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# NR LATEX APPLICATIONS AND DEVELOPMENTS

By

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One result of the rapid advances in polymer technology in recent years is that the number of competitive materials which the manufacturer can use instead of NR latex, if he wishes, is continually increasing. Depending on the application, competitive materials can be styrene-butadiene latices of various types, nitrile or neoprene latex, polyacrylate emulsions, urethane polymers, synthetically produced polyisoprene latices and several others. The biggest competitors to NR latex over the last decade have been SBR type latices. Table 1 shows the consumption of these latices and NR latex in the USA, the United Kingdom, and world-wide since 1958.

TABLE 1

CONSUMPTION OF NR AND SBR TYPE LATICES

(IN THOUSANDS OF METRIC TONS, DRY RUBBER WEIGHT)

| | USA | | UK ‡ | | World |
|---|---|---|---|---|---|
| | NR | SBR | NR | SBR | NR |
| 1958 | 71 | 61 | 30 | ? | 177 |
| 1960 | 51 | 88 | 26 | 7 | 170 |
| 1962 | 43 | 103 | 23 | 8 | 172 |
| 1964 | 49 | 112 | 26 | 13 | 186 |
| 1966 | 49 | 122 | 27 | 28 | 205 |
| 1968 | 59 | 137 | 29 | 36 | 237 |
| 1969 * | 52 | 134 | 26 | 43 | 236 |

‡ Including neoprene and nitrile types

* Estimated.

In the USA, the drop in NR consumption and the increase in SBR usage between 1958 and 1962 was largely due to the advent of high solids SBR latices of approximately 60% total solids which could partly replace NR latex in some of its major applications, such as latex foam. A similar explanation accounts for the increase in SBR latex consumption in the UK during the period 1964 — 1969.

Since 1962 the consumption of NR latex in the USA has increased only slightly and the rate of increase in SBR latex usage has slowed down due mainly to competition from other synthetics such as the polyurethanes. The figures for world consumption of NR latex are more encouraging and show a 37% increase over the seven years since 1962.

In the competition between NR and synthetics, technical advances play a highly important role and the remainder of this paper is concerned with some of the advances in the NR latex field.

## *High DRC latices*

The production of NR centrifuged concentrates with a substantially higher DRC than 60% has been carried out in Liberia for a few years now, and at the Rubber Planters' Conference in Malaysia in 1969 Gorton & Pillai (1969) presented some of the work of the Rubber Research Institute of Malaya on this subject.

Two methods of concentration were described by Gorton & Pillai. In the first, field latex was passed through the centrifuge at a fast rate to give a concentrate of just over 50% DRC. This partial concentrate was then diluted with water and re-centrifuged with different centrifuge settings to give a concentrate of at least 66% DRC. In the second method the field latex was creamed with ammonium alginate for 18 hours to give a concentrate of 50% DRC. This was diluted with water and centrifuged with suitable feed tube and skim screw settings, which again enabled a concentrate of at least 66% DRC to be obtained. Both these methods, as they stand, involve increased production costs but work is being continued to make them more economical. One of the main advantages of an extra high DRC concentrate in many latex applications is the higher productivity which should be obtainable as a result of a reduction in the time required to dry the product. Shorter vulcanization times might also be possible in many cases for the reason that vulcanization cannot, in effect, be carried out at higher temperatures than 100°C, while the product is still wet. This effect of faster processing and higher productivity is emphasized because of its potential importance in more than off-setting small increases in raw material costs.

A well known feature of natural latex is its wide versatility, but there are five major outlets which, between them, account for roughly 90% of all natural latex used. These five outlets are in the adhesives industry, the carpet backing industry and in the production of dipped goods, latex thread and moulded foam.

## *Moulded foam*

Until recently the latex moulded foam industry was by far the largest user of natural latex. It is still a big user, world-wide, but in many of the highly industrialized countries there has been increasing competition from SBR and polyurethane. The major markets for moulded latex foam are in the automobile and furniture industries, as cushioning materials. In practice, SBR is very commonly used in blends with NR, and for price reasons there has been a tendency to use as much SBR in the blend as possible. Now one of the characteristics of latex foam is that the shrinkage of the foam on drying depends on the proportion of NR to SBR latex which is used. High proportions of NR give high shrinkage, high proportions of SBR give appreciably lower shrinkage. The result is that foam manufacturers using compounds with a high SBR content may find it difficult to increase the proportion of NR in their compounds, when the price of NR latex falls, without producing unacceptable changes in the dimensions of the finished article. However, it has very recently been shown at the RRI of Malaya that the shrinkage of foam containing high proportions of NR can be appreciably reduced so as to bring it much closer to SBR in this respect (Gorton, 1969). One of the most effective ways of doing this is to use a NR latex of extra high DRC of the type referred to above.

### *Dipped goods and thread*

Both latex thread and most dipped goods must have, as a prime requirement, high extensibility combined with high tensile strength and elastic recovery. These are some of the properties in which natural latex excels, which accounts for its increasing usage in these fields. Also important is the fact that in recent years improved formulations based on NR latex have been developed. For example, it has been shown that the stabilizing agent, potassium caprylate, is very effective in increasing the stability of latex thread compounds and dipping compounds, thereby reducing variability in processing behaviour. Another development makes use of thiourea to accelerate the rate of vulcanization of latex compounds by organic disulphides such as TMTD. It has been known for a long time that TMTD vulcanizates show excellent heat-ageing resistance but in order to make practical use of this fact in dipping or other latex processes it was necessary to find some means of speeding up the *rate* of vulcanization by TMTD at temperatures in the region of 100° C. Philpott (1969) at NRPRA showed that this could be done by the addition of small amounts of thiourea to the latex compound. This development is particularly relevant of course in cases where very good heat-ageing resistance is required as for example, in the production of sterilizable surgeon's gloves.

### *Adhesives applications*

In this field latex compounds are often in competition with solvent-based adhesives of various types. Generally speaking, latex compounds tend to be used for bonding materials such a textiles, leather and fibres whose surfaces are readily wetted by latex adhesives. Within this area NR meets with strong competition from SBR, carboxylated SBR, polyvinyl acetate, polyacrylates and neoprene. Sometimes NR latex adhesives are compounded so as to be vulcanizable but very often they are not; this simplifies both compounding and processing, and for some applications one does not require the higher strength and resilience in the bond which vulcanization would give. The properties required of a latex adhesive depend to a large extent on the application, but there are some properties which are almost invariably required and one of these is adequate resistance to ageing. The work done in recent years on the ageing of unvulcanized latex rubber is therefore particularly relevant and Fig. 1 illustrates some of the results obtained by Philpott (1969).

Fig. 1 shows that a conventional antioxidant such as dinonyldiphenylamine (DNDP), does not give much protection against heat-ageing, but that a combination of thiourea with the antioxidant gives very good protection. Likewise, a combination of the antioxidant with ethylene diamine tetra-acetic acid (EDTA) and diammonium hydrogen phosphate gives good protection. Later work has shown that a mixture of thiourea with the antioxidant phenylcyclohexyl-p-phenylene diamine is particularly effective. These findings are now being put to practical use in a number of latex adhesive compounds.

Another latex application which is essentially an adhesives application is the production of rubberized hair as an alternative cushioning material to foam. In this process, loosely orientated hog hair or coir fibres are sprayed with a vulcanizable latex compound and then dried and cured. In the finished product, high resilience and fatigue resistance are very important and for these reasons natural latex compounds are mainly used. A substantial quantity of rubberized hair is produced for the upholstering of cars.

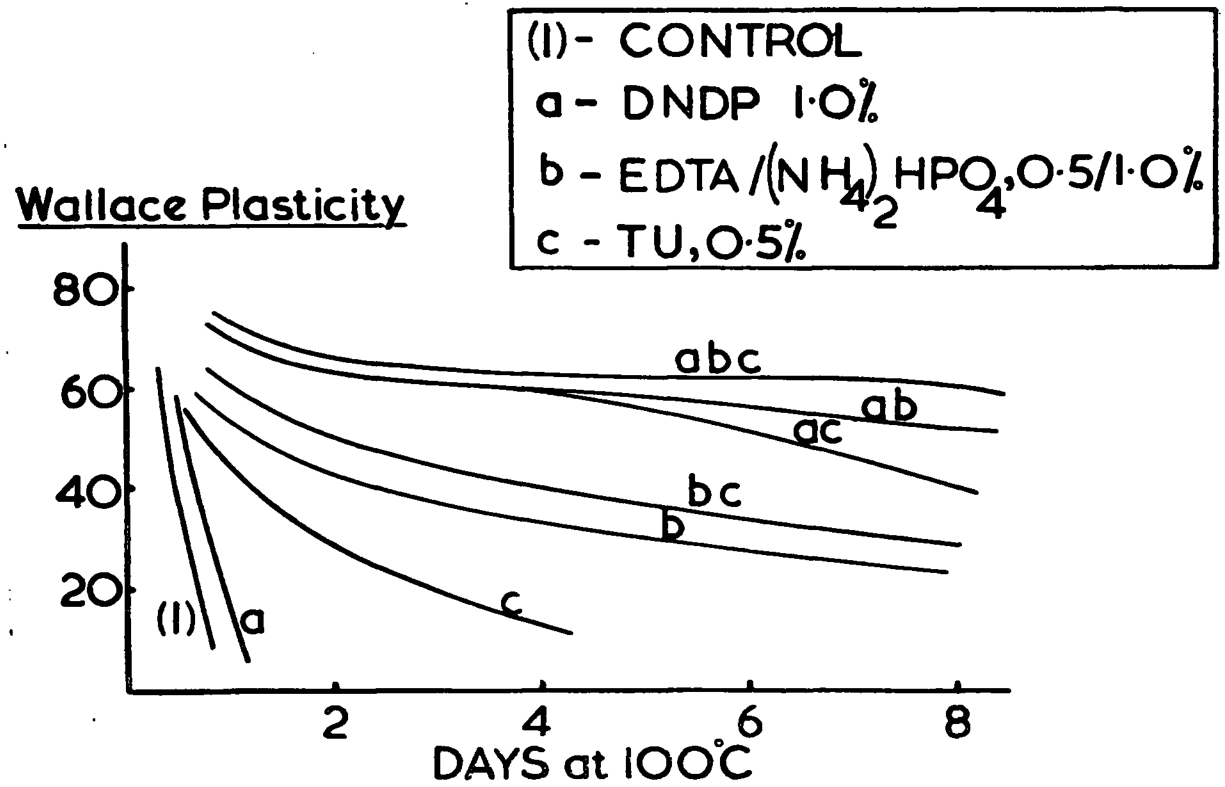

Fig. 1. Partially purified NR latex films—effect of additives on the rate of degradation

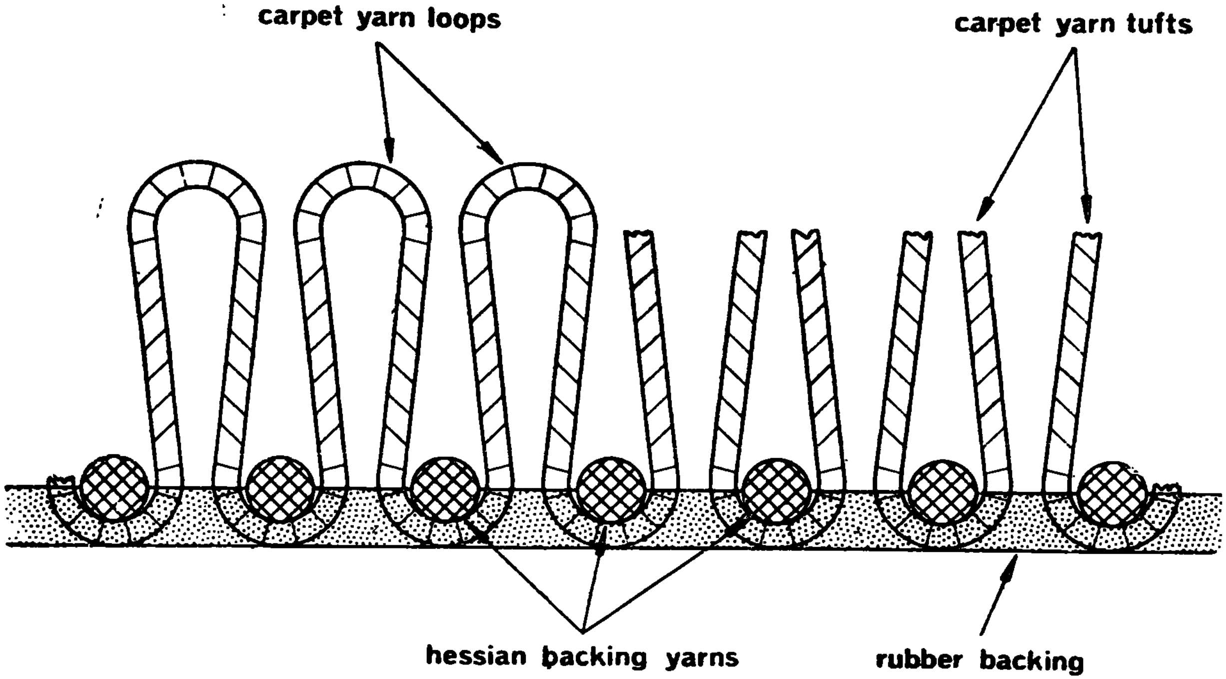

Fig. 2. Diagrammatic representation of a latex backed tufted carpet

### *Carpet backings*

Of the five major applications referred to previously, backings for tufted carpets is one of the most important, and one which is growing most rapidly. It is also an application in which competition from synthetics is very severe. The basic reason for this is partly the price factor and partly the fact that carpet backing compounds do not need to have exceptionally good elastomeric properties in order to meet the specifications required by the carpet industry. This is shown by the high levels of cheap fillers (90 % to about 400 % on the weight of rubber) which are normally included in carpet backing compounds. The growth of the tufted carpet industry is a phenomenon of the last 15 years and in America today it is estimated that about 90 % of all carpets made are of the tufted type. In a tufted carpet the pile yarn is simply threaded through the holes in a length of hessian or polypropylene and some type of latex backing is then applied so as to bond the pile yarn to the hessian. The backing also gives dimensional stabiltiy and the necessary degree of stiffness to the carpet. A diagrammatic representation of a tufted carpet is shown in Fig. 2.

The simplest type of backing put on carpets of this type is one in which a highly loaded latex compound is spread on to the back of the carpet and then dried, and if necessary vulcanized. The most popular type of latex for these "primary" backings is carboxylated SBR. Its main merits are that it is very simple to compound — all that is required is the addition of a filler such as whiting and a thickener to the latex — and secondly, that it can be processed rapidly; in particular it requires no vulcanization. At NRPRA compounds with similar merits based on NR have been developed, and carpet manufacturers' reports on them have been very encouraging.

However, there has been an increasing demand during the last few years for higher quality backings, and these demands have been met by latex foam backings which give a much more luxurious "feel" to the carpet. The two most important types of foam backing are the high density flat foam backings (no surface pattern) which are particularly popular in America and the embossed foam backings which are popular in Europe.

To produce embossed foam backings, NR latex or a blend containing a high proportion of NR is usually employed. The main reason is that the wet foam must have very good gel strength in order to get a sharply defined embossing pattern on the surface, and NR latex is outstandingly good in respect of wet gel strength. However, to produce good flat foam backings high wet gel strength is not so important and most backings of this type are made from SBR latex or blends of SBR with NR. Developments are taking place rapidly over the carpet backing field as a whole, but the ones discussed below are particularly relevant to NR foam backings.

The first concerns speed of processing which, quite apart from raw materials costs, is an important overall costs factor. One of the relatively slow steps in foam backing, as in many other latex processes, is the vulcanization process, and new ways of speeding up the sulphur vulcanization of latex compounds have been studied at NRPRA. It has been shown that a simple way of doing this is to pre-treat the sulphur dispersion with a cheap water-soluble amine such as diethanolamine (Cockbain, *et al.*, 1970). An illustration of this effect in the case of a latex film is shown in Fig. 3 in which increase in modulus is taken as a measure of rate of cure. Essentially the same results are obtained if the swelling index of the vulcanizate in benzene is taken as a measure of rate of cure.

A similar effect is obtained with foam compounds, and this has been confirmed by carpet manufacturers in production runs of foam-backed carpets.

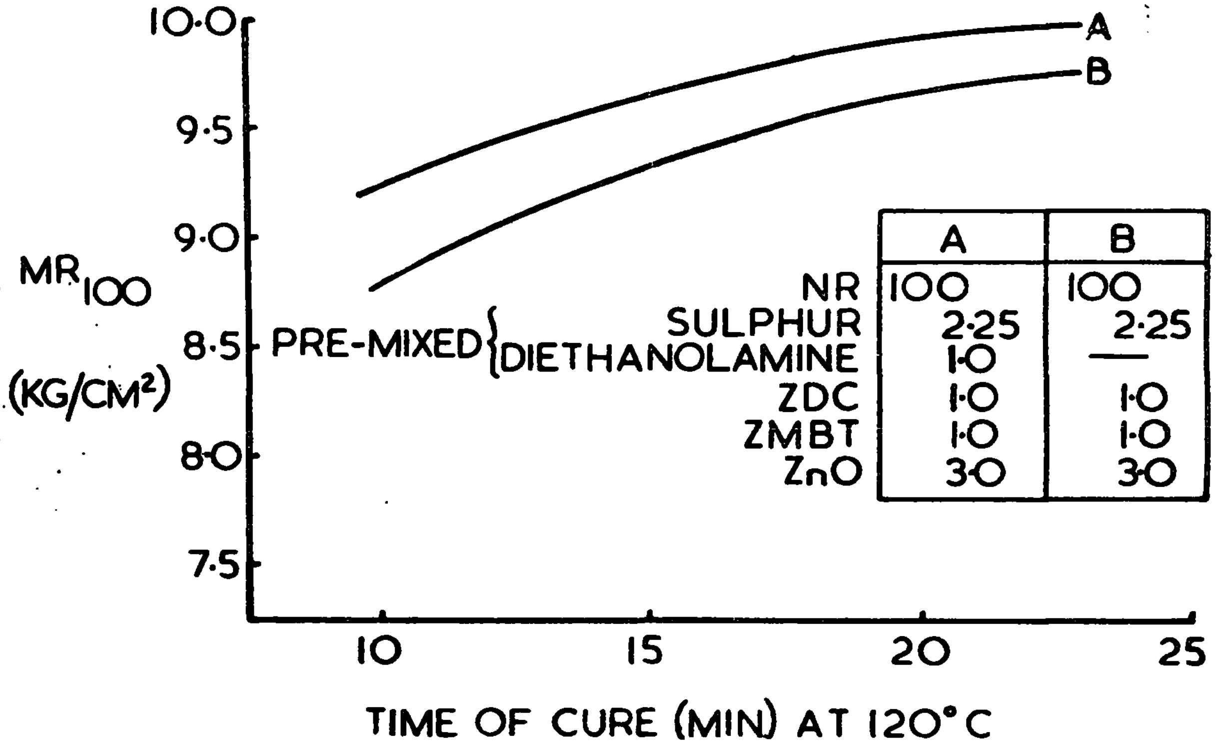

Fig. 3. Effect of diethanolamine on rate of sulphur cure of NR latex film

A second development is the recent introduction of the so-called non-gel foam backings. In conventional foam backings the foam structure is " set " by gelling it, either with SSF or heat-sensitive zinc ammonium salts. The backing can then be dried and vulcanized without any significant breakdown of the foam structure. However, means have now been found of making the foamed latex compound so stable (as a foam) that it can be dried and vulcanized without having to gel the foam first, provided the right types and the right amounts of foam stabilizers are used.

The main attraction of this development is that the processing is simpler; no carefully controlled amount of gelling agent has to be added and there is no danger of premature thickening or destabilization of the foamed compound. Formulations are available from NRPRA for non-gel foam backings based on NR latex.

A third development is the introduction of flame-resistant carpet backings. This has assumed importance because of the steadily increasing emphasis which has been put on safety in the home in America, Europe and elsewhere. Indeed, the Department of Commerce in the USA has issued a mandatory flame-resistance specification which all carpets in the USA will now have to meet, and similar specifications (even if not mandatory) may be expected before long in some of the European countries. Fortunately, the existing specification can be met without undue difficulty so far as the latex foam backing is concerned. In the case of natural latex one of the simplest solutions is to add a flame-retarding agent to the latex compound, together with a suitable amount of antimony trioxide or hydrated aluminium oxide. NRPRA has recently published a formulation (Hannam, 1970) based on the use of pentabromotoluene and hydrated alumina as additives which readily passes the American flame-resistance specification.

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