmosphere.[53] The product does not inhibit the drying of linseed oil.

Another interesting product obtained from rosin is hydroabietyl alcohol which is obtained by the conversion of the carboxyl group (–COOH) to a primary alcohol group (CH$_2$OH). This alcohol, with its relatively high molecular weight, opens up the possibility of preparing a whole series of new esters and resins by reacting it with selected acids. The alcohol itself without further modification is a useful resin-plasticiser. Incorporation in adhesives based on casein or zein improves their tack, colour and stability. Milled compositions based on natural and synthetic rubber or ethyl cellulose or moulding compositions of ethyl cellulose or vinyls are said to be improved by the addition of this alcohol.

Rosin can also be halogenated in the presence of catalysts.[54] Chlorinated rosin has been suggested for a number of uses particularly as a soldering flux.

Rosin Oil

When rosin is distilled, rosin oil is obtained which is a mixture of rosin acids and hydrocarbons. The crude oil distilling up to 250° C. is known as *kidney oil*. On fractionating, a pale yellow to reddish-brown viscous liquid is obtained. It is used in printing inks, in greases and as a softener in milling of rubber. Rosin oil has excellent penetrating properties. On heating at temperatures above 250° C., rosin decomposes and undergoes partial decarboxylation.

USES OF ROSIN

Rosin is a versatile material and plays an important part in a number of industries. Its main outlet, is in the paint and varnish, the paper and the soap industries. Appreciable quantities are also used in adhesives and cements, plastics,

linoleum, printing inks, rubber, asphalt emulsions, belt dressings and sealing waxes. This list is only indicative and by no means exhausts the uses.

Rosin in Paints and Varnishes

Rosin probably enters more different types of finishes and compositions than any other raw material. Rosin retards gelation of wood oil and when properly cooked, varnishes having satisfactory durability and water-resistance are obtained. Varnishes produced with softer oils like linseed oil are not so satisfactory, the films are soft, easily affected by water and have poor durability.

The solubility of fossil resins is improved by the addition of rosin ; substantial quantities of rosin are used in conjunction with Manila and Pointanak resins in spirit varnishes.

Rosin exerts excellent solvent power on gelled oils and is used as a peptising agent for reclamation of wood oil gels. It is also used as a stabiliser for varnishes of poor stability and as a flux in solubilising difficulty soluble resins.

Large quantities of limed rosin are employed for gloss oils which are often used as media for quick-drying cheap paints.

Zinc resinate and zinc-lime resinates in conjunction with drying oils are well established as is the use of ester gums. Quite satisfactory varnishes are thereby obtained. Appreciable quantities of ester gum are also used in cellulose lacquers.

Substantial quantities of rosin are also used in the production of cobalt, lead and manganese resinates which are used as driers.

Use of Rosin in Soap

The sodium salt of rosin has excellent wetting and emulsifying properties and is an essential component of all kinds of soaps, particularly laundry soaps in which it is incorporated in appreciable proportions. Somewhat smaller quantities of sodium salt of rosin are incorporated in toilet soaps.

Rosin in Paper Industry

Sodium soap of rosin is employed as a size for paper. Usually an aqueous solution of the soap is employed although a dry rosin size is also available. The size is usually added to the beater and the resin acids are precipitated in the pulp by the

CHAPTER IX

COPALS: KAURI: DAMMARS

A CATEGORY of natural resins is known as copals though it is customary to classify them according to the place of origin or the port of shipment.

COPALS

Two definite groups of copals are recognised, the hard (fossil) group and the soft group. The former are generally known as African (Congo) Copals and the latter as East Indian and Manila Copals. The varnish makers value the hard variety which is used in conjunction with drying oils. The softer varieties (East Indian and Manila) are soluble in a number of solvents and are used mainly as spirit varnishes.

Source Production and Grades

Congo copal is mined out of the swamps of Belgian Congo and is an exudation from *Copaifera demeusii* and *Liquidamba styrflua*. The resin as first mined is very dirty and needs considerable cleaning which is done by hand scrapping and sand blasting. The cleaned resin is then graded according to its colour, transparency and size. Various grades available are designated as white, ivory, straw, pale, amber and sorts; the size grading is bold, nubs, chips and dust.

Chemistry of Copals

The work of A. Tschirch,[1] K. H. Bauer and K. Gonser,[2] L. Westenberg,[3] Ruzicka,[4] and J. Scheiber[5] should be referred to in connection with the chemistry and constitution of copal resins.

Recent work by L. Hellinckx and his co-workers has greatly advanced the chemical knowledge and technology of copals. The principal constituents of Congo Copal are congocopalic acid, $C_{36}H_{58}(CO_2H)_2$, m.p. 115–118° C. and congocopalolic acid, $C_{21}H_{32}OHCO_2H$, m.p. 108–110° C.

Running

Congo copal in its original form is insoluble in almost all the common organic solvents, although with some it may swell and form clear viscous gels. These gels have been found to be solution of the solvent in the resin. Secondary alcohols like isopropyl alcohol produce such gels. Solubility is imparted to the resin by either " running " or esterifying.

When copal is heated at high temperatures the resin decomposes, yielding a product that is soluble in drying oils and in a number of organic solvents such as aliphatic and aromatic hydrocarbons, butyl alcohol, butyl acetates, etc. This thermal treatment is called "gum running" and considerable skill is required to obtain the best results. While heating, the resin must be continuously stirred to avoid local overheating and charring. The resin melts with considerable frothing due to evolution of volatile material. The temperature is gradually raised to 330–360° C. and is maintained until the molten resin runs cleanly from the stirrer. Generally the whole process is completed in about two hours out of which the first 1½ hours is spent in gradually heating to the required temperature. Shallow vessels and careful control of temperature and time give the most uniform results.

Gum running when correctly performed results in an average loss of 25 per cent. by weight of the resin. Higher losses which make the process uneconomical are usually due to over-running.

Injection of super-heated steam during the running process has been suggested in order to obtain a very pale product.[6]

Empirical methods of running or cooking may give irregular results. The chemical changes involved in the running of copals have received considerable attention. Kroll[7, 8] has shown that the dicarboxylic acids of the resin on heating change into monobasic acids and finally into hydrocarbons. Ruzicka[9] states that dicarboxylic acids are insoluble in drying oils but become soluble on decarboxylation. A scientific study of the running of Congo copals has been carried out by Hellinckx at the Institute of Industrial Chemistry of the University of Louvain and the results have been published in a series of articles in the Paint Technology.[10] According to Hellinckx, three main reactions occur during the gum running: (1) decarboxylation, (2) cracking and (3) transformation of the hydroxy acid component involving evolution of carbon monoxide.

Attempts have been made to avoid the process of running. Methods, such as direct solution under pressure,[11, 12] or involving the use of intermediate solvents like carbon tetrachloride,[13] terpineol,[14] acidified amyl alcohol,[15] phenols, cresols or naphthalenes,[16] naphtha-naphthalene and copal oils,[17] vegetable oils and sulphur,[18] and phthalic acid[19] have been suggested. There is no doubt that such efforts have not been successful mainly because the chemical changes in the resin associated with the running and the polymerisation of the oil effected during cooking do not take place under such conditions.

Considerable attention has been given to mastication methods. According to W. Krumbhaar[20] when powdered hard copal is subjected to the mechanical action of hot rollers, the resultant resin becomes soluble in *cyclo*hexanol acetate, propyl, butyl and the other higher alcohols and in pine oil. Copals on prolonged mastication show reduced viscosity in solution. It has been mentioned in the introduction that this may be caused by the breakdown of primary bonds. However, it is also possible that in the case of resins, insolubility is due to large secondary bonds, e.g. dipoles, and if this is true, mastication process is likely to break them and impart solubility to the resin. Masticated copal is not directly soluble in drying oils but may be used in varnishes with phenolic resins.

Hard insoluble copals become soluble in alcohol when the finely powdered material is treated with oxygen.[21]

Modifications and Uses

Run copal is extensively used in a variety of varnishes and is the main stock-in-trade resin for the manufacture of hard gloss paints and enamels. Copal varnishes are used for metal finishes, as internal lacquers for food-cans, as gold-sizes and as rubbing varnishes. Their durability, although inferior to varnish based on alkyd or phenolic resins, is satisfactory for most purposes.

With nitrocellulose, run copal gives lacquers from which very hard films are obtained. These films can be sanded and have excellent resistance to water, friction and abrasion.

As in the case of rosin, copal esters have been prepared and used in varnishes. Apart from the improvements in durability and resistance to water and alkali, solubility in drying oils is obtained without previous running. It is advisable to " sweat " the resin before adding glycerol, otherwise the product may polymerise during the process.[22] According to several patents, copals can be esterified by passing superheated steam through the molten mass of the resin and glycerol.[6, 23]

A. Mann[24] states that copal esters may be heated with tung oil at 300° C. without decomposition. They are less sensitive to light than synthetic resins. The highly viscous solution produced can be diluted without loss of firmness or gloss of the film. They are stated to be superior to synthetic varnishes for outside work and make excellent boat varnishes.

The Congo esters like rosin esters can be combined with various synthetic resins including the alkyd and phenolic types. In fact, according to G. Dantho,[25, 26] esterification of Congo copal can be effected by heating a mixture of 100 parts of run copal and 20 parts of rosin-modified-phenol formaldehyde resin with 6 parts of glycerol at 295° C., whereby a complex resin with softening point 105° C. and an acid value less than 20 is obtained.

Copal esters of good solubility and compatibility are available in commercial quantities for use in cellulose lacquers for furniture and food containers.

Phenol esters of Congo copal have also been described mostly in patent literature.[27–29]

The use of copal dust in the manufacture of linoleum is mentioned by F. Fritz.[30] The properties and uses of hydrogenated copals[31] and copal oils[32] have also been investigated in detail.

KAURI

Though Kauri is generally looked upon as a copal resin, it deserves special mention owing to its importance as a varnish resin. The process of running and of combining with drying oil is easy, and the varnish has good elasticity and durability. According to E. Fonrobert[33] kauri varnish is superior to all other varnishes made from natural resins in regard to blooming in a humid atmosphere. Kauri can be used in nitrocellulose lacquer if the solvent mixture is carefully adjusted. The lower grades are used in the manufacture of linoleum.

In addition to agathic acid, $C_{20}H_{34}O_4$ and several monobasic acids, $C_{20}H_{16}O_2$, $C_{17}H_{34}O_2$ and $C_{12}H_{20}O_2$, kauri contains essential oils such as d-α-pinene, dipentene and probably fenchyl alcohol. The acid value is 58–64 and the iodine value 102–124. Unfortunately, the supply of good quality fossil kauri is nearly exhausted. Processes have been developed to extract with solvents the remains of the older trees. Such solvent extracted resin is soft but can be used in spirit varnishes and lacquers. It gives soft and slow drying oil varnishes. Solvent-extracted resin from Kauri dust and small pieces is, however, quite good in quality.

Ethylene glycol esters of Kauri are classed as high grade varnish resins. The glycol esters are easier to prepare than glycerol esters which have a tendency to gel during esterification. Drying oil varnishes can be made, using the monoglycerides of the drying oil fatty acids.

Kauri resin is used in papier mâché.[34] Kauri is also used in gold sizes, hard rubbing furniture varnishes, japans, cements and oil cloth. It is also used as a substitute for amber in the jewellery trade. Recent information on Kauri is to be found in the publication *New Zealand Science and Technology*.

DAMMARS

Dammars are a group of resins originating in East Indies, Malaya and Siam. They are obtained from trees of various botanical species and are usually marketed in the form of yellow lumps or granules. Batavian dammar, which comes from Sumatra, Borneo and Java, is generally considered to be the best.

Chemical Composition

According to Dieterich,[35] dammar consists of 40 per cent. α-dammar resene $C_{11}H_{17}O$, 22·5 per cent. β-dammar resene, and 23 per cent. dammarolic acid $C_{54}H_{77}O_3(CO_2H)_2$, the remainder being moisture, some inorganic matter and impurities.

Properties

Dammars are soft resins but can be crumbled easily to a white powder. The Batavian varieties soften at 70–76° C.

and melt at 155–170° C. Their acid value lies between 30–35, saponification value between 33–40 and iodine value between 80–120. These characteristics indicate that there is still considerable scope for purification and standardisation to get a more uniform material.

The properties of dammar are intermediate between the hard Congo copals and the soft alcohol-soluble Manilas. Dammar disperses readily in drying oils on heating and does not require to be " run " like the Congo copals. It is soluble in aliphatic and aromatic hydrocarbon solvents, turpentine, chloroform, carbon bisulphide and in the common ester solvents such as ethyl or butyl acetate. It is insoluble or only partially soluble in alcohols, acetone and ether.

Solutions of dammar particularly those in aliphatic hydrocarbons have a tendency to become cloudy, and to deposit insoluble matter which is known as " wax ". Addition of aromatic hydrocarbons such as benzol or toluol is found to clarify the turbid solutions. Incorporation of rosin, Venice turpentine and alcohol in the turbid solution has also a similar effect.[36] The tendency to cloudiness can be prevented by heat-treatment of the resin but in that case darker varnishes are obtained.

Dewaxing

For use in cellulose lacquers, which is by far the largest outlet for dammar, it must be clarified, as the wax is incompatible with lacquer solvents. Clarification or " dewaxing " as it is more commonly known is carried out by dissolving dammar in a suitable solvent such as toluol or ethyl acetate and precipitating the wax by the addition of a non-solvent such as methyl or ethyl alcohols or a mixture of the two. Dewaxed dammar may if desired be recovered by evaporation of the clear filtrate but usually the dewaxing is carried out by the cellulose-lacquer manufacturers who use the clear dewaxed solution.

Uses

The principal uses of dammar are in cellulose lacquer varnishes, inks and wax compositions. Solutions of dammar give soft and even tacky films and the durability is poor. Dammar is therefore rarely used for outdoor work.

In nitrocellulose lacquers, however, dammar imparts adhesion, hardness, durability and water resistance to the films[37] and is claimed to be superior to all other resins except alkyds in this respect.[38]

Dammar-oil varnishes are almost water-white and are extensively used as overprint varnishes for printing over inked surfaces or over non-absorbent paper. Most maps get a coating of these varnishes. Their films do not yellow but on the contrary are bleached on exposure to sunlight.[39]

Incorporation of a small quantity of dammar in stoving alkyds is stated to improve hardness, gloss and colour retention of the baked films. Dammar has also been suggested as a bodying agent for alkyds[40] for which purpose it need not be dewaxed.

Uses of Dammar Wax

Dammar wax consists mostly of β-resene and is soluble in a wide range of hydrocarbon solvents. It dissolves readily in drying oil when heated with it at about 300° C. The varnish obtained by heating one part of wax and three of linseed oil for 45 minutes at 300° C. has a viscosity similar to that of a heavy lithographic varnish. Dammar wax may be used for building false body and as a matting-agent since addition of even a small amount to varnish media increases their viscosity and decreases appreciably the gloss of their films.

Modifications of Dammar

Trillich[41] claims that dammar esterifies easily with glycerol and the product gives harder films. Dammar, on reduction, gives an alcohol[42] which has interesting possibilities and may be used, after dissolving in suitable solvents, as picture-varnish.

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