Use of shellac in rubber industry*

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ABSTRACT

SHELLAC can be a very useful additive for rubber compositions because of the presence of three ingredients in it which are usually compounded into rubber, these being resin, wax and antioxidant (dye). The resin part of shellac is of low molecular weight and acts as a processing aid or plasticizer which helps in compounding of various ingredients such as fillers into rubber. Wax also acts as a plasticizer and it is believed that it migrates to the surface of the rubber compositions forming a protective film and helps checking ageing. The dyes present in lac are derivatives of authraquinone and these are well known antioxidants. No other resin being used in rubber compounding has these three useful ingredients in it.

The improvement in the properties of natural rubber on compounding shellac are not so notable as in case of synthetic rubbers such as styrene-butadiene and nitrile. The properties improved in their case include plasticity, modulus, tensile strength, tear resistance, hardness and ageing characteristics. Modified lacs behave even better than straight shellac in this respect. As rubber is a vast and fast developing industry, there are tremendous possibilities of increasing utilization of shellac in this industry.

IN THE present century. there has been a remarkable development in the science and technology of high polymers. Rubber industry is developing very fast and attempts have been made to incorporate synthetic and natural resins into rubbers to get suitable compounds having properties of both plastic and rubber.

Shellac[1] has been known to be the most versatile of all resins, natural or synthetic[2]. Despite the phenomenal rise in the number and type of synthetic resins, it is doubtful whether there is even today any single resin which is as versatile as shellac. Coming to the use of shellac in rubber compounds, the practice appears to be quite old and can be traced back to as early as 1844[3]. Thereafter for a century, a number of patents[3–27] were taken out and many claims[28–31]* made regarding advantages arising from the use of shellac in rubber.

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After 1945 or so, however, interest on the use of shellac appears to have declined, probably because many synthetic resins started appearing. It is the object of this paper to revive the interest lost in the use of shellac as a compounding ingredient of rubber compositions.

A study of the chemical constitution of shellac reveals that it has much to offer, as apart from the resin proper, it has two other ingredients which are as well usually put in a rubber compound; these being wax and antioxidant (water-insoluble lac dye).

The resin part of shellac will function as a processing aid during compounding, yet will enhance the stiffness of the cured product. After curing very little of shellac can be extracted with a solvent. It thus appears that it goes into chemical combination (or undergoes some chemical changes) and is superior to conventional plasticizers which are extractable.

Wax is present in shellac to the extent of 4·0—5.5 percent. It will act as a processing aid and after curing will migrate to the surface and help checking ageing. The dyes present in shellac are derivatives of anthraquinone and such compounds are well known antioxidants. Perhaps none of the resins being used in rubber compounding has all these three ingredients in it.

The various ways in which shellac can be used with rubber fall under the following heads :

DRY MIXING

With natural rubber

There are many patents about the use of shellac in natural rubber but it was Scott[31] who during 1936-39, made a systematic study of the subject. He found that shellac can be readily incorporated into raw natural rubber by the normal process of mixing. The advantages resulting due to the use of shellac were found to be :

i) Shellac acts as a plasticizer and helps in the incorporation of various compounding ingredients such as fillers.

ii) It exerts a useful anti-scorching effect.

iii) It brings about a remarkable hardening in rubber compounds even when used in small quantities.

iv) Improvement in flex cracking resistance and ageing are noticed and

v) Resilience is maintained.

It was further found that shellac can be used along with alkali reclaimed rubber just as well as with new rubber and acidic accelerators give better results than basic ones.

A short-coming noticed was that abrasion resistance was found to have been somewhat impaired but the effect was much less when clay was the filler. The use of shellac in such articles as flooring, hot water bottles, tyre side walls and soles was recommended. We have also worked in this institute with natural rubber and substantiated the findings of Scott. Also, we have found that generally modified lacs behave better than straight shellac possibly due to their reduced acidity.

With synthetic rubber

With styrene-butadiene rubber

Saxena and Banerjee[33] have recently made an extensive study of the effect of incorporation of shellac and shellac ester in oil extended and non-extended SBR. They have found that shellac and its ester improve the plasticity, modulus, hardness, tensile strength, tear resistance and ageing of SBR gum stock without impairing the rubberiness; shellac ester behaving more favourably than straight shellac. In the filled stock also, the technological properties are generally effected favourably depending of course on the nature and quantity of the filler and the amount of shellac incorporated.

We have worked in this institute with epoxy resin and ethylene glycol modified[34–35] lacs and rosin lac ester. It has been found that the modified lacs enhance modulus, tensile strength, tear resistance and hardness of SBR gum stock more than straight shellac. The study has been extended to filled stocks as well and the two improvements, i.e. in plasticity and hardness, have been noticed in all the cases. The behaviour of shellac or modified lacs in lowering Mooney plasticity is thus in distinct contrast to a conventional filler composition where increased hardness would involve increased Mooney value.

With nitrile rubber

As early as in 1944, a patent[27] was taken out by Goodrich and Co. in U.S.A. to the effect that shellac is an excellent softener for nitrile rubber and its incorporation improves tackiness, workability, moulding characteristics and other physical properties of this rubber. Recently, Jose and Banerjee[36] have made an exhaustive study of the subject and confirmed the earlier findings.

They have found that besides improving the physical properties like modulus, tensile strength, tear resistance and hardness, shellac also improves the oil resistance capacity of nitrile rubber to a good extent and the optimum concentration of shellac for the best physical properties is 20 to 30 phr. At present, nitrile rubber being used in the country is imported. If shellac is used along with it in the concentration worked out, it will result in saving of considerable foreign-exchange.

Incorporation with natural or synthetic latices

As a reinforcing filler

An ammoniacal solution of lac mixes well with ammoniated natural rubber latex. It will be a good idea to co-precipitate the two together and study the reinforcement brought about by shellac. A chemical combination or grafting of lac to the natural rubber latex on the lines of Heveaplus M. G.,[37] in which methyl methacrylate is grafted to latex can also be attempted.

A recent patent[38] described the co-polymerization of lac styrene and butadine in presence of a free radical catalyst to give latex which gives films with enhanced tensile strength.

Coagulant for latex

Shellac is acidic in nature and as such will bring about coagulation of latex if it is added in the form of a dispersion or alcoholic solution. In fact there is a claim[32] that if it is used for the purpose in the manufacture of dipped latex articles improvement in certain properties of the product obtained is noticed.

In surface coating

There are a number of patents which describe the use of shellac with latex for coating such articles as cigar tips,[12] fabric gloves[17] as bonding agent for metals,[24] for preservation of foodstuffs[23] and preparation of moisture-proof paper.[16] Shellac improves adhesion, hardness and water-resistance of the resulting composition and makes them non-tacky.

We thus see that there are a number of ways in which shellac can be used with rubbers. A molecule of shellac has been shown to contain one carboxyl, five hydroxyl and one carbonyl group together with unsaturation.[1] Such a molecule is capable of being modified to give a host of product, *viz.*, esters, ethers, metallic salts, hydrolysed lac, epoxidised lac, etc., and the incorporation of these into rubbers will give different set of properties.

We have made a small beginning in this institute in this direction but perhaps much more concentrated effort is required to explore the very vast and ever increasing field of elastomers so that shellac may find a position of prestige in the rubber industry.

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