



شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم



شبكة المعلومات الجامعية
@ ASUNET



شبكة المعلومات الجامعية التوثيق الالكتروني والميكروفيلم



شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكرو فيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of
15-25- c and relative humidity 20-40%

بعض الوثائق الأصلية تالفة

بالرسالة صفحات لم ترد بالاصل

Physico-Chemical Studies of the Evaluation of some Stabilizers for Solid Rocket Propellants

Presented by

W102UP

Mahmoud Ahmed Mabrouk Said

**A Thesis Submitted
To
Faculty of Science**

**In Partial Fulfillment of the
Requirements for
The Degree of
Master of Science
(Chemistry)**

**Chemistry Department
Faculty of Science
Cairo University**

(2010)

APPROVAL SHEET FOR SUBMISSION

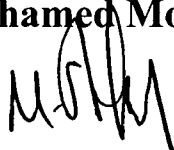
Thesis Title: Physico-Chemical Studies of the Evaluation of some Stabilizers for Solid Rocket Propellants

Name of candidate: Mahmoud Ahmed Mabrouk Said

This thesis has been approved for submission by the supervisors:

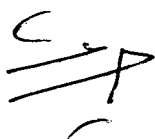
1- Prof. Dr. Mohamed Mohamed Shoukry.

Signature:

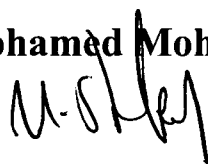


2- Dr. Hussien Alwany Abd Elrahman.

Signature:



Prof. Dr. Mohamed Mohamed Shoukry



**Chairman of Chemistry Department
Faculty of Science- Cairo University**

ABSTRACT

Student Name: Mahmoud Ahmed Mabrouk Said

**Title of the thesis: Physico-Chemical Studies of the Evaluation of some
Stabilizers for Solid Rocket Propellants**

Degree: The Master of Science (Chemistry)

The present work deals with the study of effect of stabilizer ratio on stability of solid rocket propellant by using different techniques. Several Double-Base Propellant samples have been prepared using different ratios of Centralite 1 (as Stabilizer).

Traditional methods for study of Stability are carried out after manufacture and after aging. The results are consistent with the Control Laboratory of Bofors. HPLC is used to determine the composition of DBP samples after manufacture and after aging.

The mechanical properties of solid rocket propellants are very important for the good functioning of rocket motors. Compression test, as Mechanical analysis, is applied at two different temperatures (25 and 50°C). Mechanical properties are improved with the increase of stabilizer ratio but until certain amount of stabilizer ratio.

Ballistic tests were carried out (at -20 and +50°C), all the ballistic properties decrease with the increase of stabilizer ratio.

Thermal analysis methods for study of thermal stability are carried out. The TGA and DTG were carried out under Non-isothermal and Isothermal conditions, the thermal stability are increasing by increase the ratio of stabilizer until certain ratio of stabilizer. DTA results show that, the increase of Stabilizer ratio (C1) is associated with a shift of decomposition temperature, and these results are consistent with the results of non-isothermal TGA.

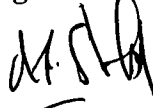
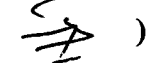
Keywords: Double-Base Propellant, Stabilizer (Centralite 1), Stability Tests, HPLC, Mechanical properties, Ballistic properties, Thermal Analysis.

Supervisors:

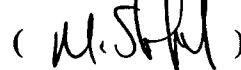
1- Prof. Dr. Mohamed Mohamed Shoukry.

2- Dr. Hussien Alwany Abd Elrahman

Signature

()
()

Prof. Dr. Mohamed M. Shoukry

()

**Chairman of chemistry Department
Faculty of Science- Cairo University**

Acknowledgment

First I would like to express my grateful appreciation to my supervisor

Prof. Dr. Mohamed Mohamed Shoukry.

For his considerable discussions and guidance.

I introduce my grateful appreciation to my supervisor

Dr. Hussien Alwany Abd Elrahman

for his help and guidance

Mahmoud Ahmed Mabrouk Said

Cairo University
Faculty of Science
Chemistry Department

To whom it may concern

Besides the work carried out in this thesis, the candidate **Mahmoud Ahmed Mabrouk Said** had studied the following post-graduate courses during the academic year 2006-2007 and passed their exams successfully.

- Colloids and Catalysis
- Thermal Analysis
- Solar Energy
- Electro Chemistry
- Group Theory
- Metallurgy
- Analytical Chemistry
- Polymer Chemistry
- Quantum Chemistry
- Nuclear Chemistry
- Advanced Inorganic Chemistry
- Techniques of Molecular Determination
- German Language
- Adsorption
- Cyclic Voltammetry
- Electrode Kinetics
- Thermodynamics
- Statistical Thermodynamics
- Chelatimetry
- X-ray Thermal Analysis
- Inorganic Reaction Mechanism

Prof. Dr. Mohamed M. Shoukry
()
Chairman of Chemistry Department
Faculty of Science- Cairo University

Contents	Page No.
List of table	iii
List of figures	iv
List of abbreviation	vi
 Chapter I: Introduction and Literature Survey	
- Introduction	1
- Type of Propellants	2
- Stabilizers	4
* Diphenylamine as Stabilizers for DBP.	7
* Centralite 1 as stabilizer for DBP.	12
- Stability Tests	16
-Determination of the Shelf life of Solid Propellants.	18
- Methods of Analysis for the Study of Propellants	19
* Chromatographic Methods	19
* Spectrometric Methods	21
* Electrochemical Methods	22
- Thermal behavior of Energetic Materials	23
 Chapter II Experimental	
- Materials	27
- Instruments Used	30
- Formulation Samples of the Double-Base Propellant	31
-The Manufacturing Process	32
-Stability Tests	34
- HPLC	39
- Mechanical Properties	40
- Ballistic tests	41
- Thermal analysis	43

Chapter III Results and Discussions

- Stability Tests	44
- Mechanical Analysis	53
-Ballistic Performance	57
- Comparative Study between Mass Spectra and Thermal analysis.	64
-The Effect of Different Ratio of Stabilizer on Thermal Stability of DBPs.	69
-Thermogravimetric Analysis (TGA) under Non-isothermal Conditions.	69
-DTA Study in Comparison with TGA under Non-isothermal Conditions.	74
-Isothermal Study of Thermal Stability of propellant samples using TGA Technique.	78
-Summary and Conclusion	86
- References	88
-Arabic summary	96

List of table

Table	Page No.
Table 1: Substances used as Stabilizer	6
Table 2: The Most Popular and Modern Stabilizers for DBP.	7
Table 3: The percentage of diphenylamine derivatives in deteriorated French powder.	10
Table 4: percentage of Centralite 1 and its major derivatives in samples of double - base powder containing 1% Centralite after storage at at 65°C and 75°C.	13
Table 5: percentage of Centralite 1 and its major derivatives in samples of double - base powder containing 9% Centralite after storage at at 65°C.	14
Table 6: Composition of the Samples of Variable Stabilizer Content.	31
Table 7: Stability tests using Traditional methods after manufacture.	45
Table 8: HPLC results for DBP samples after manufacture.	47
Table 9: Stability tests using Traditional methods after Aging.	50
Table 10: Stabilizer content after accelerated aging of the propellant samples.	52
Table 11: The Results of Compression test for DBP samples at + 25 °C	54
Table 12: The Results of Compression test for DBP samples at + 50 °C	55
Table 13: Ballistic Performance for sample S5 at different temperatures and different nozzles	57
Table 14: Ballistic Properties at + 50 °C	60
Table 15: Ballistic Properties at -20 °C	61
Table 16: TGA results of propellant samples containing different ratio of stabilizer	73
Table 17: DTA results of propellant samples containing different ratio stabilizer	77
Table 18: Isothermal TGA of the Propellant Samples Containing Different Ratio of Stabilizer at Different Fixed Temperatures	85
Table 19: Rate of Decomposition of the Propellant Samples Containing Different Ratio of Stabilizer at Different Fixed Temperatures	85

List of figures

Figure	Page No.
Figure 1: Heat Storage	34
Figure 2: Methyl-Violet-Test	35
Figure 3: Bergmann-Junk Test	36
Figure 4: Isoperibol Calorimeter with 1108 Oxygen Bomb, an A391DD Oval Bucket, and 1757 Printer.	38
Figure 5: Zwick universal mechanical testing.	40
Figure 6: Small scale with diameters $D = 29$ mm., $d = 10$ mm. and $L = 200$ mm	41
Figure 7: A simplified diagram for the test stand.	41
Figure 8: pressure- time curves	42
Figure 9: Thermal Analysis apparatus (DTG-60)	43
Figure 10 Calorific value for samples after manufacture	46
Figure 11: HPLC curve for S1 after manufacture	47
Figure 12: HPLC curve for S2, S3, S4 and S5 after manufacture.	48
Figure 13: HPLC for S6, S7, S8 and S9 after manufacture.	49
Figure 14: Calorific value for samples after Aging.	51
Figure 15: Consumption of the stabilizer at 50°C during aging.	52
Figure 16: Yield stress and Max stress against stabilizer ratio at 25°C .	54
Figure 17: The Results of Compression test for DBP samples at $+ 50^{\circ}$	56
Figure 18: Yield stress and Max stress at $+ 25$ and $+ 50^{\circ}\text{C}$ versus Stabilizer ratio.	56
Figure 19: a- Pressure against temperature. b- B.rate against temperature.	58
Figure 20: Fig. (20) The P-t curves for S5.1 (temp.-20 / nozzle 9.5 mm.)	58
Figure 21: The P-t curves for S5.2 (temp. +25 / nozzle 9.5 mm.)	58
Figure 22: The P-t curves for S5.3 (temp. +50 / nozzle 9.5 mm.)	59
Figure 23: The P-t curves for S5.5 (temp. +50 / nozzle 8.5 mm.)	59
Figure 24: The P-t curves for S5.4 (temp. -20 / nozzle 8.5 mm.)	59
Figure 25: The P-t curves for S1 to S9 at $+50^{\circ}\text{C}$.	60-61
Figure 26: The P-t curves for S1 to S9 at -20°C .	62-63
Figure 27: The TGA thermogram and DrTGA of 1,3diethyl-1,3diphenylurea	65

Figure	Page No.
Figure 28: The TGA thermogram and DTA of 1,3diethyl-1,3diphenylurea	65
Figure 29: Mass spectra of 1,3diethyl-1,3diphenylurea	67
Figure 30: TGA and DrTGA curves of propellant (S1, S3, S4, S5, S7 and S9).	69-71
Figure 31: TGA and DTA curves of propellant (S1, S3, S4, S5, S7 and S9).	74-76
Figure 32: Isothermal Gravimetric Analysis for DBP samples (S1, S3, S4, S5, S7 and S9).	79-81
Figure 33: Isothermal Gravimetric Analysis for DBP samples: a) At 80°C b) At 110°C c) At 140°C	83-84