Re-refining vs recycling waste oils

***Dr Chem. Eng. Srđan Sokolović MBA**, Energy and Waste and Chemicals Management Consultant, Owner of Sowa Solutions*

All around the world, lubricants are present in applications where they are used to reduce the friction, heat, and wear between mechanical components that are in contact with each other. Around half of total purchased lubricants are lost during use or through leakage, with the other half of purchased lubricants ending up as waste oil.

The global waste oil market in 2021 was valued at 68.84 Bn US$ and is forecast to grow up to 98.2 Bn US$ by 2029. [1]

***Figure 1:** Overview of the global waste oil market [1]*

Collection and treatment of waste oil in the EU is defined by Directive (EU) 2018/851 [2] of 30 May 2018 amending Directive 2008/98/EC on waste. According to the aforementioned Directive [2], waste oil is defined as:
"Any mineral or synthetic lubrication or industrial oils which have become unfit for the use for which they were originally intended, such as used combustion engine oils and gearbox oils, lubricating oils, oils for turbines and hydraulic oils."

In the same Directive, regeneration (re-refining) of waste oil and recycling of waste are defined as follows [2]:

- 'Regeneration of waste oils' means any recycling operation whereby base oils can be produced by refining waste oils, in particular by removing the contaminants, the oxidation products and the additives contained in such oils.
- 'Recycling' means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes.

According to the UK European Union (Withdrawal) Act 2018 [3], EU Directive 2018/851 was adopted into UK law, meaning the same definitions of regeneration and recycling apply in the UK.

Generally waste oil could be used as industrial burner oil, where the used oil is dewatered, filtered and demineralised for use in industrial burners; mold oil to help release products from their molds (e.g. pressed metal products, concrete); bitumen-based products; or re-refined base oil for use as a lubricant, hydraulic or transformer oil. [4]

Recycling of waste oil

The processes that are used for recycling [4] are pre-treatment (or Dewatering) or filtering & demineralisation.

Pre-treatment or Dewatering

In waste oil, there is water which can be found as free phase (discrete from the other components present) or as emulsions (bound water). [4] Dewatering represents the process where free water is removed from waste oil through separation by gravity. If there is emulsion present, de-emulsifier must be used in order to free water from emulsion. Waste oil mostly free of water [4] then moves to a tank where it is heated so the remaining water will evaporate. After this, waste oil begins the process of filtering and demineralisation. [4]

Continued on page 10

Continued from page 8

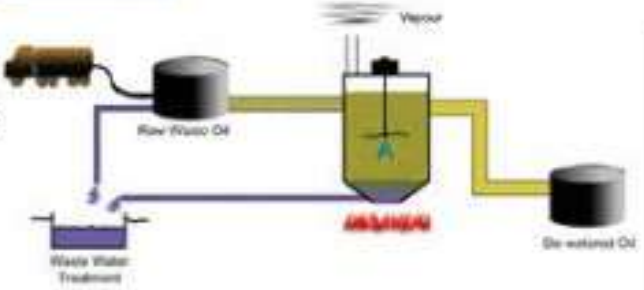

Figure 2: Dewatering of waste oil [4]

Filtering & demineralisation

Inorganic materials and certain additives are removed from waste oil by filtering and demineralisation (see Figure 3 below). This way cleaner feedstock for burning or re-refining is achieved. [4]

In the reaction tank (A) small quantity of sulphuric acid is mixed with the waste oil. This mixture is heated to 60°C, after which a chemical surface-active reagent is added to reaction tank. After stirring, the mixture is allowed to stand so it can separate into two phases: waste oil and aqueous. In the aqueous phase, the reagent causes the contaminants to accumulate, deposits settle at the tank base (A) and are then drained off. [4]

The demineralised oil is then filtered (B) removing particles, thus waste oil is run off to storage as clean burner fuel.

This clean burner fuel can be further diluted or "cut" with a lighter petroleum product (called cutter stock) to produce a range of intermediate to light fuel oils depending on the fuel viscosity requirements of the burner. [4]

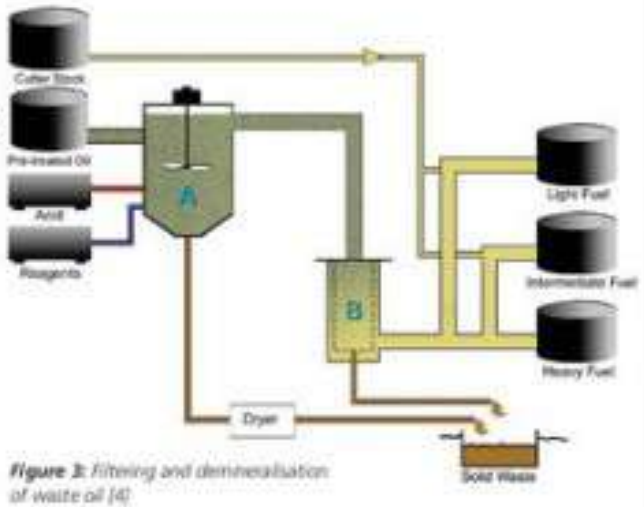

Figure 3: Filtering and demineralisation of waste oil [4]

If the burning fuel isn't sent to burning it can be used as re-refining stock.

Re-refining of waste oil

Through history three technologies were mostly used for re-refining [5]:

The acid/clay treatment is the oldest process and produces the largest quantity of acid tar as by-product waste streams that create environmental hazards. [5] This technology isn't environmentally friendly and therefore is the least best option to choose. [5]

The vacuum distillation with clay process undertakes waste oil through distillation under vacuum pressure [5] by which operating temperature is lowered and the problem of thermal breakdown is reduced. Clays with high adsorptive capacity are used to remove impurities such as heavy metals and breakdown products arising in the use of oil.

Clays are usually used to provide cleaner feed and to give recovered oil a final polish. [5] However, the problem with treating acid tar makes this technology environmentally and economically problematic.

The preferred modern process is **catalytic treatment** called **hydrotreating of waste oils**. [5] The hydrotreating technology removes contaminants by exposing the oil to hydrogen gas. This process is performed in the presence of a catalyst at very high pressure and temperature. [5] Chemical reactions that remove trace metals and other contaminants from the lube oil are promoted by the catalyst.

Quality of re-refining products

Re-refining can produce Group I and II base oils or vacuum gas oil (VGO) that is a suitable feedstock to FCC (fluid catalytic cracking) or HDC (hydrocracking) Refinery Units. [6] The average material balance from 1 litre of used oil is:

- Water and Light 7% vol.
- Ends Light Gasoil 5% vol.
- Lube Oil 75% vol.
- Asphaltic Residue 13% vol.

Hydro re-refining processes are now producing good quality API Group II or Group I+ base oils. Some are even able to make API Group III base oils, depending on the quality of the feedstock.

Application of re-refined oils

Although many people are sceptical about the quality of re-refined base oils, Mercedes-Benz 228.3, Volkswagen 500.00 and 505.00, and API SN and CJ-4 quality approvals have been obtained by several leading lubricant and additive manufacturers [6]. Mercedes-Benz, Volkswagen, Fiat, Ford and MAN all accept high quality re-refined oils. In addition, Mercedes-Benz and Volkswagen stated successful results that re-refined oils are achieving the same performance as new oils.

Sustainability and Environmental benefits

There are many sustainability and environmental benefits such as [7]:

- With capturing and re-refining waste oil, the risk of waste oil getting into and harming the environment is significantly reduced
- Carbon footprint of re-refined base oil can be reduced by up to 50% compared to the carbon footprint of the conventional production of base oil [8]
- For re-refining of base oil there is no need for fresh base oil to be produced
- Increased sustainability for companies which use re-refined lubricants that were originally sent as waste oil for re-refining
- Increased corporate reputation as an environmentally friendly company which uses re-refining

Conclusion

Both recycling and re-refining process will improve sustainability and environmental benefits of the companies but in different ratios. Below you can find different reduction ratios of environmental impact when the waste oil is used as re-refined waste oil or fuel oil.

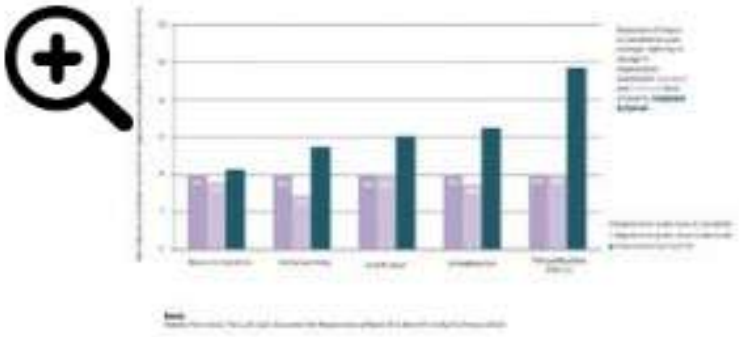

Figure 4: Reduction of environmental impact based on use of waste oil [9]

It can be concluded that the re-refining process gives greater sustainable and environmental benefits as well as larger profit then recycling process, which would mean that re-refining processes should be introduced wherever it is profitable.

One solution for reducing the consumption of virgin base oil, is using re-refined base oil in lubricant industry. At the end it can be concluded that the companies which re-refine waste oil are more sustainable and therefore more environmentally friendly than the companies that recycle waste oil.

References

[1] Waste Oil Market – Global Industry Analysis And Forecast (2021 to 2029) https://www.maximizemarketresearch.com/market-report/global-waste-oil-market/65355/

[2] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L0851

[3] European Union (Withdrawal) Act 2018 https://www.legislation.gov.uk/ukpga/2018/16/section/3

[4] Uses for Recycled Oil - What Happens to Your Recycled Used Oil https://www.environment.gov.au/protection/used-oil-recycling/recycling-your-oil/uses-recycled-oil

[5] Basel convention technical guidelines on used oil re-refining or other re-uses of previously used oil http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/old%20docs/tech-r9.pdf

[6] STP Present Used Lube Oil Re-refining; https://www.stpitaly.eu

[7] Used oil recycling: good for the environment, good for business https://www.recyclingproductnews.com/article/25604/used-oil-recycling-good-for-the-environment-good-for-business

[8] Waste Framework Directive revision: European waste oil re-refining industry position https://www.geir-rerefining.org/wp-content/uploads/GEIRpositionpaperWFD_2016_FINAL.pdf

[9] Main findings from the Institute für energie (IFEU) study https://www.geir-rerefining.org/ifeu-study-summary/