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FTIR spectroscopy Investigation of waste transformer oil as an alternative fuel for CI Engine

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Abstract

The present investigation is aimed to reuse the waste transformer oil (WTO) as an alternative fuel for compression ignition (CI) engine. For this purpose FTIR studies of WTO and its blends were determined. FTIR properties of WTO and its blends were compared with those of conventional diesel fuel. Based on FTIR finding, WTO and its blends have C–H group or hydrocarbon indicates that the liquids have a potential to be used as alternate fuels a for CI Engine.

[Key words: Waste Transformer Oil, Alternative Fuel, CI Engine, FTIR studies]

1. Introduction

One of the most important issues that affect the world economy and politics is the sustainability of energy. The conventional energy sources are mainly considered for heat and power applications. However, due to the depletion of fossil fuels and increased awareness of environmental problems, the world is looking to use alternative fuels in the form of renewable and or non-conventional fuels. People now a day are concerned about global warming because earth's greenhouse is warming up rapidly. The green house effect is being increased day by day, causing changes in our planet that can affect our lives. The problem of abnormal climate change, extreme weather conditions, intense heat, tsunami, cyclones, rise in sea level are caused by green house gases. We despicably need to control the greenhouse gases to control the situation. It has motivated the scientists of the world to search for more environmentally friendly, feasible and renewable fuels. In these connection, waste transformer oil have received a remarkable attention to be used as alternatives for diesel engines [Agarwal, 2007]

The transformer oil in the electrical transformers is for the purpose of insulation. After a usage, changes occur in the physico-chemical properties of the oil, and designated as waste oil and are replaced. When the waste transformer oil is disposed off, it causes an environmental pollution, as its constituent polychlorinated biphenyls are non-biodegradable and suspected of being carcinogenic [Demirbas,2007, Graboski ,1998] .Thus, reuse of waste transformer oil it is very much necessary in an environmentally-friendly way. The previous studies indicate that WTO could be used as a diesel substitute. When waste transformer oil is reused in a proper manner, it can fulfill the growing demand of energy source and can help in the reduction of environmental pollution [Pullagura et al, 2012, Qasim, 2017].

2. Experimental: Materials and Methods:

Material Used: Waste Transformer Oil (WTO) and diesel were used.

Transformer Oil

Transformer oil insulates and dissipates heat, extinguishes arc and act as coolant. Transformer oil has high dielectric strength, thermal conductivity, and chemical stability, and must keep these properties when held at high temperatures for extended periods [Paul, 2009].

Degradation of Transformer Oil

The waste transformer oil must be properly collected and processed but methods of disposal may release harmful substances in the atmosphere or may pollute

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water bodies and soil. At high temperatures and in the presence of moisture and sunlight the degradation of transformer oil takes place rapidly. The deterioration of transformers oil is very fast in the presence of copper, paint, varnish and oxygen. The mechanism of degradation of involves of transformer oil oxidation reaction which results in the formation acids and other polar compounds. When transformer oil is subjected to thermal and electrical stresses in an oxidizing atmosphere, it becomes unstable, breaks down, undergoes oxidation and become acidic and finally, it begins to produce mud. Now Waste transformer oil has been filtered and used for sample preparation [Mohta, 2015].

Preparation of Oil Samples:

In order to investigate the fuel quality results Waste transformer oil and Diesel were mixed with the help of magnetic stirrer. The mixing process was carried out at room temperature and the samples were allowed to stir for an hour. To investigate the suitability of Diesel Fuel seven samples were prepared. Samples are then categorized and coded accordingly.

Table 1: Details of samples and their identification

Sl. No.	Sample ID	Composition By Vol (%)
1	D100	100% diesel
2	WTO 100	100% Waste transformer oil
3	WTO10D90	10% Waste transformer oil and 90% Diesel
4	WTO20D80	20% Waste transformer oil and 80% Diesel
5	WTO30D70	30% Waste transformer oil and 70% Diesel
6	WTO40D60	40% Waste transformer oil and 60% Diesel
7	WTO50D50	50% waste transformer oil and 50% Diesel

Characterization of samples

Fourier Transform Infrared Spectrophotometery (FTIR)

The infrared spectra of diesel, waste transformer oil and its blends were recorded in the range of 4000-400 cm^{-1} on Shimadzu Corpn Japan Instrument, at CIF, BIT Mesra Ranchi

3. Results and Discussion:

FTIR studies of WTO, D100 and its blends

The FTIR spectra of oil samples are shown in Figure -1 to Figure 12 and their assignment and interpretation are given in Table 2

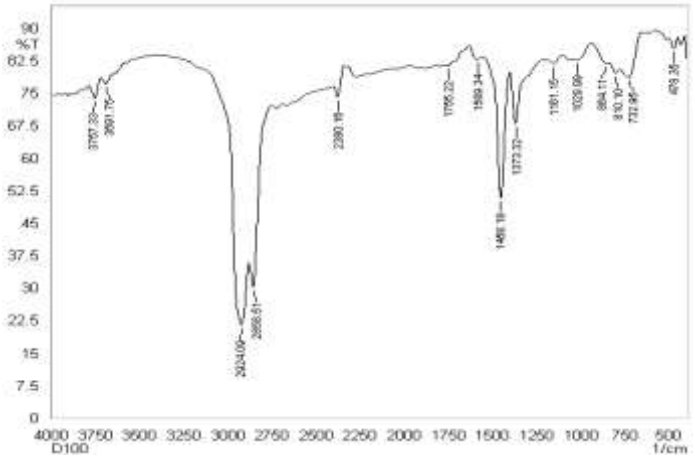

Figure1: FTIR Spetrum of D100

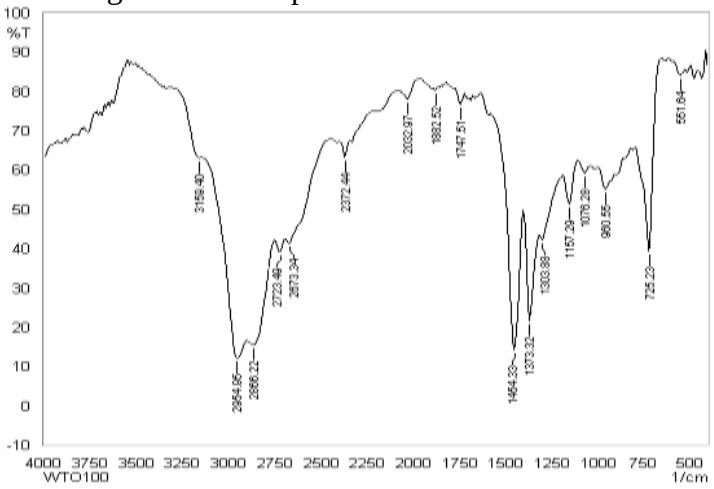

Figure2: FTIR Spetrum of WTO100

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Table2: FTIR Interpretation of WTO100, D100 and their blends

Sample Id	Type of Vibration					
	O-H Stretch	C-H Stretch	C≡C Stretch, C≡N Stretch	N-H bending C=C stretch C=O stretch	C-H bending	C=O stretch Carbonates
D100	3757 3691	2924, 2858	2380	1755	1458	478
WTO100	3159	2954, 2866	2372	1747	1454	551
WTO10D90	3757 3691	2931, 2858	2380	1747	1458	---
WTO20D80	3471	2951, 2858	2376	1747	1454	432
WTO30D70	3757 3691	2943, 2858	2376	1751	1458	474
WTO40D60	3761	2924, 2858	2376	1735	1458	474
Compound group Present	Phenol	Alkane	Alkynes / Aromatic	Alkenes / Aromatic aldehyde and ketone	Alkane	Carbonates

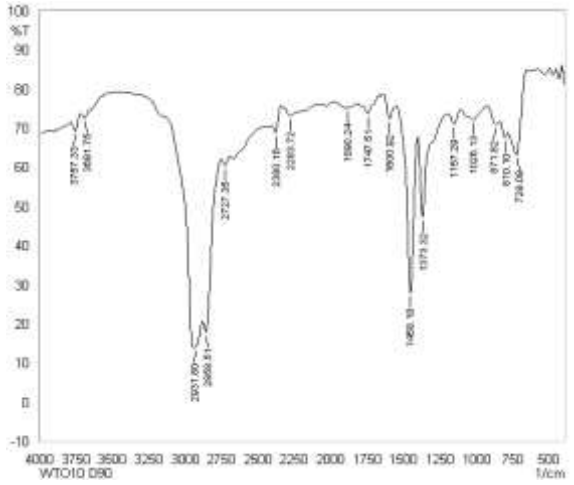

Figure3: FTIR Spetrum of WTO10D90

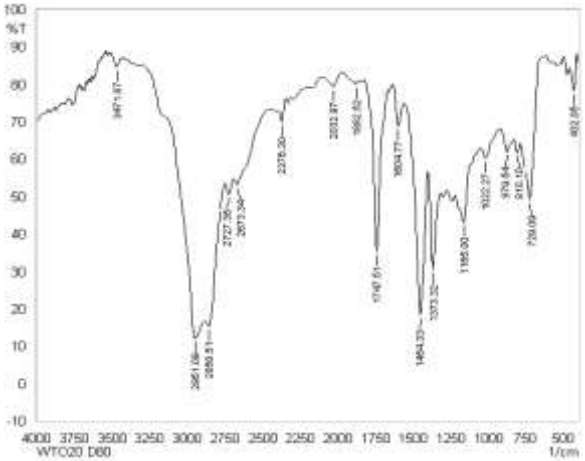

Figure4: FTIR Spetrum of WTO20D80

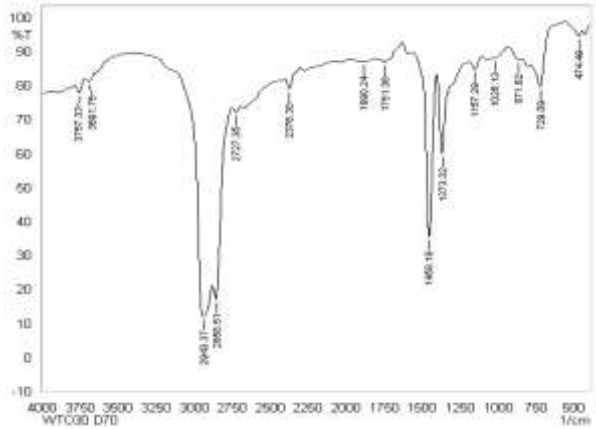

Figure5: FTIR Spetrum of WTO30D70

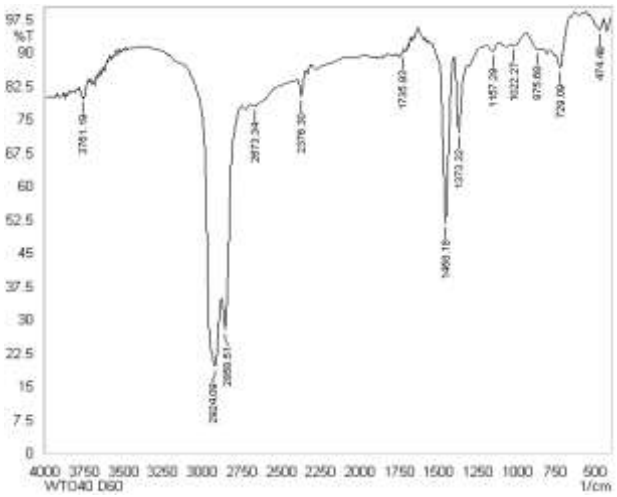

Figure6: FTIR Spetrum of WTO40D60

The FT-IR absorption is provides detailed information about the structure of molecular compounds. The results of the FT-IR analysis are in the form of a graph plotted between the wave length and percentage of transmittance (As shown in Figure1 to Figure6) which will give information about the position of various bond vibrations, distinguished by several modes of vibration such as symmetrical stretching, asymmetrical stretching, bending, scissoring etc. The wave number, bond types, for petroleum diesel and waste transformer oils are given in Table 2. In the case of petroleum diesel fuel, the strong absorbance peaks at 2924 and 2858 cm^{-1} represent C–H stretching. The peak at 1458 cm^{-1} represents C–H bending. These are the evidences which confirm the presence of alkanes. The presence of C–H group or hydrocarbon indicates that the liquids have a potential to be used as fuels [Prasana 2015, Nabi, 2013].

4. Conclusion:

Waste oils pose a very serious environment challenge because of their disposal problems all over the world. In this context, waste oils are currently receiving renewed interest. The present investigation is aimed to reuse the waste transformer oil (WTO) as an alternative fuel for compression ignition (CI) engine. For this purpose FTIR studies of WTO were determined. FTIR properties of WTO and its blends were compared with those of conventional diesel fuel. It results revealed that Waste Transformer Oil and its blends the compounds present are alkane, alkenes, aromatics, alcohols, phenols and carboxylic acids etc, which are similar to the compounds present in the diesel. Based on FTIR finding, WTO and its blends are suggested to alternative fuels for CI Engine.

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