TRIBOLOGICAL AND RHEOLOGICAL CHARACTERISTICS OF MODIFIED CALCIUM GREASE WITH CARBON NANOTUBES AND GRAPHENE NANOSHEETS

By

Bahaa Mostafa Kamel Mehany Ahmed

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

DOCTOR OF PHILOSOPHY

IN

MECHANICAL DESIGN AND PRODUCTION ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:

Tribological and Rheological Characteristics of Modified Calcium Grease with Carbon Nanotubes and Graphene Nanosheets

Key Words:
Carbon nanotubes, Graphene nano sheets, Tribological behavior, Rheological behavior, Calcium grease,

Summary:

The aim of this research is to study the influence of adding Multi- Walled Carbon Nanotube (MWCNTs) and graphene nano sheet (GNS) on the rheological behavior, tribological properties and thermal conductivityof calcium grease. The results show that the grease with CNTs and GNS exhibit good performance in anti-wear, friction reduction, load carrying capacity and extreme pressure properties with only 3% wt. The rheological behaviors were evaluated with a Brookfield. The results indicate increases stress and apparent viscosity.

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Finally, I wish to acknowledge and express my deep gratitude to all those who helped me in presenting this work.

Dedication

I sincerely dedicate this work to my mother, father and my wife…

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NOMENCLATURE

d	Spacing between diffracting planes,
κ_e	Thermal conductivity
n	any integer
q	Constant heat rate applied to an infinitely long and small ‘‘line” source, are the Changes in the temperature at times t1 and t2.
r	Distance from the contact surface on the lower balls to the axis of rotation.
T	Frictional torque (N.m)
t	Time (S)
W	applied load in (N)
$\Delta \phi$	Temperature changes
θ	incident angle,
λ	wavelength of the beam
μ	friction coefficient