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# Production of Liquid Fuels from Waste Lube Oils Used by Pyrolysis process

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**Abstract.** This study, Pyrolysis technique is founded from Recycling Principle of used oil concept from industry in local area. Waste lube oil was pyrolyzed in a batch stirred bed reactor using heat at temperatures 200, 300, 400, 500 °C under vacuum. During Pyrolysis Process at 50 – 100ºC, $N_2$ is released to extract water from the used oil as much as possible. Before pyrolysis process, used oil is looked in to its qualification by ASTM Standard Method. The pyrolysis oil obtained at 350 ºC hydrocarbon liquid (dark brown) and have smell, get product ≥ 50% wt. Pyrolysis technique to explore yield (product quantity, qualification of pyrolysis oil, especially Hydrocarbon composition) to benefits to oil industry. Indeed, this technique can reduce costs from imported technology from overseas or produce alternative choice of energy from waste lube oil.

**Keyword:** Pyrolysis, Waste lube oil

## 1. Introduction

Nowadays, we find lube oil is in demand for use increasing which results in more demand of waste lube oils each year more than 24 millions around the world. Waste lube oil is organic compound consists of hydrocarbon, solvent, heavy metal, which its components harm the environment and difficult to get rid of or treated (soot, Poly-cyclic aromatic hydrocarbons (PAHs), Chrolinated Paraffins and Poly-chlorinated bi-phenyls (PCBs) are big components).[1,8,9] Generally, to get rid of waste oil always uses simple methods of Incineration and Combustion for Energy Recovery and Vacuum Distillation and Hydro-Treatment for Re-Refining.[6] However, referred methods only get rid of the chemical value of waste and they become increasingly impracticable as concerns over environmental pollution. The process is even involved difficulties and additional costs of sludge disposal, are recognized due to the undesirable contaminants present in waste oil.[2]

Pyrolysis is the unique environmental friendly technique to get rid of waste lube oil (thermally crack). The process is under vacuum system. Temperature, pressure, reactor type, type of material is having direct affect on Pyrolysis technique in which results differently (e.g. hydrocarbon oils, gases and char or carbon black. [3] Oil and gas are the end products having high calorific value.

Advantage of Pyrolysis technique is gaining 40-60% oil, 10-30% gas, rests is char [4,5,7], but lesser chance in having Dioxinfuran compared to incinerator. Disadvantage is founding Tar mixed in waste lube oil, also stink and need to find way to get rid of it to allow good use in real practice, but high expenses and complicated system involved.

In conclusion, we study of Pyrolysis technique to explore yield (product quantity, qualification of pyrolysis oil, especially Hydrocarbon composition) to benefits to oil industry. Indeed, this technique can reduce costs from imported technology from overseas or produce alternative choice of energy from waste lube oil.[2,4]

## 2. Experimental Section

### 2.1. Raw Materials

Sample of used oil is collected from car dealer and industrial plants in local area. Used oil is volatized at 100ºC (373K) and filtered sludge (size 100 mesh). Before pyrolysis process, used oil is looked in to its qualification by ASTM Standard Method.

## 2.2. Experimental Details

Pyrolysis technique is founded from Recycling Principle of used oil concept from industry in local area. Details are as per following Fig 1.

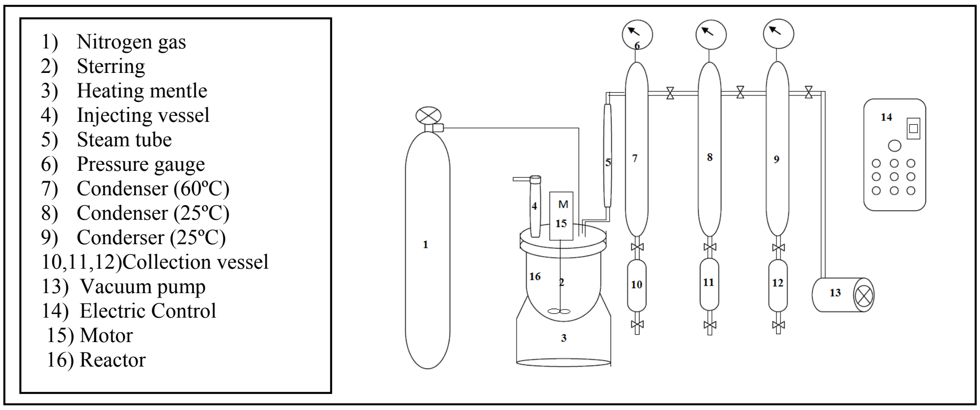


Fig.1: Schematic layout of Pyrolysis system

From Fig.1, we use Heating mental(1) as a tool for stainless steel reactor (200ºC – 500ºC) (16). 1 liter of used oil is stirred (2, 15) and purge gas flows (0.1 – 0.75 L / mm) (1), use of Nitrogen gas 99.99% (Inert Nitrogen Atmosphere). Begin with filling used oil in to reactor (batch), stir to make sure heat is transferred equally. During Pyrolysis Process at 50 – 100ºC, $N_2$ is released to extract water from the used oil as much as possible. Consequently, we get gas, liquids and suspended solid which come from vapour at different temperatures in reactor, moving pass steam tube (5) and get into condensation system (7,8,9), and condense. Therefore, we get pyrolysis oil sit in the vessel (10,11,12). Vapour in the reactor is vacuum pumped out since vapour cannot move to condenser itself (protect not to allow vapour drop back to condenser). Pyrolysis oils were examined for Hydro carbon composition by Gas Chromatography couple of with a mass selective spectrometry detector (GC-MS) and a flame ionization detector (GC-FID).

## 2.3. Analytical methods

Oils sample were analysed using a 6890/5973 GC-MS instrument (Agilent Technologies, Palo Alto, CA), allowing the qualification of compounds by both species and size, compounds were identified using GC-MS data for similar product; The detailed description of this analylical method by GC-MS using a 10 m DB-5 column (I.D. 0.53 mm). The GC-FID oven was programmed from 40ºC, held for 5 min, then ramped at 5 ºC/min to 300ºC. Helium was used as the carrier gas Qualification of compound on the GC-FID was obtain by external standard method and relative retentive times once the component had been identified using the NISI mass spectral library. The compounds were quantified according to the ratio of the peak area produced for each compound to the peak area produce for the corresponding standard with know concentration of specific compound in ppm.

The peak area of each compound was calculated from integration of the corresponding peak present within the total ion chromatography produce for each sample, then qualification was performed by calculating what proportion this area is of the peak area produced for the corresponding std. The concentration of each compound was then calculated and quantified on the basis of vol%.

Experimented analysis of the fuel properties of the pyrolysis oils was performed accordingly to the following ASTM method: D445-11[11]for viscosity, D482-07 [12] for Ash, D1796-04[13] for water and sediment, D93-10 a [14] for flash point, D4052-09[15] for Density.

# 3. Result and Discussion

From study of different processes, we get final product as liquid fuel which is matching purpose of the research. We want to change waste lube oil into petrochemical product which suitable for use as a fuel. This paper explored the effects of varying the feel injection rate of waste oil, and the purge gas flour rate. Pyrolysis at a constant temperature of 350 ºC was use as throughout based on the optimum tempertature that showed the greatest yield of valuable hydrocarbon and only low levels of residual metals in the pyrolysis oil.

## 3.1. Visual inspection of pyrolysis operation

Change of waste lube oil to pyrolysis oil start to occur when the operating temperature was above 200 ºC, where over 30% of the product was an oil mixture. At 350 ºC, get product ≥ 50% wt. The pyrolysis oil obtained at 350 ºC hydrocarbon liquid (dark brown) and have smell (fig. 2)

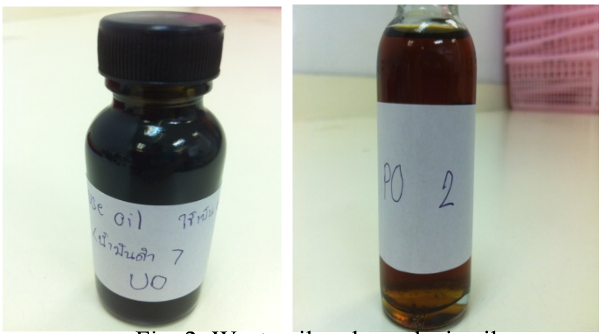


Fig. 2: Waste oil and pyrolysis oil

## 3.2. Chemical composition

GC-Ms analysis revealed that both waste oils are formed from a mixture of low and high molecular weight aliphatic and aromatic hydrocarbons (Tabel.1) The majority of the hydrocarbon compound $C_{11}$-$C_{30}$ were detected in waste oil (Table.1)

| | Waste lube oils | Pyrolysis oils |
|---|---|---|
| *Aliphatic* | | |
| Alkanes | 91 | 47 |
| Naphthenes(cycloalkanes) | 0.5 | 0.6 |
| Alkenes[a] | 0.5 | 22.7 |
| total | 92 | 70.3 |
| *Carbon components* | | |
| $C_5$ - $C_{10}$ | - | - |
| $C_{11}$ - $C_{15}$ | 3 | 42.2 |
| | Waste lube oils | Pyrolysis oils |
| $C_{16}$ - $C_{20}$ | 7 | 22.4 |
| $C_{21}$ - $C_{25}$ | 57 | 4.3 |
| $C_{26}$ - $C_{30}$ | 25 | - |
| $C_{31}$ - $C_{40}$ | - | - |
| *Aromatics* | | |
| Benzene | - | 2.1 |
| Toluene | - | 2.3 |
| Xyrene | - | 3.6 |
| Alkylbenzene | 1.1 | 14.6 |
| total | 1.1 | 22.6 |
| *PAHs* | | |
| Naphthalene | 0.1 | 0.01 |
| Acenaphthene | - | 0.02 |
| Acenaphthylene | - | 0.02 |
| Phenanthrene | 0.01 | - |
| Anthracene | 0.02 | 0.03 |
| Pyrene | 0.13 | - |
| total | 0.13 | 0.2 |
| Others | 6.8 | 7 |

[a] Alkenes : n-alkenes, dialkenes

Quantitative analyses of the pyrolysis oils were undertaken and results are presented in Table.1. The compounds present were grouped into different classes of organic compound i.e. alkane, aromatic and unknoens(unidentified peaks)

The study showed that the waste oil, containing $C_{11} – C_{30}$ hydrocarbon, was thermally cracked to oil products comprising mainly of $C_{10} – C_{30}$ hydrocarbons

In this study found the end product is the liquid fuel(diesel oil ) . Overall, the result shows that waste lube oil can be thermally cracked and condensed to pirolysis oils comprising valuable light aliphatic and aromatic hydrocarbons, which could be treat and used as either an energy source or valuable chemical feedstock.

## 4. Conclusion

Process waste lube oil can be conversed into pyrolysis oil. These process parameters also influeneced the concentrations and molecular nature of the different hydrocarbons formed in the pyrolysis oils. These results, demonstrate that pyrolysis generated an ≥ 50% yield of diesel oil product.

## 5. Acknowledgements

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