

# Review of FIRE PROTECTION CHEMISTRY, Second Edition

## By Raymond Friedman

by

Richard L. P. Custer

Adjunct Associate Professor  
Worcester Polytechnic Institute

President, Richard L.P. Custer and Company\*

Over the past fifteen years, there have been significant advances in the technical understanding of the physical and chemical processes that control ignition and the growth and spread of fire. For the most part, this new understanding has been published in research reports, scholarly journals and in upper level college or graduate textbooks.

For this reason, there has not been a means for practicing fire protection engineers who have been out of school for a number of years to obtain a concise, understandable overview of recent scientific developments that are affecting the field today. In addition, there has been no up to date text to meet the needs of the fire science and fire protection engineering technology students. The second edition of *Fire Protection Chemistry* published by the National Fire Protection Association goes a long way toward meeting those needs.

The author, Dr. Raymond Friedman, directed the fire research activities of Factory Mutual Research Corporation for 18 years until his "semi-retirement" in 1987. He is presently a consultant and serves as an adjunct professor in the fire protection engineering graduate program at Worcester Polytechnic Institute. Dr. Friedman's work on the Second Edition represents almost a complete rewrite of the first edition which was published in 1976. The new technology is presented without the use of complex mathematics or chemical formulae. In most cases, the concepts are revealed through the use of tables, graphs and diagrams, a technique well suited to the audience. The author also provides a glossary that is helpful where terms are not

defined in detail in the text.

The book is organized in two parts. The first is a review of the fundamentals of chemistry and the second covers fire protection chemistry. The information in each chapter is well documented with specific references to the fire protection and fire research literature. Problems for homework or self study and evaluation are also provided.

The level of the materials presented in Part I assumes that the readers have studied chemistry in the past but need to refresh their memories. Attention is given to S.I. units, and such principles as ions, free radicals, isomers and the physical states of matter. Part I also covers the basics of chemical reactions including energy of reaction, chemical equilibrium and kinetics. The review is, however, superficial in nature and the author recommends that those who have not had a previous exposure to chemistry obtain and study a good text in general chemistry in order to gain the most from this book.

Part II is specifically aimed at relating chemistry to fire protection issues and to presenting the results of recent research. The process of combustion is introduced, and how it is originated, spread and terminated is explained using common materials and fire situations as examples. This introduction is followed by detailed discussions of gaseous, liquid and solid combustibles. Since for most practical causes, combustion takes place in the gas phase, this is covered first.

In discussing gaseous combustibles, the concepts of pre-mixed and diffusion flames are introduced. Minimum ignition energy and ease of ignition are covered for pre-mixed flames, and the conditions necessary for ignition to occur are

\*Address for correspondence: 155 South Street, P.O. Box 741, Wrentham, MA 02093.

discussed. Flammability limits and their effect on flame propagation rate are discussed, and the concept of stoichiometry is introduced.

Diffusion flames, those most common in fire protection problems, are discussed and practical examples of ignition and fire growth scenarios given. Particular note is taken of the relationship of rate of heat release to height of diffusion flames. This chapter also provides a detailed example of the chemical mechanisms of combustion. The chapter ends with a section on flame radiation and brings together the materials previously covered with a detailed discussion of the hazards of three specific gases.

The chapter on flammable liquids focuses on "Which liquids are flammable" and "how flammable liquid fires should be handled." The fact that fire point is not always a relevant measure of flammability is pointed out, and five categories of liquid fires are discussed as examples. The topics of heat release rate and burning rate of pool fires, flame spread rate over liquid surfaces and boilover are also included.

In the chapter on solid combustibles, the concepts of pyrolysis and minimum radiant flux needed for ignition are introduced. Considerable attention is also paid to flame spread mechanisms and to factors that affect the burning and heat release rates of solid materials. As in the previous chapters, common examples such as furniture fires and compartment flashover are used to integrate the concepts presented. Although not entirely related to the subject of "fire protection chemistry," the discussion of compartment flashover was rather limited and, considering the importance of the phenomenon, could be expanded. A discussion of the special issue of combustible metals is also included.

One chapter is devoted to combustion products. Solid particulate production is discussed as related to visibility and smoke detection. Toxicity of combustion products is also addressed with discussion of specific gasses as well as the issues of oxygen deficiency and mixtures of gasses and particulates.

A chapter is provided on fire extinguishing procedures and extinguishing agents. A wide vari-

ety of agents are presented and the physical and chemical attributes related to their extinguishing mechanisms are discussed. A brief overview of the extinguishment of gaseous, liquid and solid fueled fires is presented.

The book concludes with a section covering several special fire situations. Included are spontaneous ignition, exothermic materials and oxidizing agents in contact with reducing agents. Fires in abnormal environments such as oxygen-enriched atmospheres and low gravity situations are also covered.

Overall, Dr. Friedman's revisions to the first edition of *Fire Protection Chemistry* represent a substantial advance in the communication of evolving fire science and technology. This book is highly recommended reading for the practicing fire protection engineer for an overview of recent advances and as a text in fire science and fire protection technology courses.