

**Ignition Handbook,
Principles and Applications to Fire Safety
Engineering, Fire Investigation, Risk
Management and Forensic Science
by Vytenis Babrauskas, PhD**

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THE FOREWORD OF this book describes very well the nature of this work with the following phrase: “The Ignition Handbook leaves no stone unturned.” This is a comprehensive compilation of ignition data together with selected theoretical descriptions that in the words of the author “could lead to conceptual understanding of the problem or provide a framework for making useful practical calculations.” The book consists of 15 chapters that cover a multiplicity of areas related to ignition. Accompanying the book is a CD-ROM that contains five Excel files describing various properties directly related to ignition such as ignition temperatures (piloted, auto-ignition, flash points), flammability limits, adiabatic flame temperatures, quenching diameters, boiling points and miscellaneous thermal properties. Tables provide information for many materials compiled in four different categories: pure chemicals, dusts, commercial natural products and solids. The CD-ROM might be of practical use to those searching for specific information but it adds little information not available in the text.

This book can be divided in five sections characterized by a combination of theoretical material, anecdotal information and an exhaustive compilation of data. An introductory section of Chapters 1–5 opens the book. A second section (Chapters 6–10), that addresses in a classical manner all known forms of ignition, follows. For organizational purposes the author presents the material in the classic format of liquids, solids and self-heating and then adds a novel section on explosives, pyrotechnics and reactive substances generally not treated in fire textbooks. The third section looks into external factors directly related to ignition, such as ignition sources and preventive measures. The chapter on preventive measures focuses on design and lacks some discussion on maintenance-related aspects. Chapter 13 includes a number of important miscellaneous items and can be included within this section. Section four is a magnificent compilation of color plates that illustrate many of the issues discussed in the previous three sections. The book has a final section of two chapters, 14 and 15. Chapter 14 corresponds to an encyclopedia where diverse subjects are listed in alphabetical order covering every condition that might lead to ignition. Chapter 15 presents a great amount of data in summary tables. This section is very useful for those readers seeking specific information. A minor criticism is the lack of appropriate references to authors within the figure captions. It makes it difficult to identify the source of the data.

The first two sections deserve more detailed attention not only because of the large amount of information, but also because they truly represent the conceptual core of this book.

The introductory section provides a detailed presentation of the subject that covers some basic combustion principles as well as very important statistical facts that put the reader in the context of the problem to be studied. No detail or derivations are present emphasizing the physical description of the processes. Throughout this section the author shows a clear preference for simplified models. The material is limited to thermochemistry, reaction kinetics and premixed flame characteristics. Auto-ignition, piloted ignition and more complex concepts such as cool flames and the effects of variables such as pressure on the ignition temperatures are discussed. Semenov and Frank-Kamenetskii theories receive significant attention. Practical issues related to piloted ignition of gases such as spark ignition, Auto Ignition Temperature (AIT), Minimum Ignition Energy (MIE) concept and quenching are explored. Experimental issues like the mode of ignition are discussed in great detail. Chapter 5 extends the premixed flame approach to the ignition of dust clouds. Some references are made to studies that discuss lofting in the context of moisture content but it would have been interesting to discuss in a bit more detail the importance of particle lofting. This section is equivalent to the introductory chapters

of any good combustion book but has a practical side that will make it appealing especially to fire investigators. In addition to classical material the author highlights the apparatus dependent nature of some ignition parameters, the probabilistic nature of the ignition event and provides some practical advice for fire investigators using this material. A detailed definition of terms and acronyms used in the book is also presented. This is very useful because the fire literature is filled with terms that are not defined with precision.

Chapters 4 and 5 analyze standard test methods including mostly US based tests (US Bureau of Mines, UL, ASTM) but a brief description of German and British methods is also provided. Similar presentations are made in the second section (Chapters 6–10). This information is very useful not only for the practitioner using this book but also for those who seek to clarify the limitations of the data presented.

The second section encompasses Chapters 6 to 10. Chapter 6 deals with the ignition of solids and 7 with that of liquids. These chapters open with a revision of such concepts such as auto ignition temperature, flash point and fire point. Practical relations between the different values coexist with fundamental explanations on the different physics behind each parameter. Historical accounts of the development of assessment methodologies and parameters are presented together with dispelling comments related to common statements on ignition parameters such as the ignition temperature. Consistently, questions are being raised on the utility of some correlations and analysis that link fundamental properties such as the heat of combustion or the vapor pressure to practical parameters such as the flash point. Discussions on limitations of different techniques and standard test methods are done with great thoroughness. An oddity of Chapter 6 is the separation of piloted ignition from flashpoint and fire point and the emphasis on droplets and aerosols. A comprehensive treatment of the theories used for interpretation of piloted ignition data allows a clear understanding of the limitations and advantages of each theoretical approach. It would have been nice if the author could have synthesized the theory and converged to a conclusion of what is “good practice” in the interpretation of these results. The double transition between Atreya’s theory that applies to piloted and auto-ignition, to procedures regularly used to analyze only piloted ignition and finally back to more general analysis, such as that of Niioka, is drastic and might lose the novice reader. Chapters 6 and 7 provide an enormous amount of data and references. Chapter 8 represents a brief addition to Chapter 7 that emphasize the different treatments necessary for metals and carbon particles. Chapter 9 takes a different path and discusses self-heating. From the onset emphasis is given to the importance of size in these processes. The author briefly

reviews the Semenov approach to self-heating together with other alternate formulations. Emphasis is given mostly to geometrical effects. An extensive section on practical considerations follows which cover fundamental aspects such as chemical composition to practical issues such as available airflow. The Frank-Kamenetskii theory is reviewed again extensively in the context of the FRS test method. This is done thoroughly and the final example is very useful. The review of the test methods in this chapter is especially thorough and didactic. Explosives, pyrotechnics and reactive substances are treated in Chapter 10 in a manner that is consistent with Chapters 8 and 9. The treatment is brief and general and concentrates on emphasizing the differences in procedures necessary to address unstable substances or those that have the potential to burn very fast.

In summary, the author should be commended for being able to compile such a fantastic amount of information into a single text. This book will become a reference to be used broadly within Fire Safety Engineering and Fire Investigation.