ENVIRONMENTAL IMPACT OF HYDROCARBON INDUSTRIES

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Abstract— Lubricating oil requirement is increasing day by day with the establishment of new industries, increase in number of vehicular transports and mechanization of agriculture. The Generated use oil can be considered as a source of pollution or as a resource, depending on the methods of utilization and management. Used lubricating oil has been reclaimed by treatment with commercial sulphuric acid followed by adsorption on kieselguhr. A maximum yield 70% of reclaimed oil at acid-oil ratio of 14:100 with addition of 15% (w/v) kieselguhr has been obtained. In this paper, an attempt has been made to discuss composition of used lubricating oil and various facts about hazardous nature of used oils. This will enhance more awareness about environmental impacts of hydrocarbon industries to the science community.

Index Terms— Lubricating oil, Fuel, Kieselguhr

I. INTRODUCTION

The lubricating oil after a time of use in vehicles must be replaced because of the degradation of the flash lubricant components and the contamination from metals, varnish, gums and other asphaltic compounds coming from overlay on bearing surfaces. This used lubricating oil results in serious pollution problem, since its dumping may contaminate water, earth and if burnt as a low-grade fuel, harmful metals and other pollutants may be released into the air. However, a proper collection system and recycling process of this oil would help to reduce its environmental impacts and helps in preserving valuable natural resources (Jesusa Rincon). The main function of lubricating oil is to reduce the friction and stress between metal or plastic surfaces that move against each other. Lubricating oils are generally formulated from the mineral based oil obtained in one of the fractions of crude oil distillation, mainly from paraffinic or naftenic mineral oils between 300 to 400^{o}C characterized by compounds that have 16-20 carbon atoms [Heitor Breno2014]. Used oils are an excellent example of high-volume recyclable commodity that can be turned from a waste in to valuable products [Dennis W. Brinkman2015]. As motor oil is used in automobile engines, it picks up a number of additional components from engine wear. These include iron and steel particles, copper, lead, zinc, barium and cadmium, sulfur, water, dirt and ash. Because of the additives and contaminants, used motor oil disposal can be more environmentally damaging than crude oil pollution. These materials may cause both short and long term effects if they are allowed to enter the environment through our waterways or soil [4].Used oil is very serious waste management problem [5]. Used oil is dangerous to environment. It is estimated that one liter of used oil can contaminate a million liter of surface water. Further, the burning of used oil releases sulfur dioxide, carbon monoxide, lead, zinc etc. into the atmosphere leading to negative effects on wild life and human beings [Gomez, M.E.G. Hildige2015].India is still lagging in the field of lubricating oil production. The re-refining of used oil in large scale will be a boon in disguise for our country's development, and a large amount of foreign exchange will be saved if the used oil is properly reclaimed to get lubricating oil base stock [M.J. Chaddha2016].

II. USED OIL SOURCES

AUTOMOTIVE SERVICE CENTERS AND COMMERCIAL ENGINE FLEETS

This includes service stations, garages, new car dealers, other retail establishments and automotive fleet service areas where used oils are drained from crankcases of automobiles and some trucks. Used oils from automotive service centers and commercial engine fleets represent the largest relatively uniform source of feedstock with good recycling capabilities.

Aviation Service Centre

The aviation industry is an important user of petroleum based fuels and lubricants. Used oil generated at major airports is likely to include: Jet fuel drained from aircraft, draining of petroleum based engine and transmission lubricants (primarily from ground support equipment) and synthetic lubricants, which may be resumed as long as they meet specific gravity, viscosity acid number and water specifications.

Industrial Oils

Included in this category are all industrial oils (lubricating and non-lubricating), which have as their source lubricating oil stocks, sold to industry. These include: turbine oils, gas engine oils, refrigeration oils, heat transfer oils and hydraulic oils.

Storage Tanks at Source of Used Oil

Most used oil generators have small storage tanks on their premises, which are used to store the used oil. The size is generally appropriate to the quantity of oil collected in any particular period of time. In some cases the tanks may be too small for carrying out efficient collection [Michel Bourgois2016].

Used oil and Its Composition

Lubricating oil becomes unfit for further use for two main reasons: accumulation of contaminants in the oil and chemical changes in the oil. The main contaminants are listed below:

Combustion Products

Water-fuel burns to CO2 and H2O. For every liter of fuel burnt, a liter of water is generated. This normally passes out through the exhaust when the engine is hot, but when cold it can run down and get collected in the oil chamber. This leads to sludge formation and rust.

Soot and Carbon-These make the oil go black. They are produced as a result of incomplete combustion, especially during warm-up with a rich mixture.

Lead-Tetraethyl lead, which is used as an antiknock agent in the petrol, passes into the oil. Typical used engine oil may have contained up to 2% lead but today any lead comes from bearing wear and is likely to be in the 2-12 ppm range.

Fuel- Unburnt gasoline or diesel can pass into the lubricant, again especially during start-up.

Abrasives-Road dust- This passes in to the engine through the air cleaner composed of small particles of silicates.

Wear Metals-Iron, Copper and aluminum released due to normal engine wear.

Chemical Products-Oxidation products- some of the oil molecules, at elevated temperatures, will oxidize to form complex and corrosive organic acids.

Facts about Hazardous Nature of Used oils

- Used oil themselves are not toxic. Contaminants such as additive, degradation products, etc. make them so hazardous.
- They have high potential to cause damage to the environment by virtue of their persistent nature and potential to spread over large surface areas on land and water.
- Layers of oil prevent light and air from reaching to life forms of all types on land and water.

For these reasons, most of the countries in the world have classified used oil as hazardous waste and introduced regulations clearly recommend re-refining used oils over burning or other means of disposal. Unlike virgin crude oils, re-refined oil is a renewal source of energy. Recycling of used oil helps in the following ways.

- Conservation of valuable oil reserve by using the oil again and again.
- Saving of huge amount of foreign exchange.
- Checks environmental degradation and saves ecology.

III. METHOD OF TREATMENT

Used lubricating oils were collected from different local garages and service stations in Aligarh and mixed in a single container. Used lubricating oil was stored for several days to allow large suspended particles to settle under gravity. As the samples were obtained from many locations, it was assumed that it could represent a typical feedstock of re-refinary plants for recycling used lubricating oil. The used lubricating oil mixture was kept in a closed drum of 20 liters and the contents were homogenized prior to any testing and different types of additives such as Zincdithiophosphate, Polyisobutylene and Molybdenum disulfide were procured from the local market. The process included the following steps.

- Filter the raw oil.
- Dehydrate the oil to remove gasoline and other low boiling contaminants. The used oil if agitated with commercial sulphuric acid (15% v/v) for 25 minutes at 40-45oC. The contents were kept overnight for settling sludge. The supernatened oil was separated by decantation and centrifuge up to 25 min at 2000 R.P.M. to separate insoluble contaminants.
- Kieselguhr (15 gm Kieselguhr for every 100 ml of acid treated oil) and lime (5 w/v %) were mixed to the oil. Temperature was maintained between 70-80oC to avoid of oil. The whole mass is then percolated through filter to remove metallic contaminants. The experiment was repeated with different proportion of oil and acid with a view to obtaining optimum yield and the quality of the reclaimed oil. The effect of acid oil ratio on the properties of used lubricating oil was studied and shown in Table I. The reclaimed oil was then blended with Zinc dithiophosphate, Polyisobutylene and Molybdenum disulfide additives at different proportion for improvement of viscosity index and pour point that are shown in Table III, IV and V repectively. To improve colors, anthraquinone additive was added to the reclaimed oil at different proportions.

Table 1 The properties of used lubricating oil

Acid – oil ratio, v/v	Viscosity Index	Ash Content (%)	Pour Point (^oC)
2:100	85.52	0.190	+14
4:100	86.20	0.165	+12
6:100	86.80	0.150	+11
8:100	87.81	0.120	+9
10:100	88.21	0.105	+8
12:100	90.29	0.090	+7
14:100	92.41	0.080	+5
16:100	91.10	0.76	+4
18:100	90.89	0.060	+3
20:100	89.91	0.050	+2

Table 2 Comparative properties of used, reclaimed and fresh lubricating

Property	UsedLubricating oil	Reclaimed Oil	Fresh Lubricating Oil SAE 30	SAE 40
1. Yield, % wt	-	70	-	-
2. Density, gm/ml	0.8902	0.8431	0.865	0.871
3. Water Content % V/V	04	0	0	
4. Ash Content, wt %	0.22	.065	.0072	.040
5. Pour Point, 0C	+6	+5	-6	-9
6. Flash Point, 0C	152	190	200	210
7. Viscosity at 400C cst	194.87	116.61	106.56	105.78
8. Viscosity at 1000C cst	16.01	11.30	12.67	13.67
9. Viscosity Index	87.4	93.40	106.76	0.069
10. Acid Value, mg KOH/gm	0.52	0.061	0.075	0.069

Table 3 Effect of additive 1 on viscosity Index

Name of Additive	**Quantity of Additive (% wt of reclaimed Oil)**	**Viscosity Index**	**Pour Point ^{o}C**
Zincdithiophosphate (ZDP)	0.0	92.41	+5
	0.2	95.32	-2.0
	0.4	96.20	-3.0
	0.6	97.20	-4.0
	0.8	101.72	-5.0
	1.0	102.10	-7.0
	1.2	104.23	-8.2
	1.4	105.29	-9.1
	1.6	106.82	-10.1
	1.8	106.10	-9.5
	2.0	105.29	-9.4

Table 4 Effect of additive 2 on Viscosity Index

Name of Additive	**Quantity of Additive (% wt of reclaimed Oil)**	**Viscosity Index**	**Pour Point ^{o}C**
Polyisobutylene	0.0	92.41	+5
	0.2	93.82	-1.0
	0.4	95.10	-2.0
	0.6	97.20	-2.5
	0.8	100.20	-3.0
	1.0	101.89	-5.0
	1.2	103.73	-7.5
	1.4	105.12	-8.0
	1.6	106.22	-9.0
	1.8	105.72	-8.5
	2.0	106.13	-8.2

Table 5 Effect of additive 3 on viscosity Index and pour point of reclaimed oil

Name of Additive	Quantity of Additive (% wt of reclaimed Oil)	Viscosity Index	Pour Point ^{o}C
Molybdenumdisulfide	0.0	92.41	+5
	0.2	93.70	-1.0
	0.4	95.02	-2.0
	0.6	96.12	-3.0
	0.8	98.35	-4.0
	1.0	99.20	-5.0
	1.2	101.10	-6.5
	1.4	102.25	-7.0
	1.6	102.50	-7.5
	1.8	101.78	-6.5

IV. CONCLUSION

The reclaimed oil obtained in the present investigation after H2SO4 treatment, Kieselguhr treatment and addition of different types of additives resemble the SAE 30 grade lubricating oil in terms of properties and is applicable as a standard lubricant such a reuse of waste lubricating oil, in addition to its economic effect, will help reduce environmental pollution.

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