



# **DEVELOPMENTS IN RUBBER TECHNOLOGY—2**

## **Synthetic Rubbers**

*Edited by*

**A. WHELAN and K. S. LEE**

*National College of Rubber Technology,  
Holloway, London, UK*



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## THE DEVELOPMENTS SERIES

Developments in many fields of science and technology occur at such a pace that frequently there is a long delay before information about them becomes available and usually it is inconveniently scattered among several journals.

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Information on other titles in the series will gladly be sent on application to the publisher.

## PREFACE

This book is intended for those people who have a knowledge or understanding of rubber materials and processes but who wish to update their knowledge. It should be read in conjunction with *Developments in Rubber Technology—1* as that volume discussed developments in natural rubber and selected special purpose synthetic rubbers as well as additives.

The authors have been selected for their expertise in each particular field and we, as editors, would like to express our appreciation to the individual authors and also to their companies. Such a book would be impossible to produce without such active cooperation as we have received.

Volumes 1 and 2 of *Developments in Rubber Technology* cover rubbers which are processed and vulcanised in the traditional manner. It is appreciated that the omission of non-vulcanised rubber materials (the so-called thermoplastic elastomers) will be unwelcome to many readers but it is intended, because of the size of the subject, to cover these materials in a subsequent volume.

A.W.  
K.S.L.

## LIST OF CONTRIBUTORS

J. C. BAMENT

*Elastomers Research Laboratory, Du Pont (UK) Ltd, Maylands Avenue, Hemel Hempstead, Herts HP2 7DP, UK*

H. H. BERTRAM

*Bayer AG, D-5090 Leverkusen, Bayerwerk, West Germany*

J. A. BRYDSON

*National College of Rubber Technology, The Polytechnic of North London, Holloway, London N7 8DB, UK*

L. CORBELLI

*Montedison S.p.A., DIMP/CER, Piazzale Privato Donegani 14, 44100 Ferrara, Italy*

R. J. CUSH

*Dow Corning Ltd, Barry, Glamorgan CF6 7YL, UK*

W. D. GUNTER

*Polysar Ltd, Sarnia, Ontario, Canada N7T 7M2*

J. G. PILLOW

*Elastomers Research Laboratory, Du Pont (UK) Ltd, Maylands Avenue, Hemel Hempstead, Herts HP2 7DP, UK*

M. J. SHUTTLEWORTH

*Compagnie Française Goodyear, Centre Technique, Avenue des Tropiques, 91941 Les Ulis, France*

A. A. WATSON

*Compagnie Française Goodyear, Centre Technique, Avenue des Tropiques, 91941 Les Ulis, France*

H. W. WINNAN

*Dow Corning Ltd, Barry, Glamorgan CF6 7YL, UK*



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## Chapter 1

# TRENDS IN THE USAGE OF RUBBERY MATERIALS

J. A. BRYDSON

*National College of Rubber Technology,  
The Polytechnic of North London, Holloway, London, UK*

### SUMMARY

*The future pattern of rubber usage is predicted in the light of expected global changes in living standards and, specifically, methods of transportation. It is concluded that the car and the lorry will become increasingly favoured methods of transport. Whilst there will continue to be an increasing demand for car ownership the increasing cost of energy is likely to lead to smaller, lighter cars as well as more careful patterns of usage. This will lead to a reduction in the amount of rubber used per car. Whilst non-automotive applications of rubber will continue to be developed the use of rubber will largely be determined by the automotive industries. This growth of rubber consumption will require an increase in car ownership to more than offset the amount of rubber used per car.*

*The outlook for individual types of rubber, which are far from uniform, are reviewed. It is concluded that the rubber industry will have to work much harder and more effectively than formerly to survive the next decade, and that companies that fail to undertake the necessary development work to ensure that their products find a ready market and those that make inefficient use of manpower, equipment and materials cannot be expected to enjoy a long-term prosperity.*

### 1. INTRODUCTION

Those of us who attempt to predict future trends cannot win. If our predictions turn out to be wrong, then we are simply discredited. If, on the

other hand, our predictions turn out to be correct, then we are likely to be told that what we had predicted was obvious in any case. A less pleasant alternative is that we may make predictions which, when made, were not what people wanted to hear and when they prove to be correct, the person making the prediction is, somehow, held to blame for the occurrence of the event.

Whilst predictions from an individual's point of view are games for masochists, there is a real need that they should be made. No organisation which hopes to have a successful, long-term future could reasonably expect to exist without making some assessment of what is likely to happen in the future. What, however, must be recognised is that situations may be expected to change and, consequently, it is necessary to update predictions as these changes occur. It is therefore reasonable that between writing this chapter and its publication, important changes may have occurred and so my predictions may need to be modified. It will, however, be my aim in preparing this chapter to explain the basis for the predictions so that where changes have occurred in the underlying situation, the reader will be able to modify and adapt my predictions appropriately.

In order to try and predict trends in the usage of a particular material, it is necessary to consider a variety of underlying trends. Some of these underlying trends may be very long-term and others very short. It is clearly most sensible to determine the primary long-term trends and then to superimpose on them the secondary trends of shorter duration.

In the specific case of the consideration of trends in the usage of rubbery materials, the following global underlying trends may be identified:

1. Changes in standards of living
2. Changes in patterns of transportation
3. Changes in the design of automotive equipment
4. Changes in tyre design and the use of rubber in other automotive applications
5. Changes in non-automotive uses for rubber
6. Changes in raw material supplies
7. Trends in legislation, for example in areas associated with health, safety and toxicity

## **2. LONG-TERM UNDERLYING TRENDS**

The first two of the above list of underlying trends are obviously of a very long-term nature. The 20th century has, with the two interludes of the two

world wars, seen a period of progressive increase in the global standard of living. In the first quarter of this century, the bulk of the improvement in standards of living occurred in Europe, in North America and among the white population of South Africa. Even in these parts of the world, many of the improvements were confined to a fairly small and fortunate part of the population. It is only since the Second World War that such items as cars, telephones and refrigerators have become available to a European on an average national wage. During the second half of this century, we have seen substantial increases in the standard of living of other countries. Expectations are increasing and there now seems no *a priori* reason why a large part of the population of the so called Third World cannot also begin to enjoy such a higher standard of living.

Without doubt, the major change that has occurred during this century has been the great advance in communication. This may be taken to include developments in transportation and in particular in the development of the motor car and the aeroplane. Since the automotive industry is far and away the major consumer of rubbery materials, it behoves us to try and discern trends in transportation. In spite of all the criticisms levelled against it, there is little doubt, that as far as the individual is concerned, the motor car is a wonderful asset. It gives him considerable flexibility and independence when travelling as well as apparently being able to satisfy all sorts of psychological needs. Car ownership is a habit which can only be broken with the greatest of difficulty. Thus it will take exceptional pressures for there to be a reduction in car ownership and use.

Much has been said about the energy crisis and the huge increases in the price of petrol that have resulted from this. It has to be said that to date, at least in the UK, these increases are more apparent than real. Table 1 shows how the price of a gallon of petrol and of a car have changed over the past 25 years in comparison with other common everyday costs. Clearly in real terms, petrol is cheaper now than it was a quarter of a century ago.

We are, of course, in a dynamic situation. The price of a barrel of crude oil has risen about 1500% in the seven years between 1973 and 1980. It is reasonable to expect that this will continue to rise for some time until other sources of energy become competitive. A stage will be reached when the oil shales become a commercial source of fuel, when the harnessing of light energy becomes a feasible possibility and when wave power also becomes worth tapping. Furthermore, one might expect sugar to become a source of fuel and that it may be possible to develop cars which run on hydrogen. There seems very little evidence to date that, up to the time that this occurs, car owners will give up their cars, although they may well be more prudent

TABLE 1  
SOME PRICE INCREASES IN THE LONDON AREA BETWEEN 1955 AND 1980

	<i>Price (p)</i>		<i>Price ratio</i>
	1955	1980	
First class letter	1	12	12
Evening newspaper	0.4	12	30
Suburban cinema seat	10	150	15
Typical underground railway fare <sup>a</sup>	3	80	27
Daily water rate (typical suburban semi-detached house)	1	10	10
Small family car <sup>b</sup>	$6.5 \times 10^4$	$32 \times 10^4$	5
Petrol (1 gal)	23	128	5.6

<sup>a</sup> Southgate-Holloway Road.

<sup>b</sup> 1955 Morris Minor 1000; 1980 Austin Allegro.

in their use. On the other hand, one may anticipate a considerable increase in car ownership around the world.

As cars appear to continue to be the increasingly preferred manner of personal transportation so the truck appears likely to dominate the transportation of goods more and more. Large areas of the world are remote from the railway and as standards of living improve, particularly in remote parts, there will be increasing goods traffic. Thus, although railways might recover some of the market in Europe where there is a dense railway network, the overall picture indicates increasing use of the truck. The day of the automobile seems far from over.

### 3. CHANGES IN CAR AND CAR TYRE DESIGN

Whilst cars are likely to continue to be the preferred means of personal transport both national governments and individuals are very conscious of costs, particularly fuel costs. This has led to the increasing popularity of vehicles which are more economical in terms of fuel consumption. In some places, such as in the United States, this trend is being backed by legislation. Thus cars are becoming lighter. This helps to reduce tyre wear and also means smaller tyres. These factors indicate a reduction in rubber usage although the life of a small tyre is usually less than that of a large one, everything else being equal. One prediction is that between 1980 and 1990 the average weight of an American car will drop from 2816 to 2522 lb including a drop in rubber usage from 144 to 128 lb. If, however, the smaller

tyre had a life 10% less than that of a larger tyre, on the same size car the usage of rubber, taking into account replacement needs, would be substantially unchanged.

The rubber industry is still adjusting itself to the worldwide acceptance of the radial tyre. This came much later in North America than in Europe and the repercussions of the advent of tyres of much greater longevity in this major rubber market has had an important influence on overall rubber usage. The different requirements of the radial tyre *vis-à-vis* the cross-ply have simultaneously increased the demand for natural rubber relative to SBR.

There has also been a change in the height/width ratio of tyre cross-sections. Where this is brought about by reducing the height and keeping section width constant there is both a saving in the use of rubber in tyre manufacture as well as improved wear resistance—albeit with some loss of road grip. A further trend is the use of higher tyre pressures to reduce rolling resistance—in this case at some loss to ride comfort although this is being overcome by modifications to side wall shape. Overall however, these more recent developments tend to lead to a reduction in rubber usage.

We may conclude this section by saying that whilst there appears to be a trend to increased car ownership, economical driving habits coupled with changes in car and car tyre design are likely to reduce the rate of rubber consumption per car owner.

#### 4. NON-TYRE APPLICATIONS

Tyres remain the major reason for rubber usage. This is clearly shown in Table 2<sup>4</sup> which shows the rubber consumption in various countries in 1968 and 1978. Although there are national variations the overall figure for tyres and tyre products has remained about 60% of the total. It is also interesting to note that natural rubber has a smaller part of the non-tyre market (19%) than in the tyre sector (29%).

Table 3<sup>2</sup> is an estimate, for 1978, of the relative importance of the main end-uses of rubber in western Europe.

It is not surprising that these end-uses are dominated by the general rubber goods which includes parts for cars and other means of transport, for washing machines and other domestic equipment and a wide range of industrial mouldings.

The residual usage of rubber may be divided into two categories: Non-tyre automotive uses and non-automotive uses. It is reasonable to predict

TABLE 2

USE OF NATURAL AND SYNTHETIC RUBBERS IN TYRE AND NON-TYRE PRODUCTS IN MAJOR PRODUCING COUNTRIES (1968 AND 1978) (THOUSANDS OF TONNES)

	<i>Tyre products</i>				<i>Non-tyre products</i>			
	<i>1968</i>		<i>1978</i>		<i>1968</i>		<i>1978</i>	
	<i>NR<sup>a</sup></i>	<i>SR<sup>b</sup></i>	<i>NR</i>	<i>SR</i>	<i>NR</i>	<i>SR</i>	<i>NR</i>	<i>SR</i>
USA <sup>c</sup>	402	1224	623	1464	189	697	181	1017
UK	93	130	84	118	101	114	55	195
France	86	110	132	178	42	86	31	118
Germany	80	140	117	161	90	113	68	268
Italy	56	76	65	101	44	84	48	164
Japan	125	175	251	415	130	172	103	325
Brazil	28	43	56	125	10	28	16	96
Total of above countries	870	1908	1328	2562	606	1294	502	2183
Grand total	2778		3890		1900		2685	

<sup>a</sup> NR = Natural rubber.

<sup>b</sup> SR = Synthetic rubber.

<sup>c</sup> USA data for 1977.

continuing increase of use of rubber in cars for seals, grommets, springs, mountings, hose and so on. The demands for increased safety and lightness in weight will help rubbers to maintain their areas of application.<sup>3</sup> Of rather more concern is the reliability of some rubber parts. As one who has suffered enormous repair bills due to the failure of rubber components, which were themselves of little cost, there must be concern in this area of use. For over 20 years I drove a particular make of car which I generally found excellent and reliable except for problems consequent on the continual failure of various rubber components. For this reason I changed my brand loyalties. It is reasonable to hope that good rubber technology, stimulated by more stringent specifications by the car manufacturers, can overcome these problems. If this is not done both the market for the car manufacturers and their suppliers will be badly affected.

Outside of the automobile industry usage of rubber has suffered many changes in the past quarter of a century. Applications such as cables, battery boxes, belting, footwear, rainwear and flooring which were entrenched markets for rubber before the Second World War have disappeared with the development of thermoplastic materials. Such uses

TABLE 3  
ESTIMATED RELATIVE IMPORTANCE OF MAIN END-  
USES OF RUBBER IN WESTERN EUROPE, 1978 (NON-  
TYRE APPLICATIONS)

	%
Shoe soles and heels	11
Pipes and tubes	10
Rubber solutions and dispersions	7
Carpeting	6
Cellular rubbers	3
Ebonite	2
Belting	2
Reinforced fabrics	2
Medical goods	1
General rubber goods	56

did not generally demand the property of rubber-like elasticity and the transition may now be considered to be virtually complete.

In its place we have seen increasing use of rubber in aircraft and as an engineering material. The engineering applications include such uses as damping pads, for vibration insulation, rubber springs, dock fenders, bridge bearings and so on where the high elasticity of rubber may be properly utilised. The development of the aerospace industry, in particular of aircraft, has also led to many new uses for rubbery materials. In other words rubbers are now being used where rubbery properties are required and it is reasonable to expect that they will be able to retain most of their current areas of application. If there is to be a global increase in the standards of living then we may expect that the total usage of rubber in non-automotive applications will increase.

## 5. PROSPECTS FOR INDIVIDUAL GENERAL PURPOSE RUBBERS

It is most unlikely that all rubbers will experience similar usage trends. It is therefore useful to consider the situation with both natural rubber and the synthetic rubbers individually.

### 5.1. Natural Rubber

In many ways the current position for natural rubber *vis-à-vis* the general



purpose synthetic rubbers is most enviable. During the period 1945–1974 the demand for rubber (both natural plus synthetic) grew at a rate of about 7% a year. During this time natural rubber supply grew at about 2–3% a year so that the percentage of the market taken by natural rubber decreased progressively reaching a figure of about 30% by the early 1970s. At this time about 14% of the rubber used in North American car tyres was natural rubber with a figure of about 27% in truck tyres. With the acceptance of radial tyres the demand for natural rubber, with its superior dynamic properties and green strength, has raised these figures to about 25% and 62% respectively. It must, however, be pointed out that although the percentage of natural rubber in tyres has increased in this market, this benefit is virtually cancelled out by the longer life of the radial tyre. In other words the use of natural rubber per tyre mile is virtually unchanged. The view has been expressed that at the present time the supply–demand position for natural rubber is about balanced.<sup>4</sup> There does, however, seem reason to believe that if there is an increase in car ownership then there will be an increase in the number of tyres produced per year and there could be some degree of shortage of natural rubber. This may be expected to push the price up to a point where the benefits of using natural rubber are largely negated but this would mean a substantial premium price for natural rubber over the general purpose synthetics. Whilst it is difficult to increase the supply of natural rubber sharply over a short period it is, on the other hand, possible to contract sharply the supply of natural rubber should it become obvious that alternative crops such as palm oil will give much greater returns than natural rubber to the planters.

In an attempt to achieve some sort of independence from both oil-based rubbers and from the tropic-grown hevea rubbers, the American Government has recently announced a plan to develop guayule rubber. This rubber is obtained from a small shrub which grows in the south-west of the USA and in Mexico. Methods of extracting latex are somewhat cumbersome but it is claimed that vulcanisates from this rubber show properties similar to those obtained from hevea.

In summary, it would seem that the growth in supply of natural rubber will be somewhat modest over the next few years but that the demand for this polymer will ensure that it has a premium in price over its general purpose synthetic counterparts.

## 5.2. Styrene–Butadiene Rubber (SBR)

In contrast to the natural material the prospects for SBR are less satisfactory. The worldwide acceptance of the radial tyre has cut down