TECHNICAL MEMORANDUM X-53149

BIBLIOGRAPHY ON FLUORINE AND FLUORINE OXYGEN OXIDIZERS FOR SPACE APPLICATIONS

By

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Huntsville, Alabama

ABSTRACT

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This bibliography references approximately 350 reports on fluorine and fluorine-oxygen mixtures (FLOX). In the introduction, current government contracts pertaining to FLOX and fluorine are listed. The bibliography includes separate sections dealing with material compatibility; handling, storage, disposal, and safety considerations; physical and chemical properties; propellant oxidizer studies; vehicle component design studies; and miscellaneous reports.

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MATERIALS DIVISION

PROPULSION AND VEHICLE ENGINEERING LABORATORY

RESEARCH AND DEVELOPMENT OPERATIONS

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SUMMARY

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INTRODUCTION

Since liquid fluorine in combination with most fuels gives higher performance and energy than most other oxidizers for space vehicle applications, interest in this oxidizer has been increasing in recent years. Even more recently, it has been found that a mixture of 70 percent liquid fluorine and 30 percent liquid oxygen will deliver a higher specific impulse than 100 percent fluorine when used with a hydrocarbon type fuel.

With the idea that more dilute concentrations of fluorine (20 to 40%) with oxygen (FLOX) would reduce the handling difficulties, material compatibility, and other problems associated with using pure fluorine, the use of FLOX is rapidly gaining nationwide interest. If the major engineering problems are greatly reduced, the use of FLOX would be the quickest and most economical method to increase the thrust of present space vehicles since only slight modification to the present vehicles and engines would be required.

This bibliography was compiled to provide information on materials compatibility, handling, storage, transportation, disposal facilities, safety considerations, physical and chemical properties, propellant oxidizer studies, vehicle component design studies, and other topics pertaining to fluorine and FLOX.

References were selected from the open literature as well as the unclassified and classified reports. The following sources were consulted:

1. Defense Documentation Center (Formerly ASTIA)
2. NASA STAR
3. NASA CSTAR
4. NACA Index

5. Technical Publication Announcements (TPA)
6. Classified T. P. A.
7. International Aerospace Abstracts
8. National Association of Corrosion Engineers Abstracts
9. Chemical Abstracts
10. NASA-MSFC Technical Library
11. Redstone Scientific Information Center

For convenience in using this information, the references have been grouped into various categories as follows:

1. Materials Compatibility
2. Handling, Storage, Disposal, and Safety Considerations
3. Physical and Chemical Properties
4. Propellant Oxidizer Studies
5. Vehicle Component Design Studies
6. Miscellaneous

Since the interest in FLOX is so recent, a considerable amount of research on its use and handling is presently being conducted. Current government contracts, which should provide additional information on this subject in the near future, are listed below:

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c. AF04(611)8196, Prototype Propellant Testing Systems, R. C. Adrian, H. C. Edgington and F. E. Miller.
d. AF04(611)9364, Space Environment Studies, G. K. Cornelius and others.
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Atlantic Research Corporation, Alexandria, Virginia

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Bell Aerosystems Company, Buffalo, New York

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c. AF OR(611)7264, Maneuvering Satellite Program.
d. AF04(611)8183, Research Feasibility Demonstration, A. Kimball and others.
e. AF04(611)8200, Development of Expulsion and Orientation Systems for Advanced Liquid Rocket Propulsion Systems, D. Neuman and others.
f. AF04(647)908 and AF04(695)26, Bell Model 8181 Chariot (Fluorine-Hydrazine Study), A. H. Kimball.
g. AF33(657)8555, Physical Chemistry, J. J. Quinones and A. B. Misercola.
h. NAA-P. O. M3J3XA406027 (A Sub-Contract from North American Aviation on Fluorine).

Boeing Company, New Orleans, Louisiana

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Bureau of Mines, Pittsburgh, Pennsylvania

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Convair, San Diego, California

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c. Experimental Hydrogen/Fluorine Rocket Performance at Low Pressures and High Area Ratios, C. A. Aukerman and B. E. Church.
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National Bureau of Standards, Cryogenic Engineering Laboratory, Denver, Colorado

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New York University, New York City, New York

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Rocketdyne, Canoga Park, California

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c. NAS8-2654, Aerodynamic Nozzle Study.
d. NONR 1818/00, Research in Fluorine Chemistry, Rogers, Johnson and Evans.

Rocket Power Incorporated, Pasadena, California

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Rocket Research Corporation, Seattle, Washington

a. AF04(611)8545, Development of High Energy Pulse Throttled Micro-Thrust Rocket Engines.

Space Technology Laboratory, Incorporated, Los Angeles, California

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Washington University, Seattle, Washington

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The following contractors have done research in fluorine or fluorine containing oxidizers in the last 2 years and may have information of value:

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Air Reduction Chemical and Carbide Company, New York City, New York
Borg-Warner Corporation, Chicago, Illinois
Chrysler, Missile Systems Division, Huntsville, Alabama
Connecticut Hard Rubber Company, New Haven, Connecticut
Dow Chemical Company, Midland, Michigan
DuPont de Nemours, E. I., and Company, Wilmington, Delaware
General Chemical Division, Allied Chemical and Dye Corporation, New York City, New York
Jet Propulsion Laboratory, Pasadena, California
Linde Company, a Division of Union Carbide Corporation, Tonawanda, New York
Ohio State University, Cryogenics Laboratory, Columbus, Ohio
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October 16, 1964 APPROVAL NASA TM X-53149

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By J. H. Cabaniss

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