Waste Lubricating Oil Purification and Recovery

It may be surprising to note that, under normal circumstances, lubricating oil cannot be easily destroyed; it only gets dirty and is easily contaminated by other solvents. This property makes it a potential pollutant that must not be allowed to get into the environment. The only option is to collect it and treat it so that its original properties are restored and thus enable its re-use. Modern lube oil has at least 8 additives blended into it so as to enhance its life and working properties.

So far, in India, little or no effort is being made to recover and reuse this additive cocktail, which is normally sold by re-refiners to brick kilns for burning, thereby adding it to atmospheric pollution. The value of these additives is considerable and serious thought should be given to the possibility of further treatment and recovery processes.

Refining processes

Traditionally, waste lube oil has been refined in India by 2 processes:

1. Clay / Acid Process, which is now banned by the Central Pollution Control Board (CPCB), GOVT. OF INDIA as it adds heavy pollutants to the environment.
2. Vacuum Distillation Process which is able to recover good quality light and heavy base oils and it has practically negligible pollutant load for the environment.

a) Clay / Acid Process:

Though this process is banned today, it is described briefly below and is carried out as follows:
Step 1: Pre-treatment of the waste oil, by filtering it to remove any solid impurities [particles of dirt, carbon, soot, etc.]
Step 2: The oil is de-watered in large settling tanks, wherein the heavier water settles to the bottom of the tank and the lighter oil floats on top. The water at the bottom is drained off and should normally be treated before disposal. However, this does not remove the water completely and a small quantity still remains.

Step 3: Final removal of water is done by heating the remaining oil to about 60°C in a separate Tank. To this warm oil, sulphuric acid is added and the mixture is stirred and allowed to stand. The acid separates the oil / water mixture into 2 phases. All contaminants accumulate in the aqueous phase which settles at the bottom of the tank and is drained off as slurry. This slurry contains used oil contaminants, including metals and some oil additives. The real problem is disposal of this slurry. This can only be done by drying it to a solid waste and disposing the resultant solid matter in a land-fill. This process is expensive as it requires energy inputs to remove the water. The CPCB, Govt. Of India has banned this process for the obvious reason that the slurry with all metallic contaminants finds its way into the environment. It is difficult to clean up this mess once it becomes a part of the environment.

b) Propane De-asphalting Process

[PDA]: Solvent Extraction:

This solvent-extracting process is currently not widely used in India, as it is banned. It relies on the greater solubility of waste oil in propane, compared to all contaminants which do not dissolve easily in it. The process is carried out at atmospheric pressure in an extracting column. The waste oil feed is inserted in the middle of the column and it flows

downwards through a counter-current of propane, which being less dense, rises to the top of this extraction column. We get two streams of material, one from the top of the column and the other from the bottom of the column. The propane soluble components of lube oil are removed along with propane from the top of the column and the propane insoluble material flows out from the bottom.

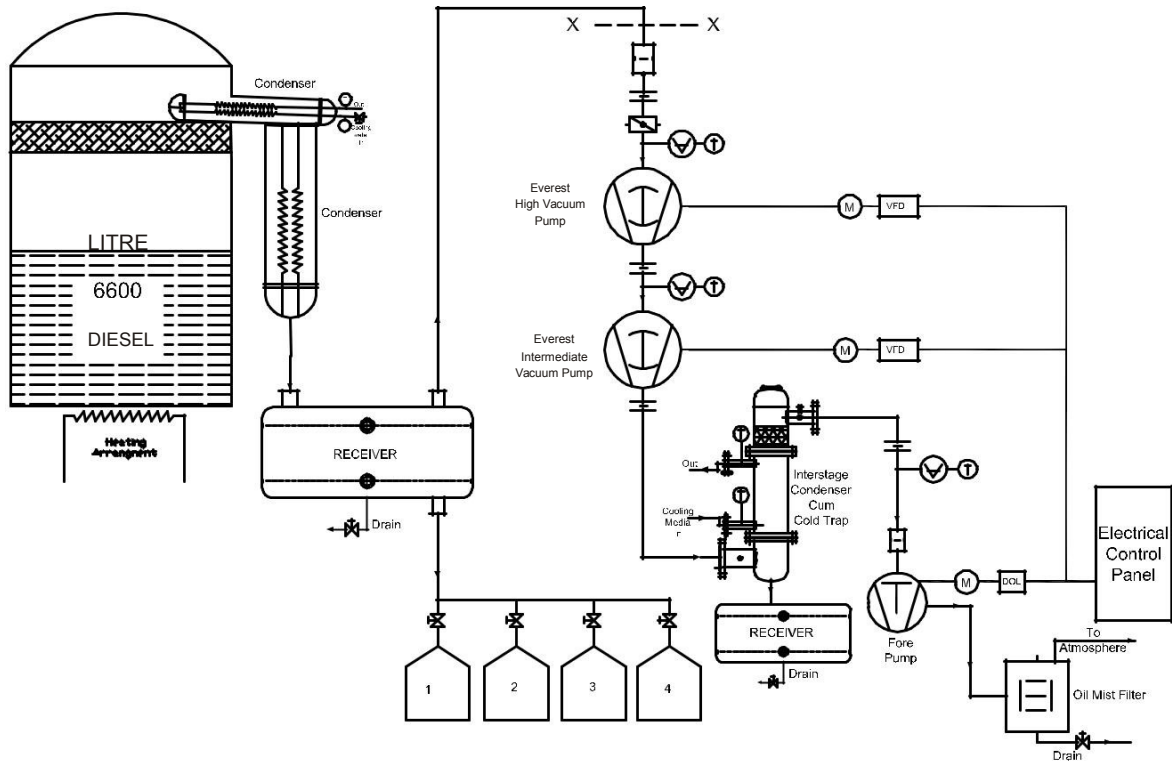
Both the streams are stripped of propane in separate columns. The propane thus recovered is re-used. The stream from the top of the column contains good quality lube oil, while the bottom stream carries all the contaminants. These contaminants are disposed off by mixing with distillation column bottom residue as asphaltic material. The top cut oil from the PDA process is sent for further refinement by distillation. Generally, this PDA process is not used in India, as it is felt that distillation alone is sufficient.

c) Vacuum Distillation

This is the core process for lube oil re-refining. In India, the general practice is to refine waste oil in a batch process. The de-watered oil is heated in a kettle under vacuum. As the temperature in the kettle rises, various cuts are liberated and rise as vapours, to be condensed in a condenser. The condenser, along with the heating kettle, is maintained under vacuum by a vacuum pumping system. The condensed products are available as different products corresponding to various kettle temperatures as mentioned below.

Finally, the process ends when the residual material in the kettle does not vapourise, even at a temperature of around 320°Celcius. At this point, the heating in the distillation process is stopped and the process is essentially complete.

Brief Description of the batch distillation process:



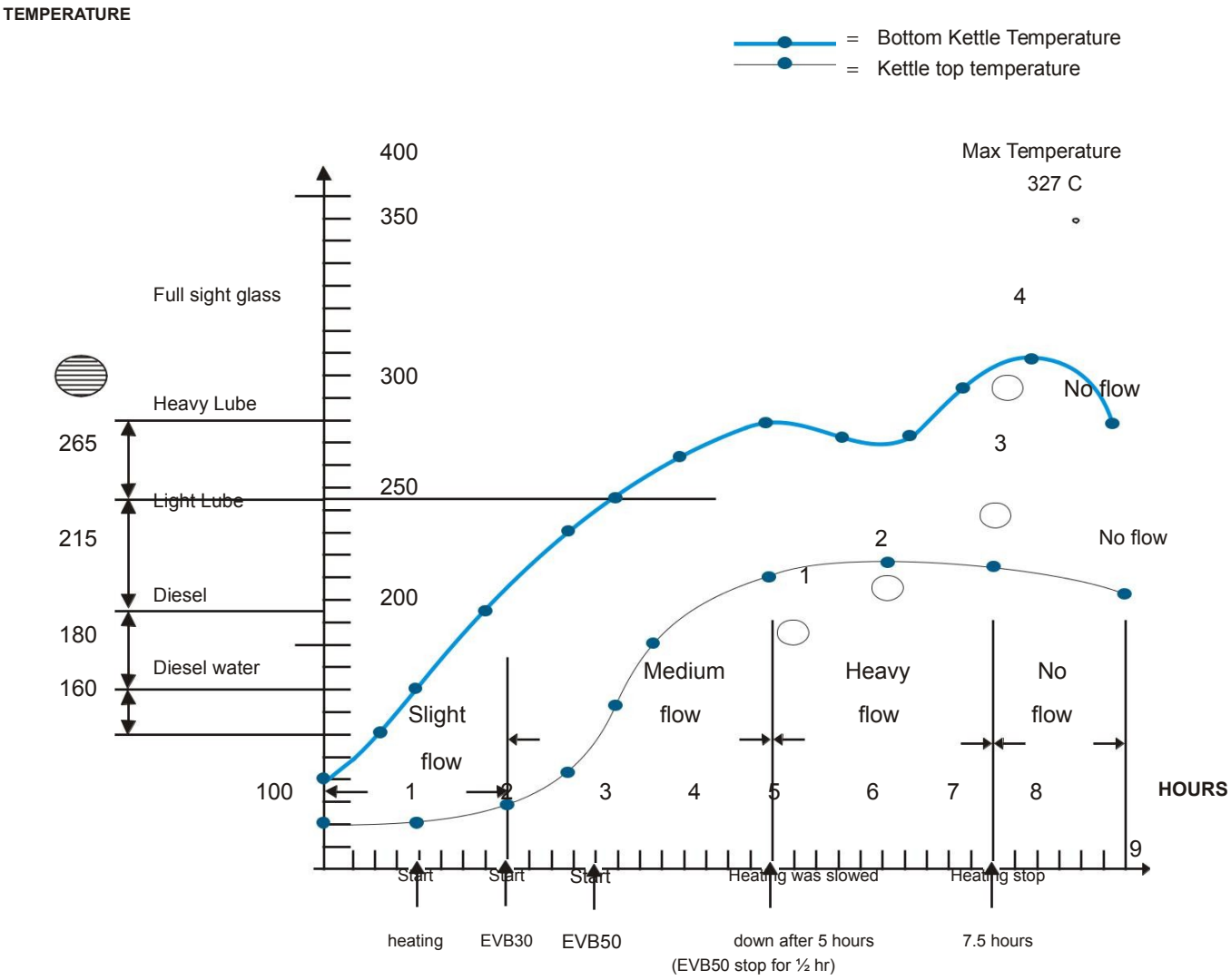
Typical Setup of a Batch Type Lube Oil Purification Plant.

The kettle is filled with de-watered lube oil. A typical batch may be around 6600 liters. It takes about one hour to charge the kettle completely and for the oil to pick up sensible heat from the kettle. Heating may be direct or indirect. As the temperature of the oil rises to around 170°C - 180° the first cut of diesel (light oil fraction) are released from

the batch. At this point the intermediate vacuum pump (Everest Mechanical Vacuum Booster) is started to attain higher vacuum of the range15-20 Torr . Now distillation of light oils takes place.

As the light oil cut tend to finish, there is temperature rise indicating completion of light oil. High Vacuum Pump (Everest Mechanical Vacuum Booster) pump is now started. At this stage the vacuum in the kettle is brought to <1 Torr. Lube Oil is the main product and its distillation starts at around 270°C and continues up to 300 - 320°C. Most of the heavy lube oil distills out during this process. At the end of the process the kettle bottom temperature begins to rise marking its completion. A look at the accompanying graph shows the kettle top and bottom temperature during the process giving a clear idea of what is happening.

Kettle top and bottom temperature during distillation



The graph has been plotted from a data collected from a practical system. Actual results may vary marginally. As shown in the graph, heating above 300°C does not result in any flow. The actual cycle ends at 7.5 hrs when the temperature. Is close to 300°C

After the lube oil has been distilled, the distilled product is still dark in colour. A final clay process gives lube oil of light golden colour, which is acceptable for sale. A table below gives an idea of the recovery from the process.

Results of Typical Waste Oil Process Batch

	6600 L			
5% water	220 L			
Amt. sent to first kettle	**6400 L**			
		3300 L	Heavy Lube	52%
		1320 L	Light Lube	21%
		800 L	Diesel	12%
				85%
Cold Trap Product		75 L	Water + Diesel	1%
Bottom		~ 800 L		12%
				98%
Loss on Distillation about				2%
Cold trap reservoir contains Diesel + Water + Lube Oil. Total quantity is 75L. (Approx). Total process time approximately 8 hours for 6600 L batch. Total Clay Used: About 4% W/V.				

Disposal of Wastes Generated.

The oil-saturated clay is generally sold off to brick kilns for burning as it is saturated with at least 20% by weight of oil. Considerable economy is possible if this clay is processed to recover the oil as well as regenerate the clay for use again.

Typically, the process of regenerating the spent clay involves the following steps:

a. Treating the clay with a solvent to extract the oil from the clay.
b. The solvent is processed to recover the oil extracted and have the solvent ready for reuse.
c. The clay is reactivated by acid treatment. The regenerated clay is then fit for use and the acid is recovered for reuse.

It is possible by using clay recovery techniques to get better quality of oil by using expensive high quality clays, which can then be reused almost indefinitely.

Typical additives added to lube oils.

There are 8 different types of additives that are added to lube oil, these are:

1. **Detergents:** whose function is to hold acid neutralizing compounds in the oil.
2. **Dispersants:** keep soot and other products of combustion in suspension in the body of the oil.
3. **Anti-oxidants:** whose function is to delay the process of decomposition that occur in lubricants.
4. **Anti-foam additives:** prevent foaming in the oil.

5. **Pour Point Depressants:** prevent rapid changes in viscosity at low temperatures.
6. **Anti-wear and extreme pressure [EP] additives.**
7. **Polymer thickeners :** used to adjust the viscosity characteristics of the oil
8. **Corrosion Protection:** Included to protect vulnerable metallic surfaces.

Economics of Process:

About 45 L per hour of diesel is burnt for about 6 -7 hours to meet the heat energy requirements of the process. The vacuum pumps required for distillation process consume approximately 15 kW x 7 hours = 105 kWh. At Rs. 5/- per kWh, the cost of electric power works out to Rs. 525/- per batch. Hence, the total cost of the refining operation would be much less as comparing it to a steam jet ejector sysem of similar capacities making the process more economical. The actual cost of the operation may be a little lower, since the diesel recovered is used for burning in the process cycle. (Heating of the kettle).

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In conclusion, it can be commented that the biggest economy a lube oil processor can take is the clay recovery process. Implementing this in a successful manner would result in:

a. Very considerable reduction in the purchase of fresh clay, since even if the spent clay is sold, there is still a loss of approximately Rs. 2/- per kg of the clay consumed.
b. Improvement in quality of product, as the finest quality of clay can be used.

Further, refining steps on the bottom product, which is now burnt in brick kilns could result in the recovery of additives which are now lost. This would reduce environmental pollution and would be well worth the effort.

Photo:- Typical Waste Oil Re-Refining Vacuum System offered by Everest Blower Systems.

Article compiled on actual field trials conducted by the technical cell of Everest Blower Systems.

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