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NAVORD REPORT

A COMPILATION OF IGNITION ENERGIES OF SEVERAL PROPELLANTS AND SOME EXPLOSIVES (U)

7 JULY 1960

U. S. NAVAL ORDNANCE LABORATORY

WHITE OAK, MARYLAND

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AD 318

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WHITE OAK
SILVER SPRING, MARYLAND

To all holders of NavOrd Report 6901
insert change; write on cover 'Change inserted'
Approved by Commander, U.S. NOL

Change 1

pages 4

Albert Lightbody
By direction

This publication is changed as follows:

1. The cal/cm^2 column should read

   cal/cm^{2***}

2. The following footnote should be added:

   *** Note: Relative values of ignition energy are good to ±5% (Ref. 4). Some difference is notable in the energies reported in NavOrd Report 6849 and this report. This difference is attributed to the accuracy of the method and the close control exercised in the round robin testing.

Insert this change sheet between the cover and the title page of your copy.

A COMPILATION OF IGNITION ENERGIES OF SEVERAL PROPELLANTS AND SOME EXPLOSIVES (U)

By

John D. Ferguson
George J. Bryan

Approved by: Evan C. Noonan
Chief, Physical Chemistry Division

ABSTRACT: Ignition energies for a large number of propellants and some explosives have been determined using the locked-stroke compressor (2,3,4). The energies have been compiled and presented in tabular form.

Effects of varying the sample diameter as well as the space between the sample and the viewing window have been investigated. The results show that the rate of heat transfer decreases as the diameter of the propellant cylinder increases, and increases as the spacing between the sample and the window increases. (U)

CHEMISTRY RESEARCH DEPARTMENT
U. S. NAVAL ORDNANCE LABORATORY
White Oak, Silver Spring, Maryland

NAVORD Report 6901 — 7 July 1960

Over a period of years a locked-stroke compressor has been used to determine the minimum energy required to ignite a propellant or explosive in a short time interval, about 3 milliseconds. Hot gas from adiabatic compression ignites the material under study; in this sense the locked-stroke compressor resembles a one-shot diesel engine. Because of the complicated nature of the heat transfer phenomenon calculation of the absolute value of the energy is a difficult matter. Energies quoted may therefore be considerably in error. Relative values are believed to be much better since many of the unknown errors cancel.

The purpose of this report is to compile all ignition energy values obtained to date. This compilation was supported under task NO 506-925/56015/01040 Guided Missile Rocket Motor Ignition Systems Supporting Research.

W. D. COLEMAN
Captain, USN
Commander

Albert Lightbody
ALBERT LIGHTBODY
By direction

TABLE OF CONTENTS

ILLUSTRATIONS

A COMPILATION OF IGNITION ENERGIES OF SEVERAL PROPELLANTS AND SOME EXPLOSIVES

I. INTRODUCTION

This report is designed to combine earlier and recent ignition energy values in one source. Some data have appeared in earlier reports (2,3,4), but results on many propellants and seven explosives have not been previously reported except in informal progress reports.

Discrepancies in some of our ignition energy data caused us to study the effect of the cylinder diameter of the propellant sample and the spacing between the sample and the Lucite window. Because of availability, N-5 propellant was chosen for this study.

II. APPARATUS AND INSTRUMENTATION

The locked-stroke compressor and instrumentation was used to obtain the data. A thorough description of the compressor and instrumentation is given in references 1,2,3, and 4.

III. EXPERIMENTAL PROCEDURE AND RESULTS

A. Discussion of Experiment

Operational details of the compressor will be omitted here, as they have already been covered (2).

The propellant samples were mounted in the compression chamber in front of a recessed Lucite window C, Figure 1. The depth of the recess F can be varied by varying the thickness of the Lucite window. For samples of N-5 propellant and a fixed window thickness (recess) the minimum ignition conditions for various sample diameters (0.467, 0.757 and 1.006 centimeters; 0.185, 0.298, 0.396 inches) were determined. Next, minimum ignition conditions were determined for various recesses (0.267, 0.483, and 0.711 centimeters; 0.105, 0.190, 0.280 and 0.456 inches). Depth measurements were made from the surface of the face plate, 0.0127 cm. (.005 inches) being added to account for a small thickness of inhibitor between the face plate and the propellant. The space behind the sample is known to within ±.6% for the deep recess and ± 2.5% for the shallow recess. From Figure 2 wherein the results are presented graphically it is seen that this variation in the recess makes an insignificant change in the energy ratio.

B. Compilation of Ignition Energies

Minimum ignition energies for thirty-three propellants and seven explosives were computed by the usual method (4) and are tabulated in Table I.

C. The Effect of Sample Diameter and Spacing on the Ignition Energy of N-5

1. Effect of Sample Diameter

Figure 2 shows that the apparent ignition energy of N-5 propellant decreases as sample diameter decreases. This decrease suggests an increase in the rate at which heat is being transferred to the sample. The curve asymptotically approaches unity at the lower diameters. A diameter of 0.467 cm (0.185 inches) was chosen as a reference value since it is within the asymptotic region and much of the previous data had been taken using diameters equal to or near to this value.

2. Effect of Spacing

As the space between the sample and the Lucite window increases, the energy required for ignition decreases (Figure 2). This effect is believed to be due to an increase in the flow rate past the sample causing a higher localized heat transfer to the sample. This flow rate is partially governed by the quantity of turbulent gas which must move behind the sample. This quantity increases as the spacing behind the sample increases. It should be noted that for spacings greater than 1.168 cm (.460 inches) the curve becomes asymptotic approaching an energy ratio of 0.525.

IV. SUMMARY

Ignition energies for thirty-three propellants and seven explosives are given in Table I.

Figure 2 indicates that the minimum ignition energy is affected by the sample cylinder diameter and the space behind the sample. The data apply only to N-5 propellant; other propellants probably behave in the same fashion, although this should be confirmed. Therefore, for more

valid comparison of minimum ignition energies, energy determinations should be made in the region in which energy requirements appear to be relatively insensitive to changes in experimental geometry.

TABLE I

Ignition Energies of Propellants and Explosives

Propellants

	Propellant	cal/cm^2		Propellant	cal/cm^2
1.	OGK (4)	.37	18.	BGQ	.22
2.	OGK	.25	19.	BHQ	.24
3.	N-5 (4)	.30	20.	BGY	.22
4.	N-5	.35	21.	BIC	.23
5.	N-4 (4)	.33	22.	OKP	.24
6.	JPN (4)	.24	23.	OIO	.28
7.	Arcite 141 (4)	.12	24.	OIY	.22
8.	Arcite 178 (4)	.27	25.	OV	.24
9.	TRX-135D-1	.18	26.	IHBE-152 (4)	.28
10.	QQd 112	.21	27.	IX-94 (4)	.29
11.	ANP 2639	.26	28.	SPDN 9836 (4)	.29
12.	AHH	.18	29.	IMR 6962 (4)	.29
13.	ALL	.20	30.	SPCG 7833 (4)	.36
14.	ARP	.19	31.	EX 7077 (4)	.35
15.	BEC	.21	32.	TRX-118*	.14
16.	BFA	.26	33.	TRX-118/TP-90B*	.11
17.	BFZ	.19			

Explosives**

1.	TNT	>.38	4.	PETN	.25
2.	Tetryl	.33	5.	Blasting Gel	.19
3.	RDX	.33	6.	Lead Styphnate*	.046
			7.	Lead Azide*	.087

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*Flat sample.
**Report in reference 10.

A - COMPRESSION PISTON
B - FACE PLATE
C - LUCITE WINDOW
D - MOUNTED CYLINDER OF EXPLOSIVE
EE - "O" RING
F - SPACE BETWEEN SAMPLE AND WINDOW (RECESS)

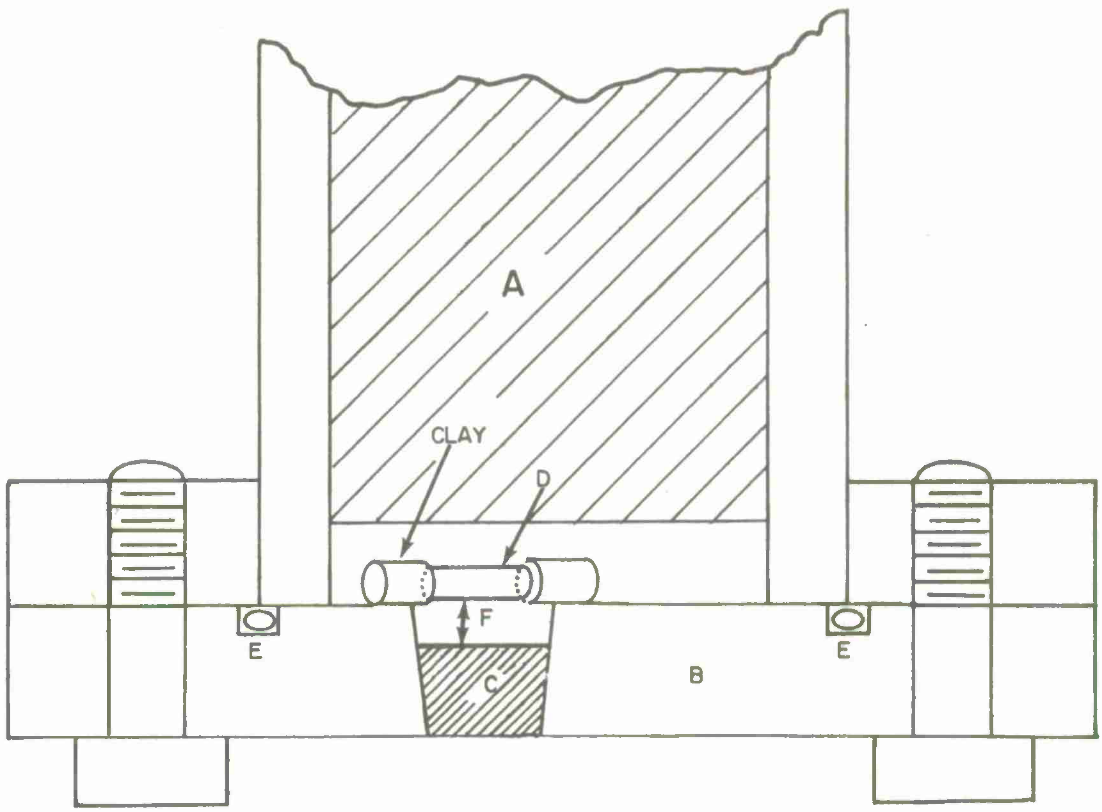

FIG. 1 COMPRESSION CHAMBER AND PROPELLANT MOUNTING

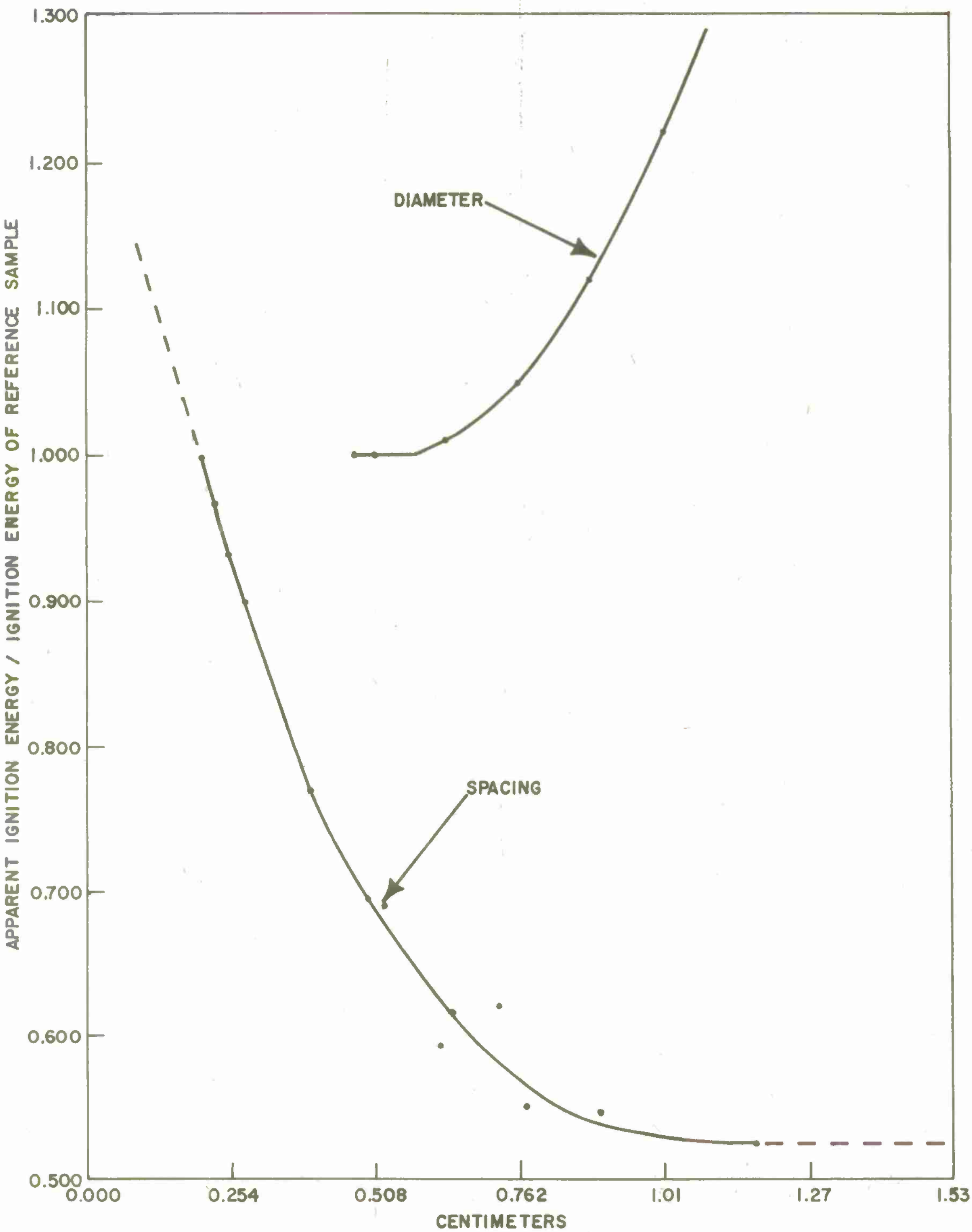

FIG. 2 PLOT OF IGNITION ENERGY RATIO
VS DIAMETER AND SPACING

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Naval Ordnance Laboratory, White Oak, Md.
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Abstract card is unclassified

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2. Propellants - N-5
3. Explosives - Ignition
4. Compressors, Locked-stroke

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