



Photo: Neste

Neste produces renewable diesel from used cooking oil, tallow, fatty acid distillates and spent bleaching earth oil

Waste not, want not

Spent bleaching earth oil is a sustainable feedstock for renewable diesel and sustainable aviation fuel but lack of logistics and volumes remain as obstacles to its development

Andreia Nogueira

The number of companies producing spent bleaching earth (SBE) oil as a biofuel feedstock has been increasing, but despite the opportunities that new regulations and technologies offer, logistics, the lack of feedstocks and manufacturing costs remain major challenges.

That utilising spent bleaching earths and clays is a good idea is clear.

Egypt-based Central Metallurgical Research and Development Institute noted in a 2023 paper that while these minerals act as effective adsorbers – removing impurities from vegetable oils and improving their “visual aspect, taste, flavour and consistency” – the waste spent bleaching earth left behind “has been considered one of the main problematic hazardous wastes of the food industry”.

The paper, published by *Science Direct*, noted that SBE “is typically disposed of in landfill, which is costly, unfriendly to the environment, and represents an inefficient use of a potentially useful and valuable byproduct”.

Dr Patrick Howes, technical director at Malaysia-based bleaching earths manufacturer Natural Bleach Sdn Bhd, tells *Oils & Fats International (OFI)* that “there are many SBE oil producers globally”, including in several regions of Malaysia.

“It is our customers that generate the SBE that is sent to companies like [Malaysia-based] EcoOils or Gamalux Oils, who extract the oil from the SBE, and then sell the spent bleaching earth oil to biofuels producers and others,” he explains.

“Typically, SBE contains about 20-25% oil. After extraction of the oil using chemicals like solvent, the residual oil in the SBE drops to about 1-3%. The extracted oil is then sold for use in a number of applications including biofuels production,” he says.

Waste oil recycling firm EcoOils prides itself on “deploying cutting-edge recycling technology to divert waste away from landfills while simultaneously generating” SBE oil, which can be used as a biofuels feedstock that can then be applied to produce sustainable low carbon fuel, the company website says.

Aware of growing opportunities in this segment, in November 2022, Singapore-based Shell Eastern Petroleum, a wholly-owned subsidiary of the multinational oil and gas company Shell, acquired EcoOils.

The acquisition – which included 100% of EcoOils’ Malaysian subsidiaries and 90% of its Indonesian subsidiary – was part of “Shell’s ambition to increase production of sustainable low carbon

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fuels for transport, including sustainable aviation fuel," Shell said in a press release.

Shell said low carbon fuels such as SBE oil will "help to meet growing demand for decarbonisation solutions from customers in the transport sector, including hard-to-decarbonise sectors such as aviation."

Market expansion

Dr Howes notes that "many companies in various countries buy SBE oil".

For instance, Finnish petroleum refiner and renewable fuel producer Neste and Spain's Lipsa "buy SBE oil for HVO production in Singapore, Finland and Spain". HVO or hydrotreated vegetable oil is a renewable diesel created from lipids like vegetable oil and tallow.

"These companies will also buy UCO [used cooking oil] and fatty acid distillates that can be utilised as feedstocks for biofuels", Dr Howes adds.

There is potential to increase SBE oil sales however, with a Neste note sent to OFI saying how "single raw materials like SBE oil" currently "play a limited role" in the company's portfolio.

Neste told OFI that animal fat waste, UCO and various wastes and residues from vegetable oils processing currently represent the top three largest waste and residue raw material categories, but their usage varies from year to year depending on availability, price and specific market requirements.

The company is the largest renewable diesel and sustainable aviation fuel (SAF) producer in the world and says it has been using its NEXBTL technology, which was patented 25 years ago, to turn low quality waste and residues into "renewable products that have consistent high quality independent of the raw materials used".

After removing impurities from feedstocks, raw materials go through hydrodeoxygenation, where oxygen atoms are removed by using hydrogen, which creates a pure hydrocarbon with high energy density, Neste says.

Afterwards, the hydrocarbons are isomerised [a chemical process by which a compound is transformed into forms with the same chemical composition but with a different structure] to tune the properties of the end products for different product applications, the company adds.

Dr Howes explains that besides processes such as Neste's variant of hydrogenation, SBE oil can be also transformed into biofuels through esterification, which transforms fatty acids in the oil to fatty acid methyl ester (FAME), normally by reaction with methanol in the presence of an acid catalyst such as sulphuric acid. SBE oil

can also be processed into FAME through trans-esterification, in which neutral oil is trans-esterified [a reaction of oil with an alcohol], this time with methanol and an alkaline catalyst such as sodium methylate.

"The application of hydrogenation to produce HVO fuels such as SAF is relatively recent," Dr Howes says.

"HVO is superior to FAME diesel and can be manufactured from UCO and waste oils. For these reasons, HVO is becoming more popular than FAME diesel."

Meanwhile, also driven by growing market needs, vegetable oils and fats manufacturer Lipsa decided in 2019 to

dedicate its refinery in Huelva, south Spain, "to exclusively processing raw materials, including SBE oil, for the biofuel market", it said on its website.

Lipsa's commitment to the "circular economy and zero waste" also led it to inaugurate a plant at its Barcelona refinery in 2019 "for the recovery of oil that remains in bleaching earth", using "a globally unique technology developed" by the company to produce a "unique" bleaching earth oil, the company said.

Challenges hinder expansion

Dr Howes says that the the global potential supply for SBE oil is about

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► 500,000 tonnes a year, although its production can only be as large as the edible oil refining business, which is growing at about 3% per annum.

“SBE oil depends on how much SBE is available,” he notes, adding: “There is more availability of edible oils than waste oils, but there is an issue related to using edible oils for the manufacture of biofuels.

“Some people think that foodstuffs should not be used for the manufacture of something that we are going to burn. They want all foodstuffs to be consumed by humans or animals.”

However, Dr Howes adds that “the current use of edible oils for biofuels production, being close to carbon neutrality, could reduce man-made contribution to greenhouse gases, allowing future food production in areas that may otherwise be barren due to global warming.”

Felipe Cavalcante and Bruno Noronha Baptista, specialists in oleochemicals at the São Paulo, Brazil-based commodity broker Aboissa Commodity Brokers, explain how important logistics is in this segment.

For instance, Brazilian companies with know-how to extract SBE oil face “high logistical costs to transport a complex product” after use.

In such a large country, SBE oil producers would need an extraction structure in each region of Brazil, close to the industries that generate the waste, a network that could be “very costly” to run, they told *OFI*.

Given this issue, the process of extracting oil from SBE is “certainly much more expensive than obtaining other by-products available on the Brazilian market, such as fatty acids obtained from refining sludge, cashew nutshell liquid, UCO, among others”, they add.

In addition, Bruce Patsey, an expert on SBE oil and board member for the American Oil Chemists’ Society (AOCS), believes “more and more plants” will extract the oil of the clay, but he warns that they “have to be big enough” and “have enough spent clay to be able to run it through those processes to take the oil out”, which is expensive.

If a company processes at least 3,000 tonnes of spent clay, it makes sense to invest in it, because it “can get a lot of oil out of that”, he told *OFI*.

In addition, companies investing in this segment have to obtain permits to deal with solvents, since they are potentially explosive, and “not every company wants to go down that path”.

However, the alternative is landfilling the waste, which “might be an issue” since the clay can smoulder and must be

buried immediately to remove oxygen and prevent it from becoming a hazard.

Cavalcante and Baptista still see possibilities to boost the SBE oil sector.

Research has explored the pyrolysis extraction method, which is a decomposition reaction through heat to make products such as bio-oils that serve as alternative fuels.

They say pyrolysis is “a promising alternative for the extraction of oil from SBE, offering several advantages in comparison to traditional methods”, such as the ability to extract a greater percentage of oil and deliver a better quality product for biofuels.

With solvent extraction – the most common extraction method – “the final product may contain traces of solvent”.

On the other hand, research suggests that the “pyrolysis process extracts heavy metals and nitrogenous compounds [chemical substances with one or more nitrogen atoms], which are crucial points for the production of biofuels”, they say, adding that the second method requires significant amounts of capital to equip a plant.

Potential applications

In light of the commitment of the International Air Transport Association (IATA) to deliver net-zero carbon operations by 2050 and insufficient SAF supplies currently to realise this goal, SBE oil could theoretically be an option in this sector.

Charles Jans, vice-president of analytics and consulting at London-based market intelligence company Argus Media, believes that HVO/SAF are the “most likely applications” of SBE oil as a renewable transport fuel. However, he told *OFI* that SBE oil currently represents a “very small proportion of overall available feedstocks” for biofuel.

The sector faces not only a “lack of overall availability”, but also a “lack of systematic recovery in industrial processes”, he stresses.

Dr Howes echoes this view: “There is nowhere near enough SBE oil or UCO to supply all the necessary SAF” but oils from food and agricultural waste should be sufficient to give the required amount of SAF. These solutions may be medium-term fixes for aviation, however, as Dr Howes adds: “By 2050, it is expected that hydrogen will be the fuel utilised by aircraft.”

That said, Patsey is optimistic that he will see diesel fuel and jet fuel produced from SAF in the market for many years to come due to all the support and tax benefits from governments.

For instance, the US government offers a SAF credit of US\$1.25 for each gallon of SAF in a qualified mixture.

“There are a lot of airlines that want to get involved in this” because “they have no other way to achieve carbon reduction”, he stresses, adding that other main applications would be “diesel trucks and diesel fuel”.

Cavalcante and Noronha agree: “SBE oil is certainly a flow with good volume potential to be explored, and companies, mainly European ones, are increasingly willing to invest in this line of products,” especially due to the restrictions on first generation raw materials (natural gas, among others) and more authorisations for sustainable products, such as waste/by-products.

“Besides SAF, SBE oil can be used to produce biodiesel and HVO [which can be used in several industries as an alternative to diesel, such as construction and rail] and can replace first-generation oils/fats in several applications, such as agrochemicals, animal nutrition, oleochemical products, paints, plastics, and rubbers among others,” they add.

However, not all biofuel companies are interested in SBE oil.

Claudio Rocchietta, founder of Italy-based biofuel consulting firm BFPartners and former CEO of the leading Italian biodiesel maker Novaol, tells *OFI* that companies he works with are not interested in SBE oil.

“The feedstock origination is the most critical part of this business. There is a strong demand but the quantities of feedstock available are limited (...) and there is no way you can increase it.

“There are probably close to 200M tonnes of vegetable oils produced in the world, and palm oil has been prohibited for use in biofuels in Europe and in the United States”, he says.

Given the limits on production of vegetable oils, there is also a limit on how much waste oil can be created from them, and how much bleaching earth is used to process the oils.

Rocchietta sees more hope in cultivating algae as a biofuel feedstock, since “in 24 hours, the algae are duplicating themselves and there are several research and development projects around the world” regarding its usage. He also hopes for the development of technology to source biofuels from municipal waste.

Therefore, while SBE oil represents a sustainable option to supplement fossil fuels, logistics, regulations and volumes continue to challenge its development. ●
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