the Vanderbilt

Rubber Handbook

1958

the Vanderbilt

Rubber Handbook

edited by George G. Winspear

published by

R. T. Vanderbilt Company, INC. • 230 PARK AVE. • NEW YORK, N. Y.

Copyright 1958 R. T. Vanderbilt Company, Inc., New York, N. Y. All Rights Reserved

The following trademarks referred to in this Handbook are registered in the United States Patent Office and with the appropriate authorities of many foreign countries:

AGERITE
ALTAX
AMAX
BISMATE
BLACK-OUT
BONDOGEN
BRAZE
BUTYL EIGHT
BUTYL NAMATE
CAPTAX
CUMATE
DIXIE CLAY
ETHYL SELENAC
ETHYL TUADS
LEDATE
METHYL SELENAC
NYTAL
P-33
PAR CLAY
PLASTOGEN
PYRAX
REOGEN
RIO RESIN
RODFORM
RODO
ROTAX
SULFADS
TELLOY
TELLURAC
THERMAX
THIATE
TUADS
TYSONITE
UNADS
VANCIDE
VANDEX
VANFRE
VANWAX
ZETAX
ZIMATE

CONTRIBUTORS

William Arnott
J. M. Ball
L. A. Brooks
Otis D. Cole
J. Dempsey
J. D. D'Ianni
E. M. Fettes
S. D. Gehman
Irving Gibbs
F. L. Holbrook
W. A. Ladd
F. Lichtey
Paul Lupke, Jr.
F. S. Malm
W. D. Parrish
V. H. Perrine
W. H. Schoenbach
John Sigman
M. A. Smook
D. P. Spalding
H. Sternglanz
J. D. Stoner
D. C. Thompson
J. F. Wernersbach
W. M. Widenor
David R. Wolf

Editorial Assistants

H. C. Beadle
H. M. Schiller

FOREWORD

This Handbook has been compiled to serve as a modern source of technical information for those directly connected with the compounding and processing of rubber and synthetic elastomers in their dry forms. It does not contain information on latex compounds and their uses. That subject is covered comprehensively in a separate publication, the Vanderbilt 1954 Latex Handbook.

In scope, this tenth edition covers essential points that a new-comer in the field of rubber technology will find most helpful to his advancement. It should also serve as a handy and up to date reference for the experienced man who may already have acquired the habit of using earlier Vanderbilt Handbooks as his compounding guide. Many features of previous editions have been retained or revised, as required, to keep pace with changing times. New information on synthetic elastomers and their uses has been added.

Some of the material contained in earlier Handbooks has been deleted, with reluctance, from this current edition. While reflecting in no way on the value of former features, the displacement of historical information, statistics available from trade publications, and test procedures adequately described in ASTM and other publications has been necessary to permit the incorporation of current essentials while holding size to reasonable proportions.

Articles on elastomers have been contributed by well qualified individuals. Much of the information on their compounding and current uses is also of industry-wide origin, supplied direct or worked into its presented form with assistance from members of the Vanderbilt technical service organization.

Our thanks to all whose efforts are reflected in the contents. It is hoped that the overall presentation will be a lasting testimony to their kind co-operation.

George G. Winspear
Editor

试读结束，需要全本PDF请购买 www.ertongbook.com

CONTENTS

试读结束，需要全本PDF请购买 www.ertongbook.com

Introduction to RUBBER COMPOUNDING

RUBBER COMPOUNDING is a broad term used to describe the art of developing useful products from elastomeric materials of natural or synthetic origin. For over a century, the tree-derived rubbers were the center of all compounding activities in the field which gives our industry its name.

Then the tree grew many branches. Man-made synthetic rubbers were discovered and became available in commercial quantities. Some of these have proved to be capable of substituting for, or replacing natural rubber in many of its established applications. Others serve as base materials for compounding to obtain unique properties as judged by natural rubber standards.

To be a successful and competent "rubber compounder," capable of using all these materials to best advantage requires a thorough understanding of the following points:

1. The rubbers as raw materials
2. Chemicals (compounding materials) used to modify them and develop the desired properties
3. Handling and processing methods and problems
4. How to compare and evaluate compounded rubbers
5. The design and fabrication of rubber products for various end uses.

These subjects and related information covered in the following text can serve in a number of ways . . . as an introduction to rubber compounding, as a refresher for the memory that tries to retain many things, but frequently forgets; or as a source of information on subjects relating to the specialized fields that make up the rubber industry.

1.

Commercial Rubbers

Types Available • Properties • Uses

- Natural Rubber
- Butadiene-Styrene Rubbers
- Neoprene
- Nitrile Rubber
- Butyl Rubber
- Reclaimed Rubber
- Polysulfide Polymers
- Silicone Elastomers
- Fluorocarbon Elastomers
- Hypalon Synthetic Rubber
- High Styrene Resins

NATURAL RUBBER

by Otis D. Cole

The Firestone Tire & Rubber Co.
Akron 17, Ohio

Although rubber is found in over 200 different plant species distributed over various countries of the world, the majority of the natural rubber of commerce comes from well under a dozen of these. In normal times, only one of these few has any great significance in the natural rubber picture. This is Hevea brasiliensis, a tree which is indigenous to Brazil and is now cultivated in the tropical rain forest regions of all continents. It does not thrive well outside a belt including 15 degrees of latitude on each side of the equator. Since Hevea rubber comprises such a large portion of the natural rubber of commerce, the material in this chapter, unless specifically stated otherwise, will concern it only.

Historical

When the first European explorers came to the New World, they found the natives of Central and South America playing a lively game in which the object was to hit or knock a solid rubber ball through a stone ring*(1)*.

They found that the ball was made from dried "milk" which could be obtained by cutting the bark of certain trees. These trees were called "Ulli" or "Ule" in Mexico and Central America, and in South America were called "hhévé," or "Cau-uchu" which meant "weeping wood." The natives also made shoes, syringes, bottles and other useful objects from the material.

The Spaniards and Portuguese made a few desultory experiments in coating capes with the sticky liquid latex to make them waterproof, but the hot sun melted the rubber and ruined the garments. Pieces of rubber and articles such as shoes, bottles, etc. were taken home as souvenirs. However, the Spaniards missed the real value of rubber.

A Frenchman, Charles Marie de la Condamine, first pointed out the possibilities of using rubber, providing it could be transported as a liquid latex, or if the solid rubber could be dissolved to obtain a liquid form for processing. The rubber industry, as such, started with invention in 1820, of the "masticator" or "pickle" by an Englishman, Thomas Hancock. This machine made it possible to put the tough rubber gum in a softened condition so that it could be dissolved easily in a solvent such as turpentine and spread on fabrics.

The English name for the gum was given to it by Joseph Priestley, the discoverer of oxygen, who found that it served much better to rub out or erase pencil marks than the moistened bread crumbs which people were accustomed to using for this purpose. He mentioned this in his writings and suggested the name "rubber" for the gum.

The rubber coated fabrics which were waterproofed, or simply "proofed," by coating with a solution of rubber were sticky when hot, stiff when cold, and became resinous and very brittle after aging for a short time. The discovery of sulfur vulcanization by Charles Goodyear in 1839 solved these problems and is considered to be the turning point in the rubber industry. There are numerous stories about the "accidental" aspect of Goodyear's discovery, but it must be remembered that he was attempting to find a way of doing what he finally did by heating rubber with sulfur, so that like a number of more recent inventions it was a more or less "planned accident."

At about the same time, Thomas Hancock, in England, also "discovered" the secret of vulcanization with sulfur. For a long time there was considerable controversy as to who was the original discoverer, but it now is agreed that the honor belongs to Goodyear. However, Goodyear died without having obtained any great financial benefits from his discovery.

The discovery of vulcanization along with the industrial revolution and its increased demands for rubber products caused a greatly increased demand for raw, or crude, rubber. For a time, increased production of known wild rubber areas in South America and Africa and discovery of new areas both of vine and tree type were sufficient to keep up with the increased demand. However, the demand both for quantity and quality grew to such an extent that the plantings of Hevea rubber established in the Far East by the British began to pay off. After 1910, the amount of wild rubber being used fell off rapidly to the point where only in emergencies were any sizable amounts produced.

An Englishman, Henry Wickham, has been credited with the introduction of Hevea rubber to the Far East. In fact, he was knighted for it. However, it has been rather definitely established and authenticated that Wickham actually acted only as the collector of the seeds for the British India Office. He arrived in England in June, 1876 with 70,000 seeds from Brazil which were planted at the Kew Gardens in London. Only 2397 of these germinated. About 2,000 plants were taken to Ceylon. In June, 1877, 22 plants were received in Singapore. However, it is not definite whether these came from Ceylon or Kew Gardens, where another shipment of seeds from Brazil had been germinated. From these 22 plants has sprung about 75 per cent of the cultivated rubber of the world. By 1888 over 1,000 trees were ready for tapping in Singapore and others were scattered in various parts of the Malay peninsula.

In retrospect, it is amazing to note how difficult it was for anyone to become interested in growing rubber. It is reported that until 1898 the idea of plantation rubber was laughed at by the very people who later became its champions. The man who actually has been credited with the practical establishment of the rubber plantation industry in the Far East is Henry N. Ridley *(2)*.

While he was Director of the Botanic Gardens in Singapore, he was reprimanded by one governor for "wasting his time" and was called "Mad Ridley" or "Rubber Ridley" by his friends. Nevertheless, he persevered with his idea, and not only distributed seeds to all who would plant them, but also devised a satisfactory tapping system which did not kill the trees, and developed methods for control of various diseases which afflicted the trees. Ridley's contributions to the plantation industry were recognized recently when, on June 2, 1955, at the age of over 99 years, he received the Colwyn Medal from the Institution of the Rubber Industry, 43 years after he retired from active work in Singapore. He had also been honored previously with the Gold Medal of the Rubber Growers' Association in 1914, and the Frank Meyer Medal in 1928, in addition to Civil and financial honors at the time of his retirement.

After the establishment of the plantation industry the production and consumption of rubber increased rapidly. The development of the plantation industry coincided closely with that of the automobile industry. Each was dependent on the other for its growth. The growth of natural rubber production since 1900 is shown graphically in Fig. 1. In 1954, approximately 93 per cent of the total was produced in Southeastern Asia (chiefly Malaya, Indonesia, Ceylon, and Indo-China). Africa produced about 5 per cent and the remaining 2 per cent was produced in Latin America and the South Sea Islands.

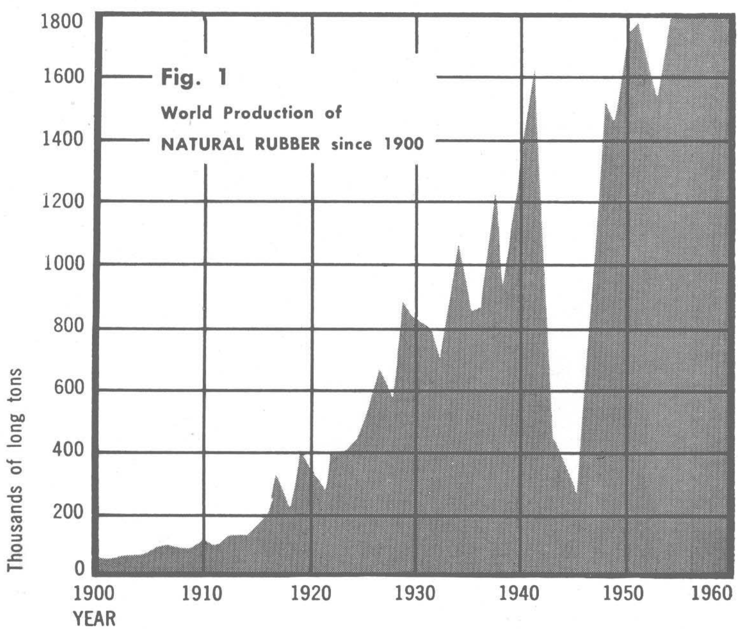


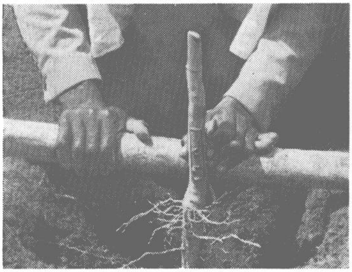
Fig. 1
World Production of
NATURAL RUBBER since 1900

Plantation Rubber—Selection of Planting Material

The early plantations were all of the seedling type, that is, all of the trees were raised from seeds which may or may not have been taken from selected trees. On these plantations, occasionally, some of the trees yielded considerably more rubber than others. By grafting buds from these "high yielders" onto the lower stems of ordinary seedlings, it was possible to obtain a large number of high yielding trees. All the descendants of a single tree are called a "clone." Today most of the plantations have been, or are being, replanted with high yielding clonal rubber. It is of interest that probably not over two dozen clones make up the majority of the clonal rubber plantations.

By cross breeding high yielding clones with others having other desired characteristics, new clones having characteristics of both parents are developed. The best of these are selected for further cross breeding. Since it takes several years for a seed to develop into a tree which will bear more seeds, the improvement of Hevea by cross breeding is necessarily slow. It generally takes from 15 to 20 years to develop and thoroughly establish a new clone. From a production standpoint it pays, because the average seedling stand produces 250-500 lbs. per acre per year, while some of the first clonal stands produced twice that amount. There are new clones which are reported to produce upward of 1500 lbs. per acre per year under average plantation conditions while under carefully controlled conditions some of them have been reported to yield up to 3000 lbs. per acre per year.

Bud-grafting Hevea Rubber



Planting Bud-grafted Stump

Young Bud-grafted Rubber Tree

试读结束，需要全本PDF请购买 www.ertongbook.com