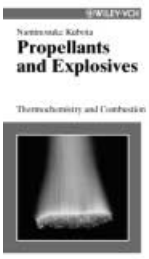
Bang up to Date

Propellants and Explosives. Thermochemical Aspects of Combustion. By *Naminosuke Kubota*. Wiley-VCH, Weinheim 2002. 245 pp., hardcover € 119.00.—ISBN 3-527-30210-7

The thermochemistry of the combustion of propellants and explosives is certainly not a simple subject. The materials usually have heterogeneous structures, the combustion process involves a transition from the solid to the liquid state and finally to the gaseous state, and the very wide range of pressures and temperatures that can be involved makes severe practical demands for experimental studies.



The book reviewed here consists of nine chapters: "Thermodynamics of Energy Conversion", "Thermochemistry of Combustion", "Combustion Wave Propagation", "Energetics of Propellants and Explosives", "Combustion of Crystalline and Polymeric Materials", "Combustion of Double-Base Propellants", "Combustion of Composite Propellants", "Combustion of Explosives", and "Combustion in a Rocket Motor".

The first, introductory, chapter explains the thermodynamic fundamentals that are needed for the discussions to follow, and shows briefly how they are applied to flow systems. The properties of shock waves and supersonic jet flow are described. This is followed by a discussion of the thermochemistry of combustion processes. Aspects treated include the available energy sources, adiabatic temperature conditions in flames, and the role of thermal dissociation.

There then follows a chapter on the propagation of combustion processes, with particular attention to the transfer of heat from the flame to the solid phase, which (apart from detonation) is of crucial importance in the combustion of propellants. Next comes a detailed description of the energetics of the various types of propellants and explosives, including a listing of the enthalpies of formation of different fuels and combustion products. Data on nitrogen content, oxygen balance, flame temperatures, and composition of exhaust gases are also listed.

These introductory chapters are followed by a detailed discussion of the combustion of crystalline and polymeric materials, beginning with ammonium perchlorate, its thermal decomposition, its rate of combustion, and the structure of the combustion zone. Ammonium nitrate, HMX, and triaminoguanidinitrate are then treated in an equally clear and systematic way, followed by glycidyl azide polymer, and bis-azidomethyloxetane.

The discussion of double-base propellants begins with nitrocellulose-nitroglycerin (NC-NG). The effects of pressure and composition on the rate of combustion are described, as also are the detailed characteristics of the combustion zone, including the dark space, temperature distribution, and reaction rates in different regions. The activation energy and the dependence of the combustion rate on temperature are discussed. Other double-base propellants are then treated similarly: nitrocellulose-trimethylolethane trinitrate, and nitro azide materials. Catalytic effects on double-base propellants are then discussed, with special reference to lead compounds. These and other catalysts can be used to alter the pressure-dependence of the rate of combustion, and can give greatly increased rates in specific pressure ranges.

Composite propellants are then discussed, beginning with those based on ammonium perchlorate. The chapter describes how the combustion characteristics are influenced by particle size, temperature, the choice of binder, and various catalysts. Nitramine composite propellants such as HMX-GAP (cyclotetramethylene tetranitromine with glycidyl acid polymer) are then treated similarly and their special properties are described. These are followed by composites consisting of triaminoguanidine nitrate with glycidyl azide polymer, and various composites of double-base propellants. Composite propellants designed for smokeless combustion are also discussed.

The book is completed by a short chapter on explosives and one on the combustion of propellants in a rocket motor, in which some current outstanding problems are carefully explained and discussed for a number of illustrative examples.

Propellants and Explosives provides a good survey of a field that is far from simple. The essential facts are presented systematically and in a clearly understandable way, helped by many figures and photographs. The author has deliberately avoided giving details of chemical reactions and mechanisms. The book will provide the interested reader with an easy introduction to this complex subject.

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