# ASSESSMENT AND RATIONALIZATION USE OF VEGETABLE BASED OILS IN POWER TRANSFORMERS

**Submitted By**

**Naglaa Ahmed Abd El-Gawad**

B.Sc. of Science,(Chemistry), Faculty of Women, Ain Shams University, 1991

Diploma in Environmental Science, Institute of Environmental Studies and Research, Ain Shams University, 1998

Master in Environmental Sciences, Institute of Environmental Studies and Research,

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A Thesis Submitted in Partial Fulfillment

Of

The Requirement for the Doctor of Philosophy Degree

In

Environmental Sciences

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APPROVAL SHEET

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**This Thesis Toward Doctor of Philosophy Degree in Environmental Sciences Has been Approved By:**

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**2016**

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# ABSTRACT

Mineral oils are used as insulating oils in power transformers and other electrical equipments for decades. Mineral oils are derived from petroleum which is non renewable resource. There is a great effort and continuous work to get benefit of renewable resources as much as possible. Vegetable based oils are reliable alternatives of mineral oil to be used as they are completely biodegradable so, they can be disposed safely and there is no fear of pollution in case of leakage. They also can be used as a type of recycling.

In this respect, eight vegetable oils namely; Castor oil, Jatropha oil, Linseed oil, Mustard oil, Jojoba oil, Rapeseed oil, Radish oil and used frying oil were chosen and converted into methyl esters via transesterification process to improve their electrical, physical and chemical properties.

Then, the best four methyl esters obtained namely; linseed methyl ester , rapeseed methyl ester, radish methyl ester and used frying methyl ester) are reacted with pentaerythritol to give the corresponding polyesters. Linseed polyester gave the best result then used frying polyester.

A field study was performed in which the polyester obtained from the used frying oil was used as an insulating liquid in a simple module of electric transformers for its negligible capital cost, and being waste recycling process.

The module filled with used frying polyester was put under operation conditions for one month, then the insulating liquid was tested after aging conditions. The results were compared with the IEC standards. The results are satisfactory and reliable.

**Keywords:** Insulating oils, Power transformer, Vegetable oils, Transesterification, Polyesters, Field study.

## List of Abbreviations

| | |
|---|---|
| **ASTM :** | **American Society for Testing and Materials.** |
| **BDV:** | **Breakdown voltage.** |
| **BHT:** | **Butyl hydroxy toluene** |
| **DC:** | **Direct Current.** |
| **DGA:** | **Dissolved Gas Analysis.** |
| **DP:** | **Degree of polimerization.** |
| **FR3:** | **Envirotemp natural ester.** |
| **HMWH:** | **High Molecular Weight Hydrocarbon.** |
| **IFT:** | **Interfacial tension.** |
| **IEC:** | **International Electrotechnical Commission.** |
| **KV:** | **Kilo Volt** |
| **M/DBT:** | **Mono/dibenzyltoluene.** |
| **MVA:** | **Mega Volt Ampere.** |
| **NE:** | **Natural Ester.** |
| **NOMEX:** | **Fire resistance material.** |
| **PD:** | **Partial Discharge.** |
| **PAO:** | **Polyalphaolefins.** |

**PCBs:** **PolycChlorinated Biphenyls.**

**RBDPO:** **Refined, Bleached and Deodorized Palm Oil.**

**RBDSO:** **Refined, Bleached and Deodorized Soybean Oil.**

**$SF_6$ :** **Sulfurhexafluoride.**

**TBHQ:** **Tertiary Butylhydroquinone**

**DBPC:** **2, 6-di-tert-butyl-p-cresol.**

**2-FAL:** **2-furfural aldehyde.**

**2-ACF:** **2-acetylfuran.**

**5-MEF:** **5-methyl-2-furfural.**

**2-FOL:** **2-furfurylalcohol.**

**5-HMF:** **5-hydroxymethyl-2-furfural.**

# Contents