ORGANIC CHEMISTRY

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PREFACE

Organic chemistry is rapidly developing today. Whole classes of new substances, unusual by their structure and properties, are being discovered, new compounds for diverse applications are being created, modern methods of investigation based on achievements in physics are being used on an ever wider scale, and theoretical conceptions are being elaborated. All this gives rise to certain difficulties in studying organic chemistry, because enormous material must be confined to the framework of a curriculum and of textbooks. The authors are convinced that there is only one way of overcoming these difficulties, and that is to give maximum attention to general principles while inevitably reducing purely descriptive material.

Like a century ago, organic chemistry is based on A. M. Butlerov's theory of the chemical structure of organic compounds. The theory is now supplemented by a better understanding of the nature of the chemical bond and the causes of reactions. Besides Butlerov's classification by the structure of molecules, there is another classification, i.e., that by the type of reactions. It is precisely owing to the revelation of the nature of organic reactions that the transformation of organic substances could be regarded not as a set of diverse exceptional cases which are difficult to remember, but as a streamlined system.

The authors sought to expound the general principles of organic chemistry within the framework of this textbook, regarding the study of the theory not as an aim in itself, but as a means of understanding and remembering the material better and ultimately of facilitating its assimilation. But organic chemistry cannot be studied without knowing the techniques of obtaining specific substances, their properties and fields of application. The authors endeavoured above all to tell about the practically important organic substances used in industry, agriculture and medicine.

This book is based on the classification of organic compounds by functional groups, which determine the chemical behaviour of organic substances. At first, the authors consider various types of hydrocarbons that constitute a single large family which is bound together by numerous mutual transformations, and then all the halogen derivatives, hydroxyl derivatives, and so forth.

The authors will be grateful to readers for their suggestions and remar s that may help to improve the book further.

CONTENTS

INTRODUCTION

I.1. Subject of Organic Chemistry and Its Practical Importance. Organic chemistry is usually defined as the *chemistry of carbon-containing compounds.* Such a definition immediately begs the question: how about such well-known inorganic substances as carbonic and hydrocyanic acids and their salts, since they also contain carbon? Indeed, it is impossible to draw ana bsolutely clear-cut line between organic and inorganic chemistry. However, the bulk of carbon compounds are organic substances.

There is also another definition: *organic chemistry is the chemistry of hydrocarbons and their derivatives.* The profound meaning of this will become clear later. For the time being, it should be explained that hydrocarbons are the simplest organic substances consisting of atoms of only two elements: carbon and hydrogen. Derivatives are substances of greater complexity which can be obtained by substituting hydrogen atoms in hydrocarbons for atoms of other elements or for complex groups.

The name *organic chemistry* originated at the beginning of the nineteenth century, when it was ascertained that carbon-containing substances are the main component of plant and animal organisms.

Originally, the task of organic chemistry was to study substances existing in living nature. However, *products of organic synthesis*, i.e., artificial substances, many of which are not found in nature, gradually began to grow in importance. As for natural substances, simple and eventually more and more complex ones were studied, and then an investigation began to be made of *chemical processes* constituting the basis of vital activity. Modern organic chemistry deals with both natural and synthetic organic substances: their structure, the ways of obtaining them, their properties, and the possibilities of practically using them. In addition, apart from purely chemical methods, i.e., those of analysis and synthesis, diverse physical methods are also widely used.

As far back as prehistoric times, man used natural organic substances (foodstuffs, wood, hides) for his needs. In the course of millennia, mankind gradually learned to process organic substances found in nature: it learned how to produce textiles from the fibres of cotton, wool, flax and silk; convert hides into leather by tanning; extract medicine, dyes and fragrant substances from plants; obtain glycerin and fatty acids from fats; draw out sugar from sugar beat; convert natural rubber into rubber; and process wood, coal and petroleum. Many industries, both light and heavy, are now processing organic substances; they include the oil, gas, petrochemical, coke-by-product, textile, food and pharmaceutical industries.

In the last decades, the production of synthetic high-molecular-weight compounds (polymers) has become especially important: these compounds are used as building materials and for making various household utensils. At first, synthetic materials were regarded only as substitutes for natural ones (rubber, wood, leather, textiles, resins, etc.). But they have now really become "indispensable substitutes", because many tasks of modern technology can be carried out only with new synthetic materials.

I.2. Raw-material Basis of the Organic Synthesis Industry. In the course of many centuries, mankind obtained the necessary organic substances from plant and animal raw material. The variety of industrially-produced organic substances was not very great, while the scale of their production remained rather small.

Since the latter half of the nineteenth century, pit coal became very important as raw material. Coal tar, a by-product of coking, opened the way for the industrial production of benzene, toluene, naphthalene and other aromatics. These substances became the raw material for the synthesis of dyes, medicine and explosives. In the twentieth century, petroleum, whose main components are paraffin hydrocarbons and naphthene hydrocarbons, is becoming increasingly important as raw materials. Natural gas, whose main component is the simplest paraffin hydrocarbon, methane CH_4, has also become important raw material. Organic substances are separated from shale as well. Wood, whose reserves, unlike minerals, are constantly replenished, has lost none of its importance.

It follows that modern industry rests on the processing of hydrocarbon raw material. The simplest organic compounds, hydrocar-