RE-REFINING OF USED LUBRICATING OIL USING SOLVENT EXTRACTION AND VACUUM DISTILLATION

By

Eng. Mohamed Sayed Abdo Mohamed

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

MASTER OF SCIENCE

In

Chemical Engineering

FACULTY OF ENGINEEREING, CAIRO UNIVERSITY

GIZA, EGYPT

2014

RE-REFINING OF USED LUBRICATING OIL USING SOLVENT EXTRACTION AND VACUUM DISTILLATION

By

Eng. Mohamed Sayed Abdo Mohamed

A Thesis Submitted to the

Faculty of Engineering at Cairo University

In Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

In

Chemical Engineering

Under the supervision of

Prof. Dr. Fatma Ashour

Chemical Engineering Department, Cairo University, Faculty of Engineering

Prof. Dr. Hamdan NorEl-din

Former Head of Chemical Engineering Department In High Institute of Technology, In Damitta

FACULTY OF ENGINEEREING, CAIRO UNIVERSITY

GIZA, EGYPT

2014

RE-REFINING OF USED LUBRICATING OIL USING SOLVENT EXTRACTION AND VACUUM DISTILLATION

By

Eng. Mohamed Sayed Abdo Mohamed

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

Approved by the Examining Committee

Prof. Dr.: Mohamed Mahmoud El-Sukkary,
Petrochemical Dept., Egyptian Petroleum Research Institute

Prof. Dr.: Nagwa Mahmoud Mohamed El-Mansy,
Chemical Engineering Dept., Cairo University, Faculty of Engineering

Prof. Dr.: Fatma Ashour,
Chemical Engineering Dept., Cairo University, Faculty of Engineering

FACULTY OF ENGINEEREING, CAIRO UNIVERSITY
GIZA, EGYPT
2014

Engineer: Mohamed Sayed Abdo Mohamed.

Date of Birth: 25 / 6 / 1989.

Nationality: Egyptian.

E-mail: m.sayed1989@gmail.com.

Phone: 01007273539.

Address: 68, st. No.3, Army officers' buildings, Shobra El-kheima, Qalyubia, Egypt.

Registration date: 1 / 10 / 2011.

Awarding date:

Degree: Master.

Department: Chemical engineering.

Supervisor: Prof. Dr.\ Fatma Ashour.

Prof. Dr.\ Hamdan NorEl-din.

Examiners:

Prof. Dr.\ Mohamed Mahmoud El-Sukkary. (External examiner)

Prof. Dr.\ Nagwa Mahmoud Mohamed El-Mansy. (Internal examiner)

Prof. Dr.\ Fatma Ashour. (Thesis main advisor)

Title of Thesis:

RE-REFINING OF USED LUBRICATING OIL USING SOLVENT EXTRACTION AND VACUUM DISTILLATION

Keywords:

Used oil, Re-refining Solvent extraction, butyl alcohol, isopropyl alcohol, Vacuum distillation, Experimental design, Optimization, Net profit.

Summary:

This thesis was objected to make a semi complete study about re-refining of used lubricating oil by solvent extraction, using butyl alcohol and isopropyl alcohol as solvents, followed by fractional vacuum distillation.

Experimental work was held in "Egyptian Petroleum Research Institute". Used lube oil which is the feed of experimental work is taken as a sample from "Suez Oil Processing Company".

The target of experimental work is to make treated lube oil specifications meet the European and Egyptian specifications of neutralize oil (treated used oil), and determine the optimum operating variables, then make calculation of factorial experimental design and corresponding net profit.

The results of experimental work revealed that: Treated oil with solvent extraction followed by vacuum distillation will meet Egyptian and European specs.

Acknowledgment

First of all, I would like to thank Allah for giving me the effort to do this thesis.

I wish to express my sincere thanks to Prof. Dr. Fatma Ashour and Prof. Dr. Hamdan NorEl-din for their sustained guidance and keen supervision.

Thanks, appreciation and gratitude for my mother, my aunt, my father, my brothers, my sisters for their encouragement and patience.

Thanks, appreciation and gratitude for my friends especially Eng. Hazem Mohamed Abdallah for his assistance, encouragement and patience.

Finally, I would like to thank everyone who helped me in this study.

Dedication

I dedicate my dissertation work to Prof. Dr. Hamdan's Soul, A special feeling of gratitude to him whose words of encouragement and push for tenacity ring in my ears, I will always appreciate all he has done.

"May his soul rest in peace"

Table of Contents

List of Tables

List of Figures

Abbreviations

APC: Alex Petroleum Company.

ASTM: American Society for Testing and Materials.

CFR: Code of Federal Regulations.

DIFM: Do It For Me.

DIY: Do It Yourself.

DOE: Department Of Energy.

DWO: De-Waxed oil.

EP: Extreme pressure.

EPA: Environmental Protection Agency.

FDA: Food and Drugs Administration.

ICAT: International Association for Clean Technology.

KTI: Kinetics Technology International.

GCD: Gas Chromatography Distillation**.**

GNP: Gross National Product.

MEK: Methyl Ethyl Ketone.

MIBK: Methyl Isobutyl Ketone.

MIDOR: Middle East Oil Refining Company.

NAAQS: National Ambient Air Quality Standards.

NMP: N-Methyl-2-pyrrolidone.

PCB: Poly Chlorinated Bi-Phenyls.

PROP: Phillips' Re-Refined Oil Process.

RCRA: Resources Conservation and Recovery Act.

S.A.E: Society of Automotive Engineers.

S/F: Solvent to Feed Ratio.

TAN: Total Acid Number.

TBN: Total Base Number.

TCT: Thermal Clay Treatment.

TDA: Thermal De-Asphalting.

TFE: Thin Film Evaporator.

VDU: Vacuum Distillation unit.

VCFE: Vacuum Cyclone Flash Evaporator.

VI: Viscosity Index.

VPS: Vacuum pipe still.

VM: Viscosity Modifier.