Special adsorbents are required to purify renewable diesel feedstocks such as used cooking oil, animal fats and palm oil mill effluent

Carlos Rodriguez Gaya

Purifying feedstocks

Speciality adsorbents for renewable diesel feedstock purification have become essential for smooth and sustainable conversion in downstream processes. Among various functions, these substances are needed to remove different contaminants from feedstock, which could otherwise interfere in the catalytic process.

Due to the EU Renewable Energy Directive (RED II), renewable diesel demand is set to boom in the coming years. In addition, feedstocks considered to be second generation or later will be in focus for all stakeholders in the value chain, as they present common challenges, such as availability and quality.

'Alternative' feedstocks, such as used cooking oil (UCO), animal fat and palm oil mill effluent (POME), raise new challenges in terms of quality compared with conventional fatty acid methyl esters produced from vegetable oil streams (*see Figure 1, below*). Consequently, special adsorbents were developed to answer their unique requirements.

Feedstock	Availability 2020–2030	Main challenges
UCO/RUCO	Adequate	Alkaline metals/metals/oil stability/polymers
Animal fat Cat I & II	Adequate	N-content/metals content/acidity
POME	Adequate	Acidity/alkaline metals/metals/P-compounds
Extracted oil from bleaching earth	Low	Purest feedstock (already treated), some heavy metals from previous purification
Algae	Low	Metals, polymers

Figure 1: Projection of different feedstocks and the challenges in treatment

Source: Clariant

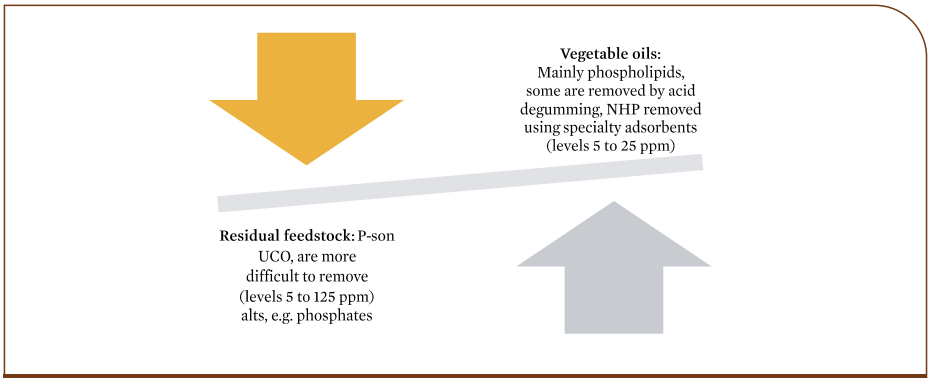

Figure 2: Phosphorus content difference between vegetable oils & residual feedstock

Source: Clariant

Vegetable oils vs other feedstocks

It is well known in the industry that some key parameters in the purification of vegetable oils are linked to metals, such as phosphorus (P), calcium (Ca), and magnesium (Mg). These are also concerns in alternative feedstocks, but are often present in other forms, thus making the adsorption process more difficult.

For example, phosphorus is mainly present as phospholipids in vegetable oils. Normally, the refining strategy includes acid degumming with consecutive washing and adsorption steps. This sequence is considered to be effective enough to remove phosphorus to the levels required for the application.

In contrast, phosphorus species in alternative feedstocks need to be oxidised and decomposed, making their efficient removal more complex (*see Figure 2, below*).

Effective removal of these contaminants requires the combination of improved purification processes, and highly advanced adsorbents with unique properties to bind such elements.

HVO vs FAME purification target

Although hydrotreated vegetable oils (HVO) and fatty acid methyl esters (FAME) share some common contaminants, their purification processes must achieve different targets.

HVO purification processes require lower specifications of contaminants such as metals, as they are poisonous to nickel-molybdenum/aluminum oxide (NiMO/Al2O3) catalysts, and may cause ▶

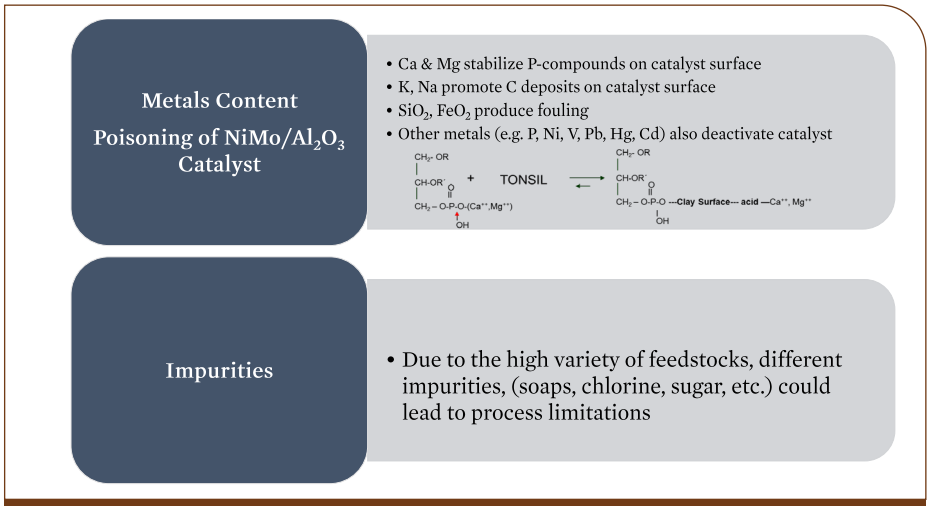

Figure 3: Some relevant contaminants in feedstocks and their consequences

Source: Clariant

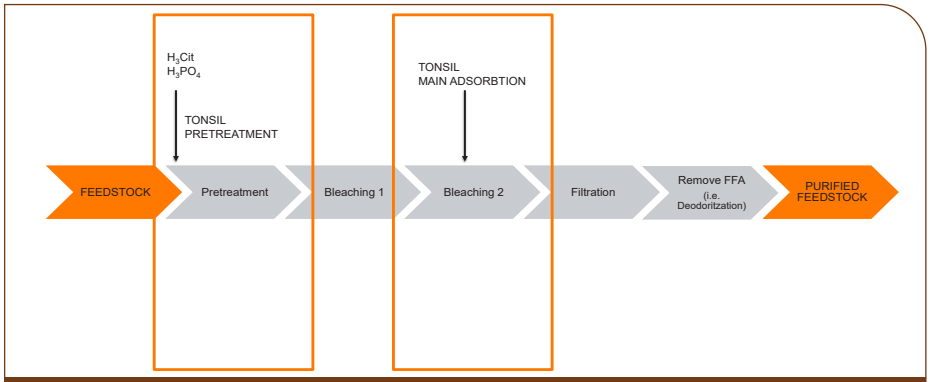

Figure 4: Simplied purification process

Source: Clariant

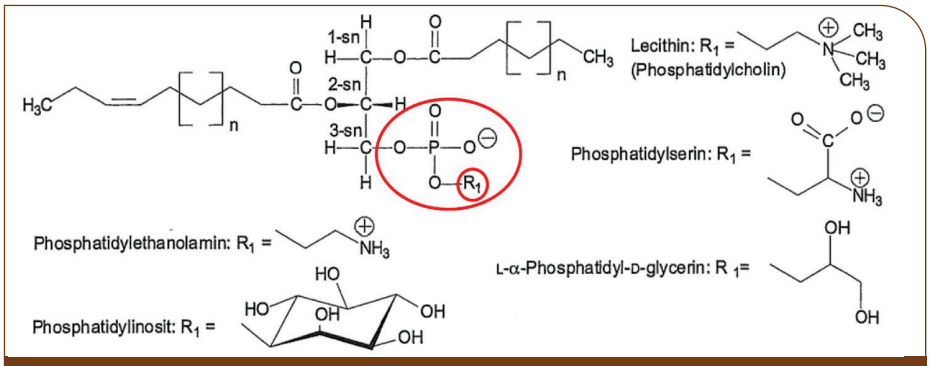

Figure 5: Relevant P-species present in oil to be purified

Source: Clariant

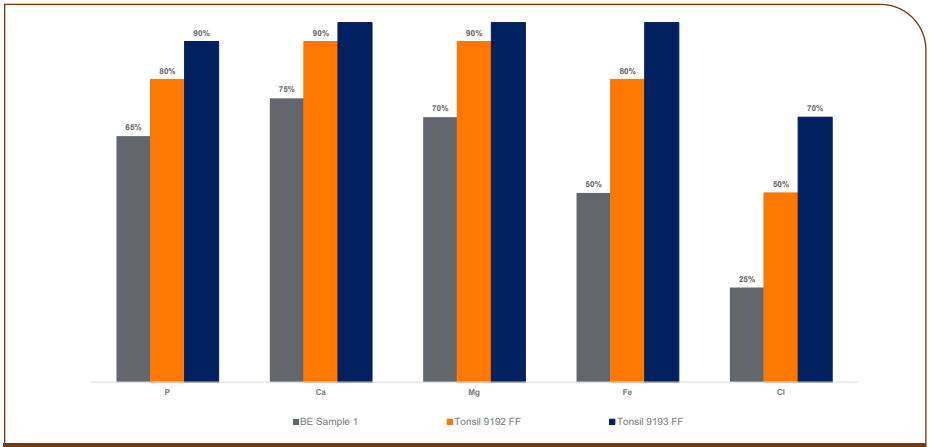

Figure 6: Performance of speciality adsorbents versus bleaching earths in relation to metal removal from untreated UCO (%)

Source: Clariant

▶ corrosion or fouling. For example, calcium (Ca) and magnesium (Mg) stabilise phosphorus compounds on their surface; potassium (K) and sodium (Na) promote carbon (C) deposits; and silicon (Si) or iron (Fe) cause fouling, among other concerns (*see Figure 3, left*).

Optimum solutions

Given that feedstock quality and availability are limiting factors for reliable downstream processes, it is vital to have the right purification strategy, with a multipurpose system which includes adsorption media suitable for different conditions and requirements. More specifically, the optimal refining solution should consider that not all feedstocks have the same level of contaminants, or even similar physical properties.

In terms of adsorption materials, highly activated bentonites have the technical specifications to ensure an efficient process. However, the contamination-binding property is not the only important factor to consider with adsorbents. The ideal materials should offer a good balance between selective removal of contaminants, minimising feedstock losses and avoiding process bottlenecks – as is the case with Clariant's Tonsil bleaching speciality adsorbents, due to its lower dosage requirements and enhanced filtration properties (*see Figure 4, left*).

It is also important to note that feedstock purification is a semi-continuous process, and very demanding in terms of process conditions and energy profile. Hence, perfect synchronisation is required between the adsorption and purification processes to avoid inefficiencies. It is equally critical that the process is unaffected by feedstock uncertainties, such as volume of refined feedstock, or operating conditions (*see Figure 4, left*).

To ensure successful renewable diesel purification, bleaching earth companies offer a wide portfolio of advanced products with high adsorption capabilities, as well as specific physical and chemical parameters to suit various processes.

Clariant, for example, recently launched Tonsil 9193 FF, a next-generation adsorbent that answers the problem of feedstock uncertainty. By acting as a safety barrier, the speciality adsorbent is able to handle different feedstock varieties due to its adsorption properties, adapted to contaminants to be removed, and a certain dosing rate. ●

Carlos Rodríguez Gaya is the head of product management and technical sales, EMEA, business unit functional minerals, at Clariant AG