Development Of Solid Propellant Technology In India

In this definitive study, J. D. Hunley traces the program's development from Goddard's early rockets (and the German V-2 missile) through the Titan IVA and the Space Shuttle, with a focus on space-launch vehicles. Since these rockets often evolved from early missiles, he pays considerable attention to missile technology, not as an end in itself, but as a contributor to launch-vehicle technology. Focusing especially on the engineering culture of the program, Hunley communicates this very human side of technological development by means of anecdotes, character sketches, and case studies of problems faced by rocket engineers. He shows how such a highly adaptive approach enabled the evolution of a hugely complicated technology that was impressive—but decidedly not rocket science. Unique in its single-volume coverage of the evolution of launch-vehicle technology from 1926 to 1991, this meticulously researched work will inform scholars and engineers interested in the history of technology and innovation, as well as those specializing in the history of space flight.

If the United States hopes to continue as a leader in space, it must invest now in better earth-to-orbit technology by replacing obsolete launch facilities while also developing a new class of more robust

and reliable vehicles. From Earth to Orbit provides strategies to reduce launch costs while increasing the reliability and resiliency of vehicles. It also recommends continued improvements for the Space Shuttle Orbiter and its subsystems and the development of a Space Transportation Main Engine (STME).

In Minuteman: A Technical History of the Missile That Defined American Nuclear Warfare, David K. Stumpf demystifies the intercontinental ballistic missile program that was conceived at the end of the Eisenhower administration as a key component of the US nuclear strategy of massive retaliation. Although its nuclear warhead may have lacked power relative to that of the Titan II, the Minuteman more than made up for this in terms of numbers and readiness to launch—making it the ultimate ICBM. Minuteman offers a fascinating look at the technological breakthroughs necessary to field this weapon system that has served as a powerful component of the strategic nuclear triad for more than half a century. With exacting detail, Stumpf examines the construction of launch and launch control facilities; innovations in solid propellant, lightweight inertial guidance systems, and lightweight reentry vehicle development; and key flight tests and operational flight programs—all while situating the Minuteman program in the context of world events. In doing so, the author reveals how the historic

missile has adapted to changing defense strategies—from counterforce to mutually assured destruction to sufficiency.

Small, unmanned aerial vehicles (UAVs) are expanding the capabilities of aircraft systems. However, a gap exists in the size and capability of aircraft: no aircraft smaller than 10 kilograms are capable of flight faster than 100 meters per second. A small, fast aircraft requires a propulsion system which is both miniature and high-power, requirements which current UAV propulsion technologies do not meet. To meet this need, a slow-burning solid rocket motor has been developed. Such motors require slow-burning solid propellants with tailorable burn rate. This thesis reports experimental results and combustion theory for a slow-burning solid propellant. It also describes a rocket motor designed to use this propellant, and the manufacturing process used to produce it. This propellant burns slowly enough for the low-thrust, long-endurance needs of UAV propulsion. Its burn rate can be predictably tailored by addition of the burn rate suppressant oxamide. Further, this thesis presents a concept for a small, fast aircraft designed around this novel propulsion technology. The motor integrates elegantly into the aircraft's structure, and compact thermal protection system insulates other vehicle systems from the heat of combustion. These results demonstrate the feasibility slow-burning rocket propulsion systems, and their application to small aircraft. It should be possible for small, rocket-propelled UAVs to sustain powered, transonic flight for several minutes. With this technology, kilogram-scale UAVs

could be able to quickly deploy over tens of kilometers, and fly joint missions alongside manned fighter jets. Small, uncrewed aerial vehicles (UAVs) are expanding the capabilities of aircraft systems. However, a gap exists in the size and capability of aircraft: no small aircraft are capable of sustained fast flight. A small, fast aircraft requires a propulsion system which is both miniature and high-power, requirements which current UAV propulsion technologies do not meet. Solid propellant rocket motors could be used, but must be re-engineered to operate at much lower thrust and for much longer burn times than conventional small solid rocket motors. This imposes unique demands on the motor and propellant. This work investigates technological challenges of small, low-thrust solid rocket motors: slow-burn solid propellants, motors which have low thrust relative to their size (and thus have low chamber pressure), thermal protection for the motor case, and small nozzles which can withstand long burn times. Slow-burn propellants were developed using ammonium perchlorate oxidizer and the burn rate suppressant oxamide. By varying the amount of oxamide (from 0-20%), burn rates from 4mms?1 to 1mms?1 (at 1MPa) were achieved. Using these propellants, a low-thrust motor successfully operated at a (thrust / burn area) ratio 10 times less than that of typical solid rocket motors. This motor can provide 5–10N of thrust for 1-3 minutes. An ablative thermal protection liner was tested in these firings. Despite the long burn time, only a few millimeters of ablative are needed. A new ceramic-insulated nozzle was demonstrated on this motor. The nozzle has a small

throat diameter (only a few millimeters) and can operate in thermal steady-state. Models were developed for the propellant burn rate, motor design, heat transfer within the motor and nozzle, and for thermal stresses in the nozzle insulation. This work shows that small, low-thrust solid motors are feasible, by demonstrating these key technologies in a prototype motor. Further, the experimental results and models will enable engineers to design and predict the performance of solid rocket motors for small, fast aircraft. By providing insight into the physics of these motors, this thesis may help to enable a new option for aircraft propulsion.

Boron-Based Fuel-Rich Solid Rocket Propellant Technology is a professional book that systematically introduces the latest research progress for boron-based fuel-rich solid propellants. It covers surface modifications, coating and agglomerating techniques, granulation, and characterization of amorphous boron powders, and its application to fuel-rich solid rocket propellants. Technologies for controlling the processing methods and combustion performance of fuel-rich propellants are examined, and the book concludes with a summary of the research progress in boron-based fuel-rich solid propellants and a look forward to the foreseeable development trends of military applications.

The book is a treatise on solid propellants in nine chapters, covering the history, chemistry, energetics, processing and characterization aspects of composite solid propellants, internal ballistics, advanced solid propellants, safety, quality and reliability and homogenous or double base propellants. The book also

traces the evolution of solid propellant technology in ISRO for launch vehicles and sounding rockets. There is a detailed table of contents, expanded index, glossary, exhaustive references and questions in each chapter. It can be used as a textbook for science and engineering students, as a reference book for researchers and as a companion to scientists and engineers working in the research, development and production areas of solid propellants.

The purpose of this program is the development, design, fabrication, and demonstration of packageable, highexpansion-ratio nozzles for solid propellant rocket motors. The program is to be accomplished by conducting (1) a design and analysis program adapting liquid technology to solid propellant motors; (2) a subscale test program to verify the selected designs; and (3) a demonstration test program that will utilize the test experience of the subscale program and demonstrate the feasibility of elastomeric and metallic packageable exit cones for solid motors. During this report period the subscale test program was successfully completed. On the demonstration program the progress was as follows: the design was completed on the metallic and elastomeric exit cones; the first four motors have been cast, the second motor has a bond separation and will require refurbishing; the igniters have been completed; and the nozzles are partially fabricated. (Author).

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.

There is no available information at this time. Author will provide once available.

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.

Rocket Propulsion has come of age. Although its potentialities and capabilities in many areas have been recognized for centuries, it is only in recent years that scientists have had the materials and the manufacturing techniques at their command so they could control and direct the tremendous forces available. Space exploration and manned flights by astronauts have brought the science of rocketry to the attention of the general public. It has also stimulated the interest of students at all level

The development of propellants for the forward and aft grains was completed by means of laboratory evaluations and subscale motor tests. Present technology was demonstrated by testing full-scale motors containing 300 lb of propellant both at sea-level and altitude. Excellent results were achieved in these tests in which the motors were programmed for both pulse and throttling operation. Thrust ratios as high as 9 to 1 were achieved. Another full-scale test series was conducted to demonstrate the technology advancements made throughout the entire three-year effort. These motors contained the advanced propellants developed during the program, an improved control valve and control system, and nozzles specifically designed for on-off motor operations. Tests of these 300-lb motors were conducted both at sea level and altitude. One of these motors demonstrated nine stop-restart cycles at altitude conditions. A full- scale test that fully demonstrated the feasibility of adapting the DCCSR concept to a post-boost propulsion system was also conducted.
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.

Solid Propellant Rocket Research

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