CURRENT SCIENCE—50 YEARS AGO

The London Shellac Research Bureau

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SINCE 1929 the Indian Lac Cess Committee has maintained in London a Special Lac Inquiry Officer to provide the necessary liaison between lac producing interests in India and lac consumers in England, Europe and America. In this way a large amount of technical information, including a comprehensive bibliography, has been collected, and a number of the problems confronting consumers of lac have been examined in the light of modern conditions. It soon became apparent that the study of problems arising out of the application of lac could be best carried out near to the centres of consumption and that a research laboratory located in London would be able to provide that necessary service which consumers to-day expect. Consequently in 1933, the Indian Lac Cess Committee founded the London Shellac Research Bureau under the chairmanship of the High Commissioner with an Advisory Committee, the Special Officer, Lac Inquiry and three Indian scientists, two of whom were chemists and one a physicist.

In the past three years the activities of the Bureau have been manifold. Some description of the work done will be found in the *Annual Reports* of the Special Officer (Mr. A. J. Gibson) but the present writer is mainly concerned with indicating and commenting upon some of the research work carried out by the staff. After a short time together at the Paint Research Station, Teddington, one of the chemists (Dr A. Karim) was posted to Mr. Bayley Parker at the Research Laboratories of the British Thomson-Houston Co., at Rugby, and his work has been mainly concerned with the development of a buying specification for lac products in the electrical industries, to be approved by the International Electrotechnical Commission Advisory Committee No. 15, of which the Special Officer, Lac Inquiry, is Chairman. This has involved a mass of research and analyses by standardised methods, work which is approaching completion. Dr Karim has also compiled a monograph of general interest discussing the various problems of lac chemistry.

The other chemist (Dr R. Bhattacharya) and the physicist (the writer) remained at the Paint Research Station and have worked in close collaboration with each other at this Station, Teddington, of which Dr Jordan is the Director.

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In dealing with any material, the first question and one of fundamental importance is "constitution," a thorough knowledge of which is absolutely necessary before any *systematic* study can be made leading to modifications showing improved and desirable properties. Some years ago Dr Werner Nagel and his colleagues isolated and identified in lac two major acids—aleuritic and shellolic, although the correct formula for the latter is still uncertain. Dr Bhattacharya's work in this direction has revealed that the former can be easily isolated and purified, whereas the latter being very sensitive to the usual chemical reagents is difficult to obtain in a pure state. There are indications that this acid lactonises readily and indeed it has been found to exist in more than one isomeric form. He has, however, worked out a simple method to isolate and purify shellolic acid, which depends on the relative solubilities of the lead salts of the lac acids in water. From the study of these comparatively pure materials it is evident that the iodine value of lac resin must be attributed to some component other than shellolic acid and not yet identified. This work and other related investigations have led to the derivation of a tentative monomeric formula for the major resinous constituent of lac—pure lac resin, which agrees with most of its known experimental constants.

It has been known for a long time that shellac resin contains a hard and a soft component, the latter being ether-soluble. The work of Tschirch and Schaeffer, Harries and Nagel and others has, in a general way, indicated that the harder ether-insoluble component is chiefly responsible for the excellent properties of shellac. Our recent work has substantiated this view, and the various means of isolating this hard com-

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ponent, which constitutes about 75 to 80 % of lac, have been investigated: of the methods available it has been found that a direct solvent extraction process is not only practicable and advantageous in several respects but is also likely to be a commercial possibility. A semi-industrial scale pilot plant was constructed last year and the experience gained has brought the process to a stage where it can well be taken up by an industrial organisation.

The properties of this material, which has been named "Hard Lac Resin" in preference to the term "Reinharz," have been investigated in great detail and it has been found to be superior to the parent lac in almost all respects. For example it is higher melting, is much more water-resistant, much quicker heat-hardening, possesses a higher degree of adhesive properties, yields harder and more flexible films, whilst the solvent retention of its films is negligibly small. In one respect, colour, it is inferior to whole lac; it can, however, be decolorised to a considerably greater extent than lac by means of a little oxalic acid or the like. It can also be bleached like ordinary lac, although this process has not yet been fully investigated. Furthermore, as it does not react with copper, no green discoloration is produced as is the case with lac under certain conditions. Other properties which make this material highly suitable for electrical insulation work are its higher breakdown voltage and its capacity to withstand high temperatures for prolonged periods of heating.

A general survey of the known physical properties of lac has indicated the need for a more detailed and systematic examination of most of them, especially those properties that are immediately important from the point of view of industrial application of lac. Investigations in this direction have yielded extremely interesting results of technical as well as theoretical importance. The following subjects have thus far reached the first stage of publication:—

(1) DARKENING OF LAC SOLUTIONS AND THE EFFECT OF OXALIC ACID THEREON

It is well known that lac solutions stored in tinned iron containers have a tendency to discolour with time and it is also well known that a small proportion of oxalic acid added to the solution has an inhibiting effect on this process. So far, no satisfactory explanation has been known for this phenomenon, nor has it been possible to determine the necessary amount of acid required to produce the effect. Our studies have revealed that on addition of acid to lac solutions the electrical conductivity of the latter decreases at first, passes through a minimum and then slowly rises. By a complicated series of conductivity measurements it has been shown that the minimum conductivity point, which varies from sample to sample between concentrations of about 0.025 and 0.25 % of acid on lac, is definitely related to the anti-corrosive action of oxalic acid. The mechanism appears to be that the addition of acid precipitates the inorganic impurities in shellac as oxalates, which causes a depression in conductivity. A slight excess of acid over and above the minimum conductivity point helps to establish an equilibrium between the corroding iron surface, oxalic acid and iron oxalate, which is formed in preference to iron-shellac salts. Such an equilibrium prevents the weaker shellac acids from reacting with iron and thus preventing the darkening of the solution. This mechanism seems to explain the known facts for example of conductivity, but the necessity for further work in this direction still exists. It may also be mentioned that the amount of oxalic acid required to give the minimum conductivity to shellac solutions is also the amount necessary to cause the maximum possible decoloration of the solution, so that either electrometric or colorimetric methods can be used to determine the necessary amount of acid for the purpose of inhibiting the darkening of solutions in tinned iron containers.

(2) PLASTICISING OF LAC FILMS

The problem of finding a suitable plasticiser and that of comparing various available plasticisers for lac films has been a subject of controversy for some time. A preliminary study of the literature at once indicated that the chief reason for this controversy had been the lack of a systematic study. A comprehensive plan was drawn up, therefore, to study ten well-known and commonly employed plasticisers. The underlying idea of the scheme was to investigate all the properties dependent on plasticising action and to compare the results with the control as well as among themselves. The properties of the film so far studied are:—

1. Tensile strength.
2. Extensibility.
3. Adhesion to metal surfaces.
4. Water-sensitivity including blushing and amount of water absorbed by
   (a) detached films,
   (b) films on metal supports.
5. Effect of baking on these properties. Other properties that may be included in the scheme are:—

6. Permeability to water and water vapour.
7. Durability under alternative exposure to dry and moist atmospheres.
8. Durability under normal as well as artificial weathering.

A good plasticiser should prove satisfactory in all these respects. So far, it has been found that among those tested sextol phthalate is the most satisfactory all-round plasticiser for lac.

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It has been found that lac can be dispersed in water by the aid of sulphurous acid and alkaline bisulphites. Sulphurous acid dispersions yield water-proof films in which lac appears to be in the "B" stage of polymerisation, while bisulphite-dispersions may be made water-proof by pigmentation to form distempers. In both cases, a reaction appears to take place between the dispersing agent and the hard lac resin component. Large-scale experiments are in progress to test the utility of distempers thus prepared.

Since no other natural or synthetic resin reacts in this manner with sulphurous acid, it appears that the sulphitation process may be successfully developed as an identification test for lac.

The difficulties of dispersing lac in drying oils have long been known but they have been overcome by an ingenious process developed by Dr. Bhattacharya. Lac, bleached lac and even polymerised lac have been found to be easily soluble in fatty acids at moderate temperatures. Such solutions esterified with glycerol yield low acid value and normally drying oil-lac varnishes, which may be pigmented and tinted to give normal oil paints. One most important feature of lac-oil varnish is that it can be combined with cellulose lacquers in any proportion. Thus it is possible to combine in one vehicle the properties of cellulose (high gloss, quick drying, etc.) of lac (hardness, good adhesion, etc.), and of oils (flexibility, weathering, etc). Paints made from such combinations have been found to be highly satisfactory.

The completely esterified product of lac and fatty acids yields a product which, when neutralised with aqueous ammonia, provides a basis for emulsion paints and varnishes. Such emulsions have been used as binding media with various materials to prepare special surfaces.

In conclusion, it may be added that the work of the London Shellac Research Bureau has only just begun and judging from the present state of developments it is not unreasonable to conclude that the future holds unknown and great possibilities. The programme of researches in hand is very comprehensive and with the co-operation of the Indian Lac Research Institute and the United States Shellac Research Bureau, effected through the office of the Special Officer, Lac Inquiry, considerable progress may be expected in the near future.

NEWS

NEW MINERAL DETECTORS

A new method based on laser radiation, developed by scientists of the Moscow Institute of Physical Engineering, will be useful for specifying the exact age of archaeological finds, detecting mineral deposits and resolving some astrophysical problems.

A laser beam helps adjust the sensitivity of dielectric detectors, special devices designed for visual observation over charged atoms emanated by any substance, including deposits. All previous detectors had a serious drawback. The plate of a dielectric material used to accumulate information about all particles let through it. In the new device, a laser beam, depending on its energy, weakens or erases completely this information. This ensures a long service life of the devices. The list of jobs performed by the new detectors is rather long. They can be used in nuclear physics, radiobiology, radiography, radiation control, isotope analysis and mineral prospecting. The study of tracks in meteorites and moon rock samples helps resolve the problems of astrophysics and physics of space particles. (*Soviet features*, Vol. XXV, No. 92, June 17, 1986 Information Department, USSR Embassy in India, P.B. 241, 25 Barakhamba Road, New Delhi 110001).