

# **Principles of Surface Coating Technology**

*By* **D. H. PARKER**

# Principles of Surface Coating Technology

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## Preface

The Department of Chemical Engineering and Metallurgy of the College of Engineering at Wayne State University in Detroit has for many years conducted a lecture course in surface coating technology sponsored by the Detroit Society for Paint Technology and the Detroit Paint, Varnish and Lacquer Association.

The objective of this course is to give those of limited experience in the field a broad general picture of the modern American paint industry, the properties and uses of the raw materials commonly employed, the principles of formulating coatings, and their manufacture, testing, and application. A further objective is to acquaint them with some of the fundamental aspects of plant and laboratory procedures, techniques, and controls. To help them expand their knowledge beyond the scope of the course, they are given suggestions relating to the more important sources of technical information available to the public, as well as lists of references to some of the better literature articles for supplementary reading.

The lecture material has been revised continually and updated over the years to keep it abreast of all important technical developments. Until now it has been supplied to students in typed form. There have been so many requests for copies of this lecture material, however, that it was decided to publish it in book form.

The book is devoted almost entirely to the technology of continuous organic coatings with only limited reference to other manufactured products which consume many of the same raw materials, such as inks, plastics, fibers, unsupported film, and sheeting.

Very little space has been devoted here to the details of the manufacture of the various raw materials used. Only the chemical structure of most of them is given, with a brief outline of their methods of

manufacture when there is some bearing on their performance characteristics.

The formulas in the text are intended more as illustrations of fundamental principles than as actual working formulas. Raw materials of the same general types from different manufacturers vary widely, and methods of manufacture are by no means uniform in the paint industry. A formula can be considered no more than indicative unless it shows specifically the manufacturers' codes on the various raw materials and the exact details of their processing. If the formulas given here are of any value to surface coating technologists as starting points in the development of practical formulas in their own laboratories, I will consider myself rewarded.

I have attempted to make this book as accurate and complete as possible according to information presently available. As time goes on, existing raw materials will be improved and their deficiencies as stated here will be corrected. New products that are not even mentioned will appear. Present methods of manufacturing will be improved and new ones introduced. The technology of surface coatings, like that of many other industries, is expanding at a very rapid rate. All books of a technical nature tend to become out of date as new techniques and products are developed and old ones are improved. It is hardly to be expected that this book will be any exception.

DEAN H. PARKER

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## The paint industry—past and present

Surface coatings have been used for many thousands of years in gradually increasing quantities as civilization developed. In the prehistoric period painting was limited almost entirely to the decoration of caves and other dwellings.

The ancients applied coatings to their ships, utensils, musical instruments, weapons, mummies, temples, and palaces in a variety of pigments and binders, some of which are still in use today. The white pigments were white lead and natural white earths, such as clay, gypsum, and whiting. The black pigments were charcoal, lampblack, bone black, natural graphite, and powdered coal, and among the yellow pigments were ochres, orpiment, gold powder, and litharge. The reds were iron oxides, red lead, cinnabar, and natural red dyes on various bases. They had a number of blues, such as Egyptian blue, lapis lazuli (ultramarine), copper carbonate, and indigo. Among the greens were terre verte, malachite, verdigris, and natural dyes. Their binding media included gum arabic, glue, eggs, gelatin, beeswax, pitch, shellac, animal fats, and saps of various trees, as well as drying oils.

Throughout the Middle Ages and even after the industrial age had begun the volume of paints made was negligible by modern standards because of the low standard of living of the vast majority of the world's inhabitants.

Many people may be surprised to know that even in Colonial America paint was considered a luxury. A painted house in those days was a mark of considerable affluence, for the lower and middle classes lived in unpainted log or hand-sawed wooden dwellings.

Until the first paint and varnish factories were started in the nineteenth century painters had to make their own by grinding pigments



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into liquids in a variety of crude mills. One type of mill consisted of a stone ball which was rolled back and forth in a trough shaped in another stone. They bought their raw materials from the apothecary shops that seem to have been the major source of supply for many things our ancestors required beyond the simple necessities of food and clothing.

Formulation was then very much an art. Painters guarded the limited knowledge they had obtained slowly and painfully by the process of trial and error, and information was handed down from father to son by word of mouth for generations. Technical progress was extremely slow. At the beginning of the nineteenth century paint technology was still quite elementary.

The first white lead factory in the United States was started in Philadelphia in 1804, and the first varnish plant appeared about 1815, although the manufacture of ready-mixed paint did not begin until about 1867. This was really the foundation of the modern paint industry. Others quickly jumped into the new field and competition was keen for the market then available. The paints were often poor in quality, since the technology of the industry was still very limited and chemists and research laboratories were then unknown. Cutthroat competition produced much adulteration, wild advertising claims, and many other unsound business practices.

About 1900 paint manufacturers began to hire chemists to find out how to produce really good paints and varnishes. In this period also they formed trade associations for mutual education in sound business practices, extension of markets, and suppression of abuses, out of which evolved the National Paint, Varnish and Lacquer Association as we know it today. Chemists and production men met first in 1914 in small local groups which finally developed into the modern Federation of Societies for Paint Technology, designed primarily for mutual education in the technology of surface coatings. As a result, trade practices, as well as the quality of the goods produced, began to improve.

Since those early days of the twentieth century the history of the paint industry has been one of constantly accelerated growth in technology as well as in volume of goods sold. A great many of the new raw materials introduced are discussed in later chapters. Certain surface coatings such as lacquers, which were virtually unknown 50 years ago, are being produced in large quantities. Modern paints are far superior in quality and performance characteristics to those made at the turn of the century. Possibly 50 years from now the surface coat-