CHEMICAL STUDIES ON SOME BASE LUBRICANTS FOR TURBO-JET-ENGINES

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SUBMITTED IN PARTIAL FULFILLMENT
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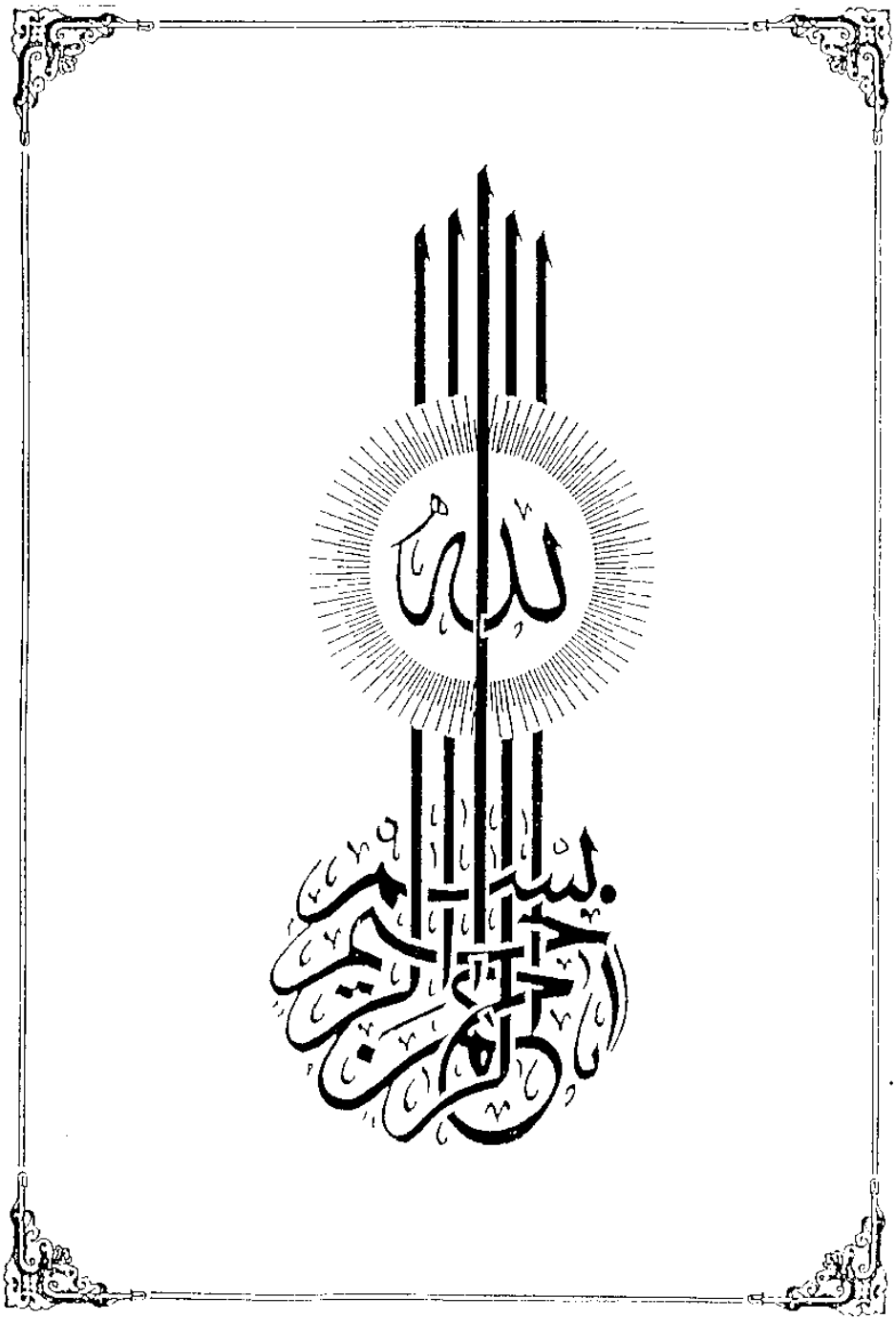

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NOTE

Besides the work carried out in this thesis, the candidate has attended postgraduate courses in the following topics :-

1- Photochemistry

2- Microanalysis

3- Polymer chemistry

4- Quantum chemistry

5- Spectroscopy

6- Chemical Kinetics

7- Thermodynamics

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NOMENCLATURE

Symbol	Meaning
TMP	Trimethylolpropane
MPE	Monopentaerythritol
NPE	Neopentylpolyol
alc	alcohol
F	Fluid
wh	white
liq	liquid
col	colourless
cb	cubic
V	Very
sl	slightly
s	soluble
SHF	Synthetic Hydrocarbon Fluid
SST	Supersonic Transport
t	time
ν_s	Wave number of stretched vibration of CH_2 & CH_3 [symmetric].
ν_{as}	Wave number of stretched vibration of CH_2 & CH_3 [asymmetric]
σ_s	Wave number of bending vibration of CH_2 & CH_3 [symmetric]
σ_{as}	Wave number of bending vibration of CH_2 & CH_3 [asymmetric]
Str.Vib	Stretching Vibration
Ben. Vib.	Bending Vibration
VI	Viscosity Index

AIM OF THE WORK

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This work is a part of a program being carried out at the Egyptian Petroleum Research Institute (E.P.R.I) dealing with study and preparation of some types of synthetic lubricants needed for the local market to meet the demands of both Civil and Military developed engines and instrumentations.

The type of lubricant considered in this work is that which meets the demands of aircraft turbo-engines of speed regimes of Mach 1 to 2.5 according to the air specification 3514 .

Esterification of trimethylolpropane or monopentaerythritol with n-monocarboxylic acids of carbon atom-number C_4 C_7 and C_9, have been investigated for the aim of obtaining several esters with increasing viscosity giving base lubricants of wide range of properties.

To outline the structure and the properties of the prepared esters their physico-chemical characteristics could be studied using recent technique and different methods of analysis.

Some parameters which affect the esterification reactions have been considered for preparation of such esters.

For the aim of finding the suitable use of such esters as base oils their properties have been compared with those of a commercial turbo-engine oil sample turbonycoil 600 according to the mentioned air specification .

SUMMARY

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In this study homologous series of esters were prepared by direct esterification of trimethylolpropane (TMP) or pentaerythritol (PE) with n-butyric, n-heptanoic and n-nonanoic acids using cadmium chloride as a catalyst, and following the technique of esterification by continuous removal of water of the reaction by the aid of azeotropic agent. The percentage conversion of the reaction was determined on the basis of the quantity of water collected periodically as one of the resultants.

Esterification of trimethylolpropane with n-heptanoic acid was studied as a model reaction and its optimum condition was applied for the others. Applying the optimum conditions and following the technique of continuous removal of water during the reaction leads to 98.8% conversion (pentaerythritoltetrabutyrate).

Trimethylolpropanetributyrate, trimethylolpropanetriheptanoate trimethylolpropanetrinonanoate, pentaerythritoltetrabutyrate, pentaerythritoltetraheptanoate and pentaerythritoltetranonanoate were prepared under the same conditions of reaction in order to study the effect of changing the alkyl chain length of the acids, and also to study the effect of the hydroxyl groups and their distribution in the polyol molecule used in the reaction, and to obtain esters of different physico-chemical properties.

Elementary analysis, mean average molecular weight determination and i. r. spectral analysis were carried out to identify the

prepared compounds and the data obtained indicate that the experimental values are in agreement with the proposed ester formulation.

Some correlations have been deduced from the measurements of density, molar volume and Kinematic viscosity that determined for the prepared esters. These correlations could identify the prepared esters and any ester belonging to the homologous series having Carbon atom number from C_4 to C_9 per acid molecule.

Laboratory tests such as appearance, colour, density, kinematic viscosity, A.S.T.M. slope, pour point, flash point, fire point, total acidity, viscosity index (VI) and refractive index were carried out for the prepared esters according to some of the tests mentioned in air specification 3514 in comparison with those of a commercial turbo-engine lubricant (turbonycoil 13B). It is concluded that some of the prepared esters are considered as base oil which may be used for the formulation of a finished lubricant according to the mentioned specification.

Infra-red spectral analysis and characteristics studied for the commercial turbonycoil 13B indicate that such oil and the prepared esters in this work are of the same type.

INTRODUCTION