



**STUDYING THE EFFECT OF NEW ADDITIVES ON THE  
CHARACTERISTICS OF SOME POLYURETHANE  
ELASTOMERS**

By

**Eng. Ahmed Mohammed Aboelmagd Salem**

A Thesis Submitted to the  
Chemical Engineering Department  
Faculty of Engineering at Cairo University  
In Partial Fulfillment of the  
Requirements for the Degree of

**DOCTOR OF PHILOSOPHY  
in  
CHEMICAL ENGINEERING**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
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**Title of Thesis:**

Studying the effect of new additives on the characteristics of some polyurethane elastomers.

**Key Words:**

polybutadiene (HTPB) / hexamethylene diisocyanate (HMDI) composite solid propellant; plasticizers; antioxidants; burning rate modifiers; aging program

**Summary:**

During propellant life time, the material has to resist various loads and environmental conditions. The main objective of this work is to increase the life time of the composite solid propellant rocket motor by studying the effect of some new additives such as plasticizers, antioxidants and burning rate modifiers on improving the mechanical and ballistic properties. Applying aging program for 90 days at assigned temperature 70 C.

## **Disclaimer**

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name:

Date:

Signature:

# Dedication

I dedicate my thesis to my family especially my wife **Manal Moubarak**.

## Acknowledgments

At the beginning, I definitely want to thank the almighty **ALLAH** for making it all possible.

I would like to express my gratitude to my supervisor **Prof. Dr. Ehab Fouad Abadir** – Chemical Engineering Department – Faculty of Engineering – Cairo University, for providing me with his constant support, encouragement and guidance. His enthusiasm and willingness to allow me to pursue my own interest have been much appreciated.

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## Nomenclature

Al	Aluminum.
AP	Ammonium Perchlorate.
B.A	Bonding Agents.
BAMO	3,3-Bis(AzidoMethyl) Oxetane
CSM	Composite Solid Motor
CSP	Composite Solid Propellant.
CTPB	Carboxy Terminated Poly Butadiene.
DOS	Diisooctyl Sebacate.
DOZ	Diisooctyl Azelate.
Cyanox 2246	2,2'-methylenebis(4-methyl-6-tert-butylphenol)
AO	N,N -Diphenyl-p-phenylenediamine
BF	Barium ferrite
CC	Copper chromite
FO	Ferric oxide
DMA	Dynamic Mechanical Analysis.
DSC	Differential Scanning Calormitry
FTIR	Fourier Transfer Infra Red
HMDI	Hexamethylene diisocyanate.
HMX	Octagen
HTPB	Hydroxy terminated poly butadiene.
HX-752	1,1(Phenyl Dicarbonyl) bis (2- Methyl Aziridine).
IPDI	Isophoron diisocyanate.
Is	Specific Impulse
MAPO	Tris [1-(2-methyl) aziridiny] phosphine oxide.
MAT4	Condensation Reaction of 2.0 mole MAPO, 0.7mole Adipic Acid, and 0.3 mole Tartaric Acid.
NCO	Miligram equivalent of isocyanate per gram of diisocyanate.
PMAA	Poly Methyl Acrylic Acid.