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Purpose and Contents of The "Short Textbook Of  
The Technology Of Fuels" (In German)

1st Edition 1939 by W.J. Müller and E.G. Graf  
2nd and 3rd Edition 1945 by E.G. Graf, Vienna, F. Deuticke

Prior to the time when the first Engineers for Fuel and Heat Technique obtained their education at the "Special Branch for Combustion and Gas Technique" of the Technical University of Vienna, Austria, founded 1920, the problems of chemical coal utilization and of heat transfer were solved by engineers, who were trained at the Fakulties of Chemistry and of Engineering and at Mining Schools.

It was visualized by the founder Professor Dr. Hugo Strache that this Special Branch met a demand of the industry of Austria and of the surrounding countries and his view was endorsed by the fact, that even in times of industrial and economical depressions, when most of the graduates of Technical Universities were without employment, all of the Engineers for Fuel and Heat Technic found jobs easily.

In 1926 the "Technology of Fuels" by H. Strache and H. Ulmann, Edition F. Deuticke, Vienna, was published for the purpose of education on the Institute of Technology of Fuels and as an auxiliary means to engineers in the industry, occupied with fuel and heat problems.

In the following decade the progress on all fields of the fuel and heat technique was remarkable. The development of new low

temperature carbonization processes for black coals, the progress in the manufacture of synthesis gases, and in the liquefaction of coals as well as in the recovery of sulfur and in the removal of carbon monoxide from coal gases were partly violent. The progress in standardization and in the development of new fuel testing and investigating methods in my Viennese laboratory and in other research laboratories was worthy of notice too.

Others of my reasons for the edition of the "Short Textbook" were maintaining the tradition of P. Strache, who died 1927, and providing the lectures of the succeeding transitory director, W. J. Muller, who was Professor of Inorganic Technology and Expert in Chemical Corrosion of Metals, with the knowledge up to date.

I was able to take into consideration a decade's experience on the usefulness of our teaching method as I was in touch with the industry and approximately the first fifty graduates of our school, M. S. and Ph. D. Engineers, who were employed in breweries, iron and enameling works, in gas works as well as in gas apparatus and gas engine industries, in the ceramics, chamotte and magnesite industries, metal foundries, in the wood carbonization industry, in the boiler, heating and oven industries and air conditioning industries, in the oil and oil burner industries, in public service, in scientific and research laboratories and as consultants for heat and fuel technique.

Since co-author Muller could participate but on insignificant parts, I took over more than 90 per cent of the work, which is pointed out in the preface to the first edition.

My intensions in presenting the status of knowledge differed in several views from those of Strache. According to their importance

I stressed more emphasis on the chemical kinetics of the combustion processes, on the modern theories of producer reactions and on the fundamental interpretation of the technological methods of separating solid, liquid and gaseous substances, the latter in cooperation with W. J. Müller.

The first edition had a favourable criticism and sold five times as good as Strache-Ulmann's "Technology of Fuels", so that a double edition became necessary four years later.

In the following pages the contents, the prefaces to both of the editions and the introduction to the "Short Textbook" are represented according to my own translations.

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Preface to the First Edition

Almost everyone of the chemists and engineers, working in the industry, has to deal with problems of the technique of fuels. It will be recognized by them, that there are several excellent books on special fields, but that a short presentation of the technology of fuels is missing which takes into consideration its partly violent development of the past decade. The present book tries to fill out this lack in literature and to give a short, but complete as possible compilation of the scientific fundamentals, on which the fuel technique is based, as well as of the special technology of fuels. The book is therefore destined for the students of chemistry and engineering sciences as well as for chemists and engineers, occupied with problems on fuel and heat technique. The intensive treatment of the physical, physico-chemical and chemical fundamentals offers to the readers the opportunity of having available the

scientific fundamentals without being obliged to use other professional books. Scholarship in physics and chemistry is presupposed in such an extent as it is required by the undergraduate examination (diploma pre-examination). The somewhat extended dealing with the physico-chemical fundamentals meets a demand of making the book useful to such engineers too, who have not studied physical chemistry. The description of the general technological methods according to the approved scheme of phases will probably be of use to readers not especially interested in fuel technique.

The fundamental and the technological chapters correspond approximately to the lectures on the technology of fuels at the Technical University of Vienna (Muller). In order to help overcome difficulties of beginners when performing calculations of fuel and heat technique, a number of examples has been incorporated. The laboratory testing method of general interest are described in order to increase the usefulness of the book. The methods presented are standardized to a certain extent and are approved and partly developed in the Institute of Technology of Fuels. The last three chapters of the book are written by only one of us (Graf) who was obliged to elaborate most of the other part of the book too.

Presenting the exceedingly extensive subject on a relatively small space necessitated of course restrictions in selecting of that which is essential and in the extent of presentations. We hope to have found the right measure.

The line drawings of the fundamental chapters and of the "Laboratory Testing Methods" have been prepared mainly at the

Institute. The technical illustrations have been contributed by companies, to which we return our thanks. We are indebted to the editor, Mr. H. Deuticke, for the care given to the book.

We appreciate all suggestions of colleagues dealing with the contents of this book.

Vienna, March 1939

W. Müller, E. Graf

### Preface to the Second and Third Edition

After the death of my former principal and honoured co-author W. J. Müller, Professor, Ph.D., the publication of a new edition soon became necessary but was retarded by war difficulties.

The appreciation by the circle of readers and the criticism of professional colleagues certified that the Text Book met a demand and that it reached our aim in presenting the material and in selecting fundamental examples as well as in its organization and structure. In the new edition enlargements and improvements could be incorporated repeatedly, stimulated partly by suggestions of colleagues.

In the introductory chapter I the tables pertaining reserves and production of fuels were adapted to the circumstances given by the union of Austria with Germany and the paragraph containing the geographical distribution of coals in Central Europe extended.

In chapter II with the physical and chemical fundamentals the formula of the flow resistance in fuel beds by R. Fehling has been inserted, newer temperature measuring methods considered

and better values of the specific heat of black and brown coals, published recently, and a formula of the specific heat of black coal briquettes, found in own experiments, were added.

The calculus of the burning time of coal particles, important for the combustion kinetics, has been incorporated according to calculations of W. Gunz. The paragraph with the heat transfer has been enriched by newer heat conductivity coefficients of coals and cokes. A more simple formula for the heat transfer coefficient of oil is presented and the radiation of technical gases according to the last status of calculations of A. Schack.

In chapter III, dealing with coal chemical fundamentals, some more data of the properties of low temperature carbonization products of coals could be made and the knock-test-values of diesel oils brought up to date.

Regarding the descriptions of high temperature carbonization furnaces (chapter V), I acknowledge suggestions for improvement and placing at my disposal better illustrations, offered by Dr. A. Thau. I am indebted to Prof. R. Heinze too for allusions concerning newest German low temperature carbonization processes. The rapid evolution on this field is striking. Some processes created in the first time of development could be omitted and the community type of a continuously operated ceramic low temperature furnace incorporated. In the same chapter the following processes were taken into consideration; the newer Koppers-Potash process and the Staatsmijnen-Otto-process of sulfur recovery, the Wintershall-Schmalfeldt process of continuously operated water-gas production and the F. Fischer - H. Pichler-process of middle-pressure

synthesis of gasoline.

The chapter dealing with combustion of fuels (VI) could be enriched by data of own measurements on the combustion rate of oil heating.

According to many wishes of readers I have enlarged the chapter "Examples" by four more examples. One example (No. 10) shows the use of the new formula of gas radiation and another (No. 11) the radiation of incandescent areas. One example (No. 13) contributes to the drying of brown coals and another (No. 14) to the drying of black coal briquettes. The latter shows the initial demonstration on a laboratory scale according to own proposals and the application of results to the construction of a commercial plant, based upon the drying rate and heat transfer, found in the laboratory experiments.

In chapter VIII with the "Laboratory Testing Methods" the fusion of standards, given by the union of Austria with the Reich, and own experiences with some testing methods have been considered. The chapter has been enlarged by Bauer-Jenkner's laboratory coking test and P. Damm-R. Kattwinkel's method of measuring the agglutinating values of coals.

I wish to acknowledge helpful suggestion offered by colleagues, and hope that the new edition will be accepted with the same generous response as the previous one.

Vienna, August 1944

E. Graf

## INTRODUCTION

The technology in its widest sense, is the science of the industrial recovery and manufacture of natural products to products of mans requirement and includes therefore the description of processes, which lead from the recovery of raw materials to the production of intermediate products and to final products.

The description of these processes can be made under different points of view. Theoretically we may distinguish between methods which cause merely a change of the form of the product, principally designated as mechanical technology, and those methods which cause a material change of the product, designated as chemical technology.

In practice this sharp theoretical separation is not feasible, because most of the manufacturing processes include mechanical conversions as well as chemical, i.e. material ones, which clasp one into the other, regarding many processes. For example the first step in manufacturing metals, the mining of ores, is foremost a mechanical process. The conversion of the ore into the metal is bound up with a process of material change, therefore a chemical process, whereas the production of the goods for mans use is carried out by means of mechanical methods.

The production of fuels begins predominantly with mechanical processes. The manufacture of briquettes or gases includes already chemical processes and finally the production of heat and power is based on the chemical process of energy evolution.

For the educational dealing with the classification into groups of material has been inducted, because the technician

needs a condensed description of all of those methods, used on his professional field.

Such a group of material of greatest technical and economical significance are the fuels. Since thousands of years they represent the base of culture on earth. When Liebig said, "The status of culture of a nation can be measured by its soap consumption", so we are now more authorized to compare a nations living standard with the consumption of fuels, regarding chiefly those used for power generation.

Until the end of the 18th century the primitively recovered natural fuels served particularly to heat homes and work places. But a relatively small part of it was used for the recovery and manufacture of metals. After the invention of the steam engine by Watt, that made possible to replace human power by calorific generated energy, a new epoch of man's cultural evolution has started. The increase in the use of calorific generated energy to work processes is expressed by the enormous augmentation of fuel production since the beginning of the 19th century. In 1800 the world's coal production was approximately 11 million tons and has mounted since this time to 1300 million tons, whereby about one third of the produced coal was used for power generation. The significance of the fuels within the general economy of energy is therefore stated in the first introductory chapter of the book.

The theoretical fundamentals in representing technical processes, are to be found in the provinces of knowledge of the physics, the physical chemistry and the chemistry. The second chapter



contains therefore the laws of physics and physical chemistry, necessary to fuel technician, and the methods of measuring based on these laws, whereby examples are selected according to the purpose of contemplations.

The next chapter deals with the basic fuel chemistry. The fourth chapter describes the technical processes which are used not only for the purposes of fuel production and fuel refining methods, but are of general significance, so that this chapter is titled as "General Technological Fundamentals".

The first section of the book, containing fundamental knowledge in four chapters, is followed by the second section, enclosing the "Special Fuel Technology" which is treated in two groups:

Chapter V, with "Refining Fuels" and  
Chapter VI, with "Burning Fuels".

Fuel refining processes generally include all the mechanical, thermal and chemical processes, leading from the raw fuels to such heat and power yielding products, which offer a more advantageous use and serve best to certain purposes. Refining solid fuels begins with the simple dividing in proper particles and the separation from undesired admixtures. It encloses further drying, briquetting, carbonization, gasification and liquefaction of coals and the methods of purifying and separating used hereby. The recent development of fuel technic shows that coals are not only used for the supply of energy, but more and more act a part as most important raw materials to the chemical industry and furthermore that the most economic use of the fuels.

in their most proper form is a general demand of applying sparingly to our profit the wealth of our earth's resources, especially those of our exhaustible natural fuels.

In spite of its great significance, the combustion of fuels in engines is but slightly touched here, because it is beyond the scope of fuel technology.

Separately, as an appendix to the technology proper, in the third section, the two chapters "Calculation Methods" and "Laboratory Testing Methods" are placed for practical reasons: the "Calculation Methods", in order not to disturb the coherence of the chapter with the physical and physico-chemical fundamentals, the "Testing Methods" in order to represent as a compact entirety these investigation methods, manifold approved in the laboratory and destined essentially to the practice.