Re-refining vs recycling waste oils

***Dr Srđan Sokolović**, Expert for chemicals and waste management, NIS a.d. Novi Sad*

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. Approximately half of total purchased lubricants are lost during use or through leakage, while the other half of purchased lubricants end up as waste oil.

The collection and treatment of waste oil in the EU is defined by Directive (EU) 2018/851 [1] of 30 May 2018 amending Directive 2008/98/EC on waste:

"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 [1]:

- '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 UK European Union (Withdrawal) Act 2018[2], the Directive (EU) 2018/851 was cut and pasted in UK domestic law, which means that the same definitions of regeneration and recycling are used in UK.

Generally waste oil could be used as [3]:

- Industrial burner oil, where the used oil is dewatered, filtered and demineralised for use in industrial burners;
- Mould oil to help release products from their moulds (e.g. pressed metal products, concrete);
- Bitumen based products;
- Re-refined base oil for use as a lubricant, hydraulic or transformer oil.

Recycling of waste oil

The processes that are used for recycling [3] are:

- Pre-treatment or Dewatering
- Filtering & demineralisation.

Pre-treatment or Dewatering

In waste oil, there is water which can be found as free phase or as emulsions (bound water) [3]. Dewatering represents the process where free water is removed from waste oil in a separator 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 [3] is then sent to a tank where it is heated so the rest of the water would evaporate. After this waste oil is sent to go through the process of filtering & demineralisation [3].

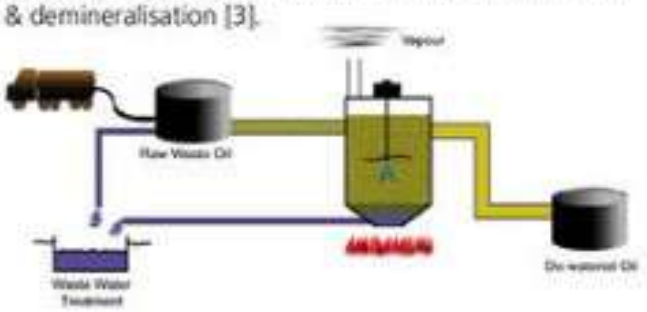

***Figure 1:** Dewatering of waste oil [3]*

Filtering & demineralisation

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

In reaction tank (A) small quantity of sulphuric acid is mixed with waste oil [3]. This mixture is heated to 60°C after which a chemical surface active reagent is added [3] to the reaction tank. After stirring, the mixture is allowed to stand so it can separate to two phases, waste oil and aqueous [3]. The reagent causes the contaminants to accumulate in the aqueous phase, which settles to the bottom of the tank (A) and is drained off [3].

The demineralised oil is then filtered (B) by which suspended fine particles are removed. This way 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 [3].

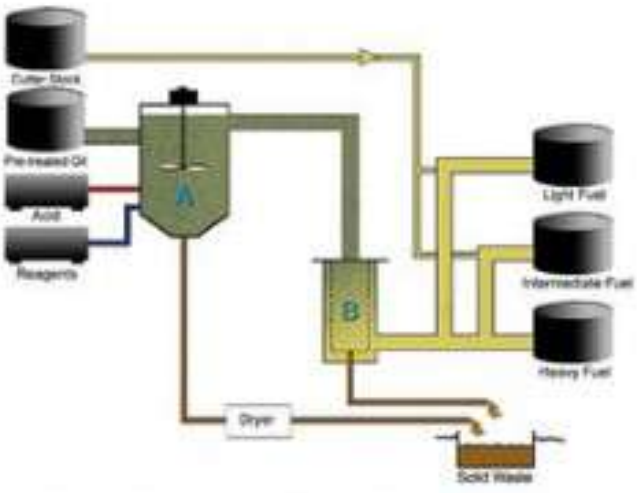

Figure 2: *Filtering and demineralisation of waste oil [3]*

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

Re-refining of waste oil

Historically three technologies were mostly used for re-refining [4]:

- The acid/clay re-refining process
- The vacuum distillation/clay process
- The vacuum distillation/hydrotreating process

The acid/clay re-refining process

The acid/clay treatment is the oldest process with the largest quantity of acid tar as by-product waste streams that represent environmental hazards [4]. This technology is the least environmentally friendly option [4].

The vacuum distillation/clay process

Vacuum distillation with clay process undertakes waste oil through distillation under vacuum pressure [4] by which operating temperature is lowered and 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 [4]. However, treating acid tar makes this technology problematic in both an environmental and economic way.

The vacuum distillation/hydrotreating process

The modern process is catalytic treatment called hydrotreating of waste oils [4]. The hydrotreating technology removes contaminants by exposing the oil to hydrogen gas. This process is done in the presence of a catalyst at very high pressure and temperature [4]. 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 Fluid Catalytic Cracking (FCC) or hydrocracking (HDC) Refinery Units [5]. 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.

The more recent hydroprocesses for re-refining are able to make good quality API Group II or Group II+ 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 oils, Mercedes-Benz 228.3, Volkswagen 500.00 and 505.00, and API SN and CJ-4

Continued on page 12

Continued from page 11

quality approvals have been obtained in re-refined base oils by several leading lubricant and additive manufacturers [5].

Mercedes-Benz, Volkswagen, Fiat, Ford and MAN all accept high quality re-refined oils. In addition, Mercedes-Benz and Volkswagen have confirmed that re-refined oils can achieve the same performance as new oils.

Sustainability and Environmental benefits

There are many sustainability and environmental benefits of the re-refining process. The most important benefits are [6]:

- With capturing and re-refining waste oil, the risk of getting waste oil into and harming the environment is eliminated;
- Carbon footprint of re-refined base oil can be reduced up to 50% compared to carbon footprint of the conventional production of base oil [7];
- For re-refining of base oil there is no need for fresh base oil to be produced;
- Increasing their sustainability for companies which use re-refined lubricants that were originally sent as waste oil for re-refining;
- Increased corporate reputation as environmentally friendly company which uses re-refining.

Final remarks

Both the recycling and process will improve sustainability and environmental benefits of companies. Both processes will save waste oils from becoming a greater environmental hazard.

With both recycling and re-refining waste oil, certain amounts of fresh crude oil will not be exploited for production of base oil or fuel for heating.

When recycled waste oil is used as fuel for heating there is need for fresh virgin base oil. This would mean the carbon footprint of recycled waste oil is bigger than the carbon footprint of re-refined waste oil.

The best solution for less consumption of virgin base oil, is using re-refined base oil in industrial lubricants.

It can be concluded that companies which re-refine waste oil are more sustainable and environmentally friendly than the companies that recycle waste oil.

It can also be concluded that the re-refining process gives greater sustainable and environmental benefits as well as higher profit than the recycling process, which would mean that re-refining processes.

The conclusions show that re-refining processes should be introduced wherever possible.

Recycling of waste oil doesn't have as many sustainable and environmental benefits as re-refining of waste oil and it is less profitable.

References

[1] 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

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

[3] 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

[4] 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

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

[6] 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

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

LINK
www.nis.eu