NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.
MOTOR, JET, AND ROCKET FUELS

Review Article

(Report No. 1 in this series)

AVAILABLE COPY WILL NOT PERMIT
FULLY LEGIBLE REPRODUCTION.
REPRODUCTION WILL BE MADE IF
REQUESTED BY USERS OF DDC.

Aerospace Technology Division
Library of Congress
Surveys of Soviet-Bloc Scientific and Technical Literature

MOTOR, JET, AND ROCKET FUELS

Review Article

(Report No. 1 in this series)

The publication of this report does not constitute approval by any U. S. Government organization of the inferences, findings, and conclusions contained herein. It is published solely for the exchange and stimulation of ideas.

Aerospace Technology Division
Library of Congress
FOREWORD

This report, prepared in response to ATD Work Assignment No. 77, is a comparison of the 1957 and the 1962 editions of a book on motor fuels. The editions were originally published as follows:


The purpose of this comparison is to show the nature of coverage of the enlarged 1962 edition. No further editions of this book are known at the present time.

Full translations of some of the source materials used in this report may be available from other agencies or commercially. Interested readers may obtain translation data for individual sources by indicating source numbers from the bibliography list on the form attached at the end of this report and returning it to the Aerospace Technology Division.
TABLE OF CONTENTS

Foreword
Publication Data ............................................. v
Comparison of Contents .................................... 1
Comment .................................................... 4
Appendix I: Phase I of 1962 Edition

- iy -
MOTOR, JET, AND ROCKET FUELS

Publication Data

A. Papok, K. K., and Ye. G. Semenido, eds. Motor fuels, lubricants, and fluids. v. 1. Motor fuels. Third revised and enlarged edition. Moscow, Gostoptekhizdat, 1957. 512 p. This volume was sent to typesetting on 18 Sept 1956 and was ready for printing 11 Feb 1957. The latest references include sources from the first half of 1956.


The statistical differences between these two editions can be seen in the following: (B) has 229 pages, 35 tables, and 117 graphs more than (A).
In order to simplify the text, the 1957 edition will be marked (A), and the 1962 edition will be marked (B). Both books, (A) and (B), contain references to Soviet research in the text in addition to the prevailing Western references.

The following table is introduced here to give the reader a preliminary comparison of the chapters in (A) and (B):

<table>
<thead>
<tr>
<th>CHAPTERS IN</th>
<th>(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter I-V</td>
<td>[See Phase I]</td>
</tr>
<tr>
<td>Chapter VI</td>
<td>Combustion of motor fuels</td>
</tr>
<tr>
<td>Chapter VII</td>
<td>Composition of motor fuels</td>
</tr>
<tr>
<td>Chapter VIII</td>
<td>Antiknock agents</td>
</tr>
<tr>
<td>Chapter IX</td>
<td>Water injection</td>
</tr>
<tr>
<td>Chapter X</td>
<td>Low-temperature behavior of fuels</td>
</tr>
<tr>
<td>Chapter XI</td>
<td>Automobile fuels</td>
</tr>
<tr>
<td>Chapter XII</td>
<td>Diesel fuels</td>
</tr>
<tr>
<td>Chapter XIII</td>
<td>Fuels for aviation</td>
</tr>
<tr>
<td>Chapter XIV</td>
<td>Jet fuels</td>
</tr>
<tr>
<td>Chapter XV</td>
<td>Rocket fuels</td>
</tr>
<tr>
<td>Chapter XVI</td>
<td>Storage of motor fuels</td>
</tr>
<tr>
<td>Chapter XVII</td>
<td>Boiler fuels</td>
</tr>
<tr>
<td>Chapter XVIII</td>
<td>Handling; toxicity</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comparison of individual chapter of edition (B) with edition (A):

Chapters I to V are essentially the same in scope in both editions, with (B) containing more recent data, e.g., (A) shows VTI-GOST 5080-49 and (B) shows VTI-GOST 5080-55 for the determination of the heat of combustion.

Chapter VI is expanded by the addition of the following section: 1) The effect of liquid-state oxidation on preignition reactions in engines; 2) Fuel combustion in
Chapters VII to X represent new headings (see Phase I). In Chapter VIII, the carbon-deposit formation of the T-4 fuel is given as 13 mg/5 min (Zarubin and Slavinskiy).

Chapter XI repeats Ch. X from (A) with the addition of one section on evaporation of fuels at low temperatures.

Chapters XII to XIV are new headings (see Phase I). The section of "Corrosivity of sulfur fuels" in Ch. XII includes data for the sulfur content in T-4 fuel and on the corrosion of VB-24 bronze in T-4.

Chapter XV is an expansion of Ch. VIII in (A) and covers organic and inorganic antiknock agents: aniline, xyldine, TEL, tetraethyltin, diethylselenium, diethyltellurium, nickel tetracarbonyl, iron pentacarbonyl, Soviet "ethyl fluids" R-9, 1-TS, and F-2, MD-CMT (AK-33x), TLA, and the Soviet additive "ekstralin."

Chapter XVI is a shorter version of Ch. XIII in (A) containing a general description of US and Soviet aviation gasolines. The Soviet fuels are: GOST-5760-51; BA; GOST 1012-54; B-100/130, B-95/130, B-91/115, B-70. A separate section discusses the stability of gasolines in storage.

Chapter XVII is an updated version of Ch. XI in (A).

Chapter XVIII is an updated version of Ch. XII in (A).

Chapter XIX covers the subject matter presented in Ch. XVII in (A) in an updated and expanded text (including 1960 sources).

Chapter XX is a shorter and updated version of Ch. XIV in (A) with references including 1959 sources. Fuels discussed in this chapter are: T-1 (GOST 4138-49; TS-1 (GOST 7149-54); T-2 (GOST 8410-57); T-5 (GOST 9145-59); US fuels and NATO fuels. Chapter XIV (A) gives some of the characteristics of T-1, TS-1, and T-2, but without GOST requirements. Instead, Table 114 shows technical norms for wide-fraction general types of fuels (gasoline type, ligroine type, kerosine type, etc.). These data are based on one Soviet source (Nikolayev, 1947) and five Western sources. Data for the ligroine type, kerosine type, and straight-run wide fraction (Table 114 in (A) corresponds to data for TS-1, T-1, and T-2 (Table 143 in (B)), respectively. Table 143 in (B) gives GOST requirements for T-1, TS-1, T-2, and the new T-5.
Chapter XXI consists of two sections taken from Ch. XIV (A) plus a new section on oxidation in storage of ABJE fuels (T-1, TS-1, T-2).

Chapter XXII is principally a new chapter which contains some of the text on fuel stability from Ch. XIV (A). Sources for this chapter include materials from 1960. Soviet fuels mentioned in this chapter are fuel types: T-1, TS-1, T-2, T-4, and T-5. The text shows that T-4 consists of straight-run gasoline and kerosene fractions plus thermal cracking products. The filtration performance of T-4 is shown in Table 172 (Sablina, Gureyev, 1959) in comparison with T-1, TS-1, T-2, T-5, and cracking kerosene.

Chapter XXIII constitutes a new chapter (16 pages) which is an expansion of the last section (3 pages) in Ch. XIV (A); "Future Trends in ABJE Fuels." The 1957 text discusses, in general terms, the need for improved fuels to be used in supersonic aircraft (Mach 1.5—2.5). Thermal stability of fuels is considered an important factor (this problem is treated in the 1963 edition as a separate chapter; Ch. XXIII). Chapter XXIII, in addition to high-energy fuels (Al, B, Mg — hydrocarbon fuels), includes the standard Soviet fuels, T-1, TS-1, T-2, and T-5, indicates that the latter has the highest energy index. The authors conclude that organometallic fuels appear to be the best fuels for use in the immediate future. The chapter is based on two Soviet sources (Zrelov, 1959; and Chertkov, et. al., 1954) and 25 Western sources.

Chapter XXIV is an introduction to liquid propellants. It gives a historical review of the LP development and, together with Ch. XXV to XXVII, gives expanded coverage of the subject dealt with in Ch. XV (A).

Chapter XXV is based mostly on Western sources (nine Soviet references out of a total of 52 including 1960 materials); for instance, the table of properties of elemental fuels (H, Li, Be, B, C, Mg, Al, Si) is taken from Hippman, Burgess, and Leonard; the table for hydrogen fuels is from Aero Digest, etc.

Chapter XXVI is based mostly on Western literature (11 Soviet out of 56 references) and reviews known oxidizers with most of the specifics quoted from Western sources.

Chapter XXVII covers general aspects of monopropellants using five Soviet references out of 17. The following compounds are mentioned: nitro compounds, H_2O_2, N_2H_4, C_2H_4O.
Chapter XXVIII is a new chapter on the filtering of aviation fuels based on Western sources with one section entitled, "Method for Visual Evaluation of Fuel Purity Used in the Soviet Union" (nine lines in the text). This rough method is based on simple visual observation of the presence or absence of macroimpurities.

Chapter XXIX is a new chapter on the flammability of fuels from the point of view of eliminating fire hazards. Air-fuel mixtures are discussed for such fuels as: A-66, A-74, B-70, B-19/115, B-95/130, T-2, TS-1, T-1, and kerosine.

Chapter XXX is essentially a repetition of Ch. XVIII in (A), updated to 1959.

COMMENT: This writer finds the 1962 edition more descriptive, too general, and less readable than the 1957 edition. The purpose of the book probably accounts for this since it is intended for engineers and technicians in fuel handling, engine operation, and petroleum refining. The usual omission of specific Soviet data in the more important fields is evident throughout the book.
Papok, K. K., Doctor of Technical Sciences, Professor, and Ye. G. Semenido, Doctor of Technical Sciences, Professor, eds.


PURPOSE: This book is intended for engineers and technicians in fuel handling, engine operation, and petroleum refining.

COVERAGE: This is the fourth edition, revised and enlarged, of the original book published in 1957. The editors believe that the large amount of new material included justifies considering it as an entirely new book. It deals with the physical, chemical, and service properties of propellants and fuels for aircraft piston engines, turbojets, ramjets, rockets, automobiles, diesels, stationary turbines, and boilers. In addition to combustion problems, discussions of corrosion, carbon deposits, and residue formation are included. No personalities are mentioned.

#References follow each chapter.*

Card 1/17

*Authors of individual chapters are listed on page 4. Additional Soviet personalities are mentioned in the text in connection with Soviet research quoted. [Writer's note]

**Most of the references cover sources up to 1960. One or two are from 1961. [Writer's note]
Motor, Jet, and Rocket Fuels

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.</td>
<td>Vaporization and Mixing of Fuel in Engines [N. A. Ragozin]</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Vaporization and mixing in carburetor-equipped engines</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Vaporization and mixing in engines with direct injection</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Vaporization and mixing in engines with compression ignition (diesel)</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Mixing in gas-turbine engines</td>
<td>94</td>
</tr>
<tr>
<td>VI.</td>
<td>Fuel Combustion in Engines [G. S. Shimonayev]</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Preignition reactions during the self-ignition of hydrocarbon-air mixtures</td>
<td>100</td>
</tr>
<tr>
<td>VII.</td>
<td>Heat of Combustion of Hydrocarbon Fuels [Ya. B. Chertkov]</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td>Methods for calculating the heat of combustion</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td>Dependence of the heat of combustion on the chemical composition of fuels</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>Effect of the heat of combustion of fuels on engine performance</td>
<td>149</td>
</tr>
</tbody>
</table>
Motor, Jet, and Rocket Fuels

- Carbon deposits 153
- Effects of carbon deposits 161
- Methods of evaluating the carbon-deposit characteristics of fuels 165
- Varnish-formation characteristics of fuels 178

Ch. IX. Nonhydrocarbon Impurities in Petroleum and Petroleum Products [Ya. B. Chertkov] 185
- Nonhydrocarbon impurities in petroleum 185
- Nonhydrocarbon impurities in various fuels 187

Ch. X. Gum and Sediment Formation in Hydrocarbon Mixtures [Ya. B. Chertkov] 197
- Gums 197
- Composition and characteristics of sediment 202
- Mechanism of formation of the solid phase in hydrocarbon media 208

Motor, Jet, and Rocket Fuels

Ch. XI. Behavior of Fuels at Low Temperatures [B. A. Englin] 214
- Separation of highly volatile hydrocarbons from fuels at low temperatures 215
- Character of the viscosity changes of fuels when their temperature is lowered 221
- Behavior of water and water vapor in the fuel lines of an engine 225
- Vaporization of fuels at low temperatures 234

Ch. XII. Corrosion Properties of Fuels [B. V. Losikov] 238
- Corrosion properties of sulfur fuels 238
- Corrosion properties of the combustion products of sulfur fuels 252
- Corrosion of piston elements of internal-combustion engines 259

Card 7/17

Card 8/17
Ch. XIII. Composition and Properties of Basic Types of Fuels and Components [B. A. Englin]

Basic fuels 267
Fuel components 282

Ch. XIV. Additives to Engine Fuels [Z. A. Sablina]

Additives improving the motor properties of fuels 296
Additives improving the chemical stability of fuels in service 302
Anticorrosion additives 316
Additives improving the service properties of fuels at low temperatures 322
Additives preventing the accumulation of static electricity in fuels 326

Ch. XV. Knock Suppressors [I. V. Rozhkov]

Tetraethyl lead 332
Mechanism of knock suppression 335
Lead "carriers" and ethyl fluids 337

Ch. XVI. Fuels for Aircraft Piston Engines [I. V. Rozhkov]

Quality requirements for aviation gasolines 352
Grades of aviation gasolines 354
Increasing the stability of ethyl gasolines in storage 358

Ch. XVII. Gasolines for Automobiles [A. A. Gureyev]

Grades of automobile gasolines 365
Chemical composition of automobile gasolines 369
Motor, Jet, and Rocket Fuels  

Fractional composition of automobile gasolines 374  
Antiknock properties of automobile gasolines 388  
Chemical stability of automobile gasolines 392  
Corrosion tendency of automobile gasolines 399  
Automobile gasolines of non-Soviet countries 402  

Ch. XVIII. Diesel Fuels [B. A. Englin] 409  
Requirements for diesel fuels 411  
Fuel properties determining the smooth operation of the fuel system 412  
Fuel properties assuring normal combustion 418  
Grades of diesel fuels 422  

Ch. XIX. Boiler Fuels [A. D. Fat'yanov] 430  
General information 430  
Basic properties of liquid boiler fuels 434  

Ch. XX. Fuels for Air-Breathing Jet Engines (ABJE) [V. N. Zrelov] 477  
Conditions for the adaptation of fuels for ABJE 478  

Card 11/17
Ch. XXIII. Prospective Fuels for ABJE [V. N. Zrelov] 571

Prospective uses of petroleum fuels for ABJE 573
Synthetic hydrocarbon ABJE fuels 576
Boron hydride fuels 578
Metal hydrocarbon fuels 582
Organometallic fuels 585

Card 13/17

Ch. XXIV. Propellants for Liquid-Propellant Rocket Engines (LPRE) [P. P. Zarudniy] 588

General information 588
LPRE in brief 592
Requirement from LPRE propellants 594
Classification of rocket engine propellants 603

Ch. XXV. Fuels for LPRE [P. P. Zarudniy] 607
Hydrocarbon fuels 607
Alcohol-base fuels 612
Amine-based fuels 620
Hydrazine and derivatives 627
Liquid hydrogen as a fuel 634
Metal-based fuels 637

Ch. XXVI. Oxidizers for LPRE [A. A. Bratkov] 641
Oxygen and ozone 641

Card 14/17

- 11 -
Motor, Jet, and Rocket Fuels

| Concentrated hydrogen peroxide | 649 |
| Oxidizers based on nitric acid and nitrogen oxides | 655 |
| Tetrani tromethane | 667 |
| Fluorine and fluorine compounds | 668 |
| Perchloric acid and chlorine oxide | 672 |

Ch. XVII. Monopropellants for LPRE [P. P. Zarudniy] 676
- Monopropellants of molecular composition 677
- Mixtures of fuels with oxidizers 679
- Monopropellants based on endothermic compounds 680

Ch. XXVIII. Fuel Filtering [N. A. Ragozin] 686
- Aircraft fueling 686
- Duration of aircraft fueling 687
- Methods of evaluating the purity of fuels 688
- Allowing propellants to settle 689
- Dimensions of particles of mechanical impurities prior to filtering 690
- Filtering of fuels 691

Card 15/17

Motor, Jet, and Rocket Fuels

Ch. XXIX. Characteristics of Fuels Presenting a Fire Hazard [N. A. Ragozin] 694
- General information 694
- Combustion characteristics of diesel fuels and tractor gasolines 697
- Temperature zones for the formation of explosive mixtures at various altitudes 698
- Concentration limits for explosive mixtures of fuel vapors 701
- Temperature of fuel self-ignition 703
- Self-ignition of liquid fuels 705
- Static charge in fuels 707

Ch. XXX. Toxicity of Fuels and Oxidizers [K. K. Papok and I. G. Baron] 717
- Toxicity of gasolines 718
- Toxicity of kerosene and diesel fuels 720

Card 16/17
Motor, Jet, and Rocket Fuels

Toxicity of benzene 721
Toxicity of ethyl fluids 722
Toxicity of ethyl gasolines 726
Toxicity of exhaust gases 729
Toxicity of oxidizers 731

AVAILABLE: Library of Congress (TP319.P3)

SUBJECT: Aerospace
## ATD DISTRIBUTION LIST

**WORK ASSIGNMENT 77**

<table>
<thead>
<tr>
<th>ORGANIZATION</th>
<th>No. of Copies</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA (AFSS-1)</td>
<td>1</td>
</tr>
<tr>
<td>NASA (Tech. Lib.)</td>
<td>1</td>
</tr>
<tr>
<td>DDC</td>
<td></td>
</tr>
<tr>
<td>DIA (DD/DIA/SA/GI)</td>
<td>20</td>
</tr>
<tr>
<td>CIA (SD)</td>
<td>3</td>
</tr>
<tr>
<td>Gen. Ast. Res. Corp.</td>
<td>1</td>
</tr>
<tr>
<td>Nat. Sci. Found.</td>
<td>1</td>
</tr>
<tr>
<td>DIA</td>
<td>1</td>
</tr>
<tr>
<td>RAND</td>
<td></td>
</tr>
<tr>
<td>SAK/DL-510</td>
<td>2</td>
</tr>
<tr>
<td>AMXST-SD-TD</td>
<td>5</td>
</tr>
<tr>
<td>CIA (OCR-STAN. DIST.)</td>
<td>6</td>
</tr>
<tr>
<td>AFTAC/IC-1</td>
<td>1</td>
</tr>
<tr>
<td>Env. Res. Ass.</td>
<td>1</td>
</tr>
<tr>
<td>Tech. Doc.</td>
<td>1</td>
</tr>
<tr>
<td>AEDC (AEY)</td>
<td>1</td>
</tr>
<tr>
<td>Nat. Bur. Stand.</td>
<td>1</td>
</tr>
<tr>
<td>ESD (ESY)</td>
<td>1</td>
</tr>
<tr>
<td>ESD (ESTI)</td>
<td>1</td>
</tr>
<tr>
<td>ASD (ASF)</td>
<td>1</td>
</tr>
<tr>
<td>McAllister-Hill</td>
<td>10</td>
</tr>
<tr>
<td>TUSTI (Tech. Lib.)</td>
<td>5</td>
</tr>
<tr>
<td>TDI-XP</td>
<td>3</td>
</tr>
<tr>
<td>AIR UNIVERSITY</td>
<td>5</td>
</tr>
<tr>
<td>OAR (RRY)</td>
<td>1</td>
</tr>
<tr>
<td>AAM (AAM)</td>
<td></td>
</tr>
<tr>
<td>AFFTC (AFF)</td>
<td>2</td>
</tr>
<tr>
<td>AFMC (AFW)</td>
<td>1</td>
</tr>
<tr>
<td>FIO, DIV.</td>
<td>1</td>
</tr>
<tr>
<td>AFFIPOLAB</td>
<td></td>
</tr>
<tr>
<td>AFCRL (CRIECP)</td>
<td>50</td>
</tr>
<tr>
<td>ARI (ARI)</td>
<td>4</td>
</tr>
<tr>
<td>DATA DATA CENTER</td>
<td></td>
</tr>
<tr>
<td>TECH. LIB. BRANCH</td>
<td>1</td>
</tr>
<tr>
<td>SSD (SSF)</td>
<td>2</td>
</tr>
<tr>
<td>Weather Res. Fac.</td>
<td>1</td>
</tr>
<tr>
<td>AMD (AMFR)</td>
<td>1</td>
</tr>
</tbody>
</table>
INQUIRY ON AVAILABILITY OF TRANSLATIONS

I am interested in availability of translations of the sources indicated below (please enter reference numbers given in the Table of Contents).

Return this form to the local monitor of the ARPA-ATD project or mail it directly to:

Head, Science and Technology Section
Aerospace Technology Division
Library of Congress
Washington, D. C. 20540