Solid Rocket Components And Motor Design

The Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) is under construction near Richmond, Kentucky, two dispose of one of the two remaining stockpiles of chemical munitions in the United States. The stockpile that BGCAPP will dispose of is stored at the Blue Grass Army Depot (BGAD). BGCAPP is a tenant activity on BGAD. The stockpile stored at BGAD consists of mustard agent loaded in projectiles, and the nerve agents GB and VX loaded into projectiles and M55 rockets. BGCAPP will process the rockets by cutting them, still in their shipping and firing tube (SFT), between the warhead and motor sections of the rocket. The warhead will be processed through BGCAPP. The separated rocket motors that have been monitored for chemical agent and cleared for transportation outside of BGCAPP, the subject of this report, will be disposed of outside of BGCAPP. Any motors found to be contaminated with chemical agent will be processed through BGCAPP and are not addressed in this report. Disposal Options for the Rocket Motors From Nerve Agent Rockets Stored at Blue Grass Army Depot addresses safety in handling the separated rocket motors with special attention to the electrical ignition system, the need for adequate storage space for the motors in order to maintain the planned disposal rate at BGCAPP, thermal and chemical disposal technologies, and on-site and off-site disposal options. On-site is defined as disposal on BGAD, and off-site is defined as disposal by a commercial or government facility outside of BGAD.

The objectives of this book is to present the fundamentals of Solid Rocket Motor, starting from the elementary analysis of rockret propulsion and then justifying the need of sophisticated computation of the internal flow. After a brief reminder of solid rocket theory, a description of its main components is proposed. The elementary parameters controlling the operation are introduced and the basic formula predicting the steadystate operation pressure is established. In this book, we have described about solid solid rocket propulsion and we explored some of the issues which are related to the performance of the whole rocket. We have also described the main design of the rocket engine and its performance related factors and design aspects which affect the perfomance of the motor, and practical limitations for motor design. The main issues faced by the Solid Rocket Engine require an accurate description of internal aerodynamics, either to predict the pressure/thrust programs and the normal transient phase like ignition, or to motor stability. A short overview of the evolution of the Solid Rocket Motor internal aerodynamics during the last thirty years is also given in the book. It is hoped that this book will provide an introductory substance to the field of solid rocket propulsion.

In the last decade, there has been an influx in the development of new technologies for deep space exploration. Countries all around the world are investing in resources to create advanced energetic materials and propulsion systems for their aerospace initiatives. Energetic Materials Research, Applications, and New Technologies is an essential reference source of the latest research in aerospace engineering and its application in space exploration. Featuring comprehensive coverage across a range of related topics, such as molecular dynamics, rocket engine models, propellants and explosives, and quantum chemistry calculations, this book is an ideal reference source for academicians, researchers, advanced-level students, and technology developers seeking innovative research in aerospace engineering.

This book, a translation of the French title Technologie des Propergols Solides, offers otherwise unavailable information on the subject of solid propellants and their use in rocket propulsion. The fundamentals of rocket propulsion are developed in chapter one and detailed descriptions of concepts are covered in the following chapters. Specific design methods and the theoretical physics underlying them are presented, and finally the industrial production of the propellant itself is explained. The material used in the book has been collected from different countries, as the development of this field has occurred separately due to the classified nature of the subject. Thus the reader not only has an overall picture of solid rocket propulsion technology but a comprehensive view of its different developmental permutations worldwide.

Whilst most contemporary books in the aerospace propulsion field are dedicated primarily to gas turbine engines, there is often little or no coverage of other propulsion systems and devices such as propeller and helicopter rotors or detailed attention to rocket engines. By taking a wider viewpoint, Powered Flight - The Engineering of Aerospace Propulsion aims to provide a broader context, allowing observations and comparisons to be made across systems that are overlooked by focusing on a single aspect alone. The physics and history of aerospace propulsion are built on step-by-step, coupled with the development of an appreciation for the mathematics involved in the science and engineering of propulsion. Combining the author’s experience as a researcher, an industry professional and a lecturer in graduate and undergraduate aerospace engineering, Powered Flight - The Engineering of Aerospace Propulsion covers its subject matter both theoretically and with an awareness of the practicalities of the industry. To ensure that the content is clear, representative but also interesting the text is complimented by a range of relevant graphs and photographs including representative engineering, in addition to several propeller performance charts. These items provide excellent reference and support materials for graduate and undergraduate projects and exercises. Students in the field of aerospace engineering will find that Powered Flight - The Engineering of Aerospace Propulsion supports their studies from the introductory stage and throughout more intensive follow-on studies.

In this book, on the basis of materials published in the Soviet and foreign press, there are expounded thermo-gas-dynamic principles of designing of rocket engines, engineering methods of calculation of processes of heat exchange, principles of the theory of burning of solid fuels and calculation of the indicated pressure curve in the combustion chamber of the engine. In it there is given basic information about solid rocket propellants applied in solid-propellant rocket engines (SPRE). There is considered regulation of thrust in SPRE in magnitude and direction, and also a general method of ballistic designing of solid-fuel rockets. (Author).

When considering the initial design of the case or load bearing components for a solid propellant rocket motor a number of possible solutions may be apparent and many factors need consideration before the design of the individual components can be finalised. The process of optimisation involves consideration of material properties, methods of manufacture, inspection and proof as well as interactions with other rocket motor and missile components. The various factors are considered and indications are given of the interactions to be taken into account. This paper concentrates primarily on the design of metallic motor cases. Both homogeneous and nonhomogeneous body structures are considered, the latter being fibre overwound metallic and strip laminates. A relatively recent requirements is that for insensitive munitions and this factor is also discussed relative to body construction.

This article introduces the PDP-11/03 microcomputer for the collection and processing of data from six component tests of solid rocket motors. It discusses the components of this system, its capabilities and special characteristics. Finally, it gives measured

values for the static precision of the system in test measurements. Keywords: Chinese translations; Test equipment. (kt).
Methods are given for nondestructively inspecting rocket motor cases, nozzles, and motor-case insulation. The motor cases may be fabricated from steel, titanium, or glass-reinforced plastics and made by welding or wrapping processes. In some designs, the nozzle consists of tungsten inserts fitted in graphite heat-sink backup rings with a molybdenum sleeve shrunk over the graphite ring. The inside insulation is generally a rubber-base substance adhered to the motor case. (Author).
The definitive text on rocket propulsion—now revised to reflect advancements in the field For sixty years, Sutton's Rocket Propulsion Elements has been regarded as the single most authoritative sourcebook on rocket propulsion technology. As with the previous edition, coauthored with Oscar Biblarz, the Eighth Edition of Rocket Propulsion Elements offers a thorough introduction to basic principles of rocket propulsion for guided missiles, space flight, or satellite flight. It describes the physical mechanisms and designs for various types of rockets' and provides an understanding of how rocket propulsion is applied to flying vehicles. Updated and strengthened throughout, the Eighth Edition explores: The fundamentals of rocket propulsion, its essential technologies, and its key design rationale The various types of rocket propulsion systems, physical phenomena, and essential relationships The latest advances in the field such as changes in materials, systems design, propellants, applications, and manufacturing technologies, with a separate new chapter devoted to turbopumps Liquid propellant rocket engines and solid propellant rocket motors, the two most prevalent of the rocket propulsion systems, with in-depth consideration of advances in hybrid rockets and electrical space propulsion Comprehensive and coherently organized, this seminal text guides readers evenhandedly through the complex factors that shape rocket propulsion, with both theory and practical design considerations. Professional engineers in the aerospace and defense industries as well as students in mechanical and aerospace engineering will find this updated classic indispensable for its scope of coverage and utility.
This report reviews rocket motor hardware component technologies for mitigating violent responses of tactical rocket motors to the various insensitive munitions (IM) stimuli and discusses major advantages and disadvantages of each technology.
The Space Shuttle Redesigned Solid Rocket Motor (RSRM) Certification Program provides confidence that the RSRM and its components/subsystems meet or exceed Mission Oriented Requirements when manufactured per design requirements and specified/approved processes. Certification is based on documented results of tests, analyses, inspections, similarity, and demonstrations. Evidencing information is provided to certify that each RSRM component/subsystem satisfies design, mission related requirements and objectives. Duersch, Fred, Jr. Unspecified Center CERTIFICATION; QUALIFICATIONS; ROCKET ENGINE DESIGN; SPACE SHUTTLE BOOSTERS; ENGINE PARTS; ENGINE TESTS; INSPECTION; MISSION PLANNING...
THE DEFINITIVE INTRODUCTION TO ROCKET PROPULSION THEORY AND APPLICATIONS The recent upsurge in global government and private spending and in space flight events has resulted in many novel applications of rocket propulsion technology. Rocket Propulsion Elements remains the definitive guide to the field, providing a comprehensive introduction to essential concepts and applications. Led by industry veteran George P. Sutton and by Professor Oscar Biblarz, this book provides interdisciplinary coverage including thermodynamics, aerodynamics, flight performance, propellant chemistry and more. This thoroughly revised ninth edition includes discussion and analysis of recent advances in the field, representing an authoritative reference for students and working engineers alike. In any engineering field, theory is only as useful as it is practical; this book emphasizes relevant real-world applications of fundamental concepts to link "thinking" and "doing". This book will help readers: Understand the physics of flight and the chemistry of propulsion Analyze liquid, solid, gas, and hybrid propellants, and the engines they fuel Consider high-temperature combustion, stability, and the principles of electric and chemical propulsion Dissect the workings of systems in common use around the world today Delve into the latest advances in materials, systems, propellants, and more Broad in scope, rich in detail, and clear in explanation, this seminal work provides an unparalleled foundation in aerospace engineering topics. Learning through the lens of modern applications untangles complex topics and helps students fully grasp the intricacies on a more intuitive level. Rocket Propulsion Elements, Ninth Edition merges information and utility building a solid foundation for innovation.
Nanomaterials in Rocket Propulsion Systems provides a broad yet detailed treatment of the use of nanotechnology relating to rocket propulsion systems. It covers the fundamentals of nanomaterials and examines a wide range of innovative applications, presenting the current state of the art in the field. Opening with a chapter on nano-sized energetic materials, the book continues to examine metal nanoparticles-based fuels, ballistic modifiers, stabilizers and catalysts as the components of rocket propellants. It then discusses the use of hydrogen storage materials for rocket propulsion based on nanotubes, nano-porous materials and metal organic frameworks, nano-gelled propellants, nano-composite ablators and ceramic nano-composites. Other applications examined include high thermal conductivity metallic nano-composite nozzle liners, nano-emitters for Coulomb propulsion of space-crafts, and highly thermostable nano-ceramics for rocket motors. The book finishes with coverage of combustion of nano-sized rocket fuels, nano-particles and their combustion in micro- and nano-electromechanical systems (MEMS/NEMS), plasma propulsion and nano-scale physics. Nanomaterials in Rocket Propulsion Systems is a valuable resource for academic and government institutions, professionals, new researchers and graduate students working in the application of nanomaterials in the aerospace industry. Provides a detailed overview of different types of nanomaterials used in rocket propulsion, highlighting different situations in which different materials should be used Demonstrates the use of new nanomaterial concepts, allowing the increase of payload capacity or decrease in the launch mass, and improvement of fuel efficiency Explores a range of applications using metal nanopowders, presenting a panorama on cutting edge technological developments
Easy PVC Rockets is a book on how to make your own model rocket engines at home with easy techniques and readily available materials. Using only stump remover, powdered sugar, kitty litter, and some PVC pipe you can create a whole array of rocket engine designs ranging from small bottle rockets to large F class engines. Also in the book are homemade methods to creating your own model rockets, launch stands, and electrical ignition systems also from readily available materials.
Developed and expanded from the work presented at the New Energetic Materials and Propulsion Techniques for Space Exploration workshop in June 2014, this book contains new scientific results, up-to-date reviews, and inspiring perspectives in a number of areas related to the energetic aspects of chemical rocket propulsion. This collection covers the entire life of energetic materials from their conceptual formulation to practical manufacturing; it includes coverage of theoretical and experimental ballistics, performance properties, as well as laboratory-scale and full system-scale, handling, hazards, environment, ageing, and disposal. Chemical Rocket Propulsion is a unique work, where a selection of accomplished experts from the pioneering era of space propulsion and current technologists from the most advanced international laboratories discuss the future of chemical rocket propulsion for access to, and exploration of, space. It will be of interest to both postgraduate and final-year undergraduate students in aerospace engineering, and practicing aeronautical engineers and designers, especially those with an interest in propulsion, as well as researchers in energetic materials.
Thermal radiation from the plume of any solid rocket motor, containing aluminum as one of the propellant ingredients, is mainly from the microscopic, hot aluminum oxide particles in the plume. The plume radiation to the base components of the flight vehicle is primarily determined by the plume flowfield properties, the size distribution of the plume particles, and their optical properties. The optimum design of a vehicle base thermal protection system is dependent on the ability to accurately predict this intense thermal radiation using validated

theoretical models. This article describes a successful effort to collect reasonably clean plume particle samples from the static firing of the flight simulation motor (FSM-4) on March 10, 1994 at the T-24 test bed at the Thiokol space operations facility as well as three 18.3% scaled MNASA motors tested at NASA/MSFC. Prior attempts to collect plume particles from the full-scale motor firings have been unsuccessful due to the extremely hostile thermal and acoustic environment in the vicinity of the motor nozzle. Sambamurthi, Jay K. Marshall Space Flight Center NASA-TM-111873, NAS 1.15:111873 ...

The purpose of this book is to discuss, at the graduate level, the methods of performance prediction for chemical rocket propulsion. A pedagogical presentation of such methods has been unavailable thus far and this text, based upon lectures, fills this gap. The first part contains the energy-minimization to calculate the propellant-combustion composition and the subsequent computation of rocket performance. While incremental analysis is for high performance solid motors, equilibrium-pressure analysis is for low performance ones. Both are detailed in the book's second part for the prediction of ignition and tail-off transients, and equilibrium operation. Computer codes, adopting the incremental analysis along with erosive burning effect, are included. The material is encouraged to be used and presented at lectures. Senior undergraduate and graduate students in universities, as well as practicing engineers and scientists in rocket industries, form the readership.

This book focuses on the performance and application of fluidic nozzle throats for solid rocket motors, discussing their flow details and characterization performance, as well as the influence of the particle phase on their performance. It comprehensively covers a range of fluidic nozzle throats in solid rocket motors and is richly illustrated with impressive figures and full-color photographs. It is a valuable resource for students and researchers in the fields of aeronautics, astronautics and related industries wishing to understand the fundamentals and theories of fluidic nozzle throats and engage in fluidic nozzle throat analysis and design.

This document sets standards for the characterization of solid propellant rocket motor propulsion systems. The characteristics are presented as a check list for ten different component parts including the overall propulsion system, analysis, the rocket motor case, nozzle, propellant, liner, insulation, igniter, ingredients, and energy management. The characterization of a propulsion system is invariably limited by available time, manpower, funding, and other resources. However, the enclosed listing attempts to identify the characteristics, properties, required tests, and information which would make up the data base for a fully characterized solid rocket propulsion system. The list recognizes that different degrees of characterization would be required at different stages in the evolution of a propulsion system. The characterizations for an initial effort (as in the research or concept phase) might be distinctly different from the characterization done late in the evolution and just prior to production.

Space Shuttle Flight Support Motor No. 1 (FSM-1) was static test fired on 15 Aug. 1990 at the Thiokol Corporation Static Test Bay T-24. FSM-1 was a full-scale, full-duration static test fire of a redesigned solid rocket motor. FSM-1 was the first of seven flight support motors which will be static test fired. The Flight Support Motor program validates components, materials, and manufacturing processes. In addition, FSM-1 was the full-scale motor for qualification of Western Electrochemical Corporation ammonium perchlorate. This motor was subjected to all controls and documentation requirements CTP-0171, Revision A. Inspection and instrumentation data indicate that the FSM-1 static test firing was successful. The ambient temperature during the test was 87 F and the propellant mean bulk temperature was 82 F. Ballistics performance values were within the specified requirements. The overall performance of the FSM-1 components and test equipment was nominal. Hughes, Phil D. Unspecified Center AMMONIUM PERCHLORATES; FULL SCALE TESTS; SOLID PROPELLANT ROCKET ENGINES; SPACE SHUTTLES; SPACE TRANSPORTATION SYSTEM FLIGHTS; STATIC TESTS; TEST FIRING; AMBIENT TEMPERATURE; BALLISTICS; INSPECTION; MANUFACTURING; QUALIFICATIONS...

A solid propellant rocket motor containing 60.9 Kg (134-lb) of propellant was successfully static fired after being subjected to eight heat sterilization cycles (three 54-hour cycles plus five 40-hour cycles) at 125 C (257 F). The test motor, a modified SVM-3 chamber, incorporated a flexible grain retention system of EPR rubber to relieve thermal shrinkage stresses. The propellant used in the motor was ANB-3438, and 84 wt% solids system (18 wt% aluminum) containing 66 wt% stabilized ammonium perchlorate oxidizer and a saturated hydroxylterminated polybutadiene binder. Bonding of the propellant to the EPR insulation (GenGard V-4030) was provided by the use of SD-886, an epoxy urethane restriction.

Testing was performed to determine the useful shelf/service life for LGM-30 (Minuteman-3) Stage I solid propellant rocket motors. A three year storage program for propellant and components was started in May 1961. This program was then extended indefinitely to assure that a deterioration in motor physical characteristics could be detected in time to take some corrective actions before the weapon system performance deteriorated below an acceptable level. This report covers solid rocket propellant test data for motor S/N 0012199. Planned dissection of selected motors in the future will provide samples for continued component testing. The data is presented in the form of regression analysis and the trends are projected 24 months beyond the last test date. From the statistical analysis of all data tested to date, significant degradation of the propellant does not appear likely for at least two years past the oldest data point.

Rocket and air-breathing propulsion systems are the foundation on which planning for future aerospace systems rests. A Review of United States Air Force and Department of Defense Aerospace Propulsion Needs assesses the existing technical base in these areas and examines the future Air Force capabilities the base will be expected to support. This report also defines gaps and recommends where future warfighter capabilities not yet fully defined could be met by current science and technology development plans.

Principles of Nuclear Rocket Propulsion provides an understanding of the physical principles underlying the design and operation of nuclear fission-based rocket engines. While there are numerous texts available describing rocket engine theory and nuclear reactor theory, this is the first book available describing the integration of the two subject areas. Most of the book’s emphasis is primarily on nuclear thermal rocket engines, wherein the energy of a nuclear reactor is used to heat a propellant to high temperatures and then expel it through a nozzle to produce thrust. Other concepts are also touched upon such as a section devoted to the nuclear pulse rocket concept wherein the force of externally detonated nuclear explosions is used to accelerate a

spacecraft. Future crewed space missions beyond low earth orbit will almost certainly require propulsion systems with performance levels exceeding that of today's best chemical engines. A likely candidate for that propulsion system is the solid core Nuclear Thermal Rocket or NTR. Solid core NTR engines are expected to have performance levels which significantly exceed that achievable by any currently conceivable chemical engine. The challenge is in the engineering details of the design which includes not only the thermal, fluid, and mechanical aspects always present in chemical rocket engine development, but also nuclear interactions and some unique materials restrictions. Sorts and organizes information on various types of nuclear thermal rocket engines into a coherent curriculum Includes a number of example problems to illustrate the concepts being presented Features a companion site with interactive calculators demonstrating how variations in the constituent parameters affect the physical process being described Includes 3D figures that may be scaled and rotated to better visualize the nature of the object under study
Hardbound. This book, a translation of the French title Technologie des Propergols Solides, offers otherwise unavailable information on the subject of solid propellants and their use in rocket propulsion. The fundamentals of rocket propulsion are developed in chapter one and detailed descriptions of concepts are covered in the following chapters. Specific design methods and the theoretical physics underlying them are presented, and finally the industrial production of the propellant itself is explained. The material used in the book has been collected from different countries, as the development of this field has occurred separately due to the classified nature of the subject. Thus the reader not only has an overall picture of solid rocket propulsion technology but a comprehensive view of its different developmental permutations worldwide.
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