. USING CLEAN TECHNOLOGY FOR RECYCLING USED LUBRICATING OILS

Submitted By

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B.Sc. of (Power Mechanics), Faculty of Engineering & Zagazig University, 1980

Master of Environmental Science, Institute of Environmental Studies & Research

Ain Shams University, 1988

A thesis submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Science

Department of Environmental Engineering Science
Institute of Environmental Studies and Research
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ABSTRACT

Analytical, thermal and performance data were derived from the analysis of 14 commercial multi and mono grade lube oils by using routine, non-routine and performance tests. When the tested oils were used in engines, they deteriorated and became less efficient and a change in their properties occurred. Such that the oils couldn't give a complete performance. The objective was to evaluate the efficiency of tested oils and estimate their deterioration using these oils in standard and recent instruments and laboratory performance engine test machines.

The 20 used oil samples obtained from 10 service stations and different industrial companies in great Cairo were analyzed in order to investigate the variation in waste oils .The waste oils are used as feedstock to activate new improved re-refining and reclaiming processes. The Waste oil management is necessary for minimizing the negative impacts of the waste oil on the environment and human health, by reusing reuse this hazardous waste with the oil of the most appropriate technologies to contribute to the national economy. In this respect, the key groups are the waste oil management system; oil producers, waste oil generators, waste oil transports, recovery and disposal facilities. Moreover, at each step of waste oil management it is important to take the necessary measures to ensure that waste management is carried out without endangering the human health or the environment.

Used oil management in Egypt is an important to clean product that has not yet received sufficient attention although recycling has been practiced for a long time. Mismanagement of waste oil thus represents not only a serious environmental hazard but also a waste of precious petroleum resources. This research work deals with a new improved method for the recycling the used lube oil by mechanical separation, dehydration, vacuum distillation and fractionation for restoring into the condition in which it has substantially the same lubricating characteristics as in its original form. Laboratory tests were selected and in some instances modified to determine the analytical, thermal and performance properties of the recycled oil. This was also performed for the additionally samples of commercially new oil and recycled oil were and comparative studies were determined. Selected samples of recycled oil were reformulated with an additive for further estimates of quality.

This proposed technology which consists of mechanical separation and distillation (atmospheric and vacuum) is environmentally sound technology. It is also

a potential for significantly improved environmentally performance relative to other technologies Energy conservation and environmental considerations would be better served by re- refining rather than burning the used oil. If every liter of used oil is re – refined rather than burned it will save 139000 BTU. Re-refining the used oil only takes one third of the energy required to re – refine the crude oil. The recovery of waste oils is of economic importance. This is because the balance of payment is reduced through saving the expensive lube oil. The cost saving arise for industry and consumers, extends the life and usefulness of natural resources and contributes to a more sustainable life style. Modern re-refining processes return the used oil to a new condition by removing dirt and contaminants before injecting the lube additives to protect engines.

The environmental benefits clearly favor recycling because the toxic heavy metals (Zinc, cadmium, chromium, and lead, among others) are extracted from the used oil, rather than getting emitted into the atmosphere during combustion. The research assesses and compares the environmental impacts and benefits of each management method in the product end – of – life scenario using a life – cycle assessment approach (LCA). A life – cycle inventory showed that 820 mg of zinc and 28 mg of lead air emissions may result from the combustion of 1 L of used oil as a fuel (50-100 times that of crude – derived fuel oils). For an example, up to 136 Mg of zinc and 5 mg of lead air emissions may be generated from combustion.

This research work contains the comparative studies of process energy requirements, yield and waste disposal. The comparison is held between the new improved process and the international recycling processes in the final part. Superior options for managing used oil, such as used oil re-refining, are readily available throughout most of Egypt. Re-refining the used oil into new lubricating oil allows the oil to be used over and over again. The used motor oil is a renewable resource. The lube oil never wears out: but it only gets dirty. Instead it can be re-refined into new lubricating oil in an endue recycled loop which saves energy and reduces greenhouse gas emissions (GHG).

Re-refining of base oils from used lubricants is attracting much of interest in Egypt .Re-refining provides a new life for the used oil, which allows continues utilization of the lubricant resource, and it has a small environment footprint compared to other methods of managing used oil. As the re-refining capacity increases, competition for used oil will increase as well and some consumers continue

to perceive re-refined oil as lower quality and lower performing. The synergistic effect of these two phenomena has created an environment in which the recycle of used lubricating oil is once again a socially desirable and economically profitable enterprise. This conserves our non-renewable petroleum resources, reduces greenhouse gas emissions and saves energy when compared to burning the used oil as fuel without treatment before burning.

The proposed technology converts used lubricant oil into 88% base lubricant and 4% fuel, 2% water and 6% heavy ends making it zero% emission from proposed process therefore, it's the solution for a green economy and lube-re-refining as the best option to save a precious raw material. By products obtained from the proposed process as fuel, heavy ends, and water can be less than other recycle process and can be sold in their own right, thereby limiting waste from the process. The proposed technology for recycling used lube oil is environmentally friendly and closed loop system. It also has a positive implications for green house challenge as well as environmental benefits such as air toxics conservation of resources and lower carcinogenic risks from re-refined oils which meet all new motor lubricating specifications.

The results showed that continuous distillation column has improved results, and suggested that a mechanical separation (such as settling, centrifuging filtration and coalescing step) is important to reduce the processing difficulties. Coking and fouling in the subsequent fractional distillation. Doubled distillation vacuum reduces the contaminants to low level of 60% ash, such that no further operational problems were encountered on vacuum distillation. The optimal conditions of pressure and temperature were 4 mBar and 200ºC during dehydration that as the best result than virgin oil. Recycling the used oil is the most preferable option over burn. Vacuum distillation of used lube oil at 4 mBar and temperature 370ºC give better result than virgin oil. Re-processing used oil saves significant energy. Just 1 liter of used oil yield the same volume of lube base oil obtains from 42 liters of traditionally refined crude oil, (while only using about one third of the energy). The metal content of used oil was greatly reduced where Fe decreased from 712 to 17 ppm and Zn decreased from 2282 to 20 ppm using dehydration and double vacuum distillation processes.

The environmental impact of re-refining is a substantial improvement over burning with respect to human toxicity potential, heavy metals hazards, eutrophication potential, aquatic ecotoxicity, carcinogenic substances, photochemical oxidant

potential and acidification potential. The preservation of energy as an environmental consideration favors re-refining or combustion in larger industrial applications. The energy balance favors re-refining because the energy consumption that occurs during the distillation and mechanical separation in the proposed process is less than that consumed in burning the used oil as a fuel or in space heaters. The burning of used oil in space heaters is considered to be a less than state-of-the-art management option for used oil.

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