FAQs

Alfa Laval HVO biofuel pretreatment systems

Contents

The 25 most asked questions about HVO biofuel pretreatment

Q: What process is followed to remove polyethylene contaminants?

A: First, we check to ensure that the polyethylene (PE) is in solution, then we cool the feed so that the PE solidifies and can be removed by filtration.

Q: How does the pretreatment process impact the lifespan of the hydrotreating catalyst?

A: In general, catalyst lifetime is determined by how pressure drop builds up and by catalyst deactivation, one of the two will determine catalyst lifetime. Impurities can affect both. It is known that phosphorous leads to an increase in pressure drop. The HVO licensors provide acceptable max. limits of impurities to secure reasonable lengths between catalyst replacement.

Q: How is Alfa Laval technology advancing in this PTU?

A: We continuously advance and fine-tune the technology/application to optimize flexibility to handle a wide range of waste oils. The use of enzymes can be mentioned as one such advance.

Q: Do innovative non-crop feeds like pongamia oil also require pretreatment, and if so, can Alfa Laval process it?

A: Non-Edible Oils (NEO) such as pongamia oil require pre-treatment and can be processed in an Alfa Laval PTU.

Q: What would be the typical (%) removal of Phosphorous and Metals in the PTU?

A: We quote absolute figures rather than % removal. P is typically reduced to max. 3 ppm and metals to 5 ppm or 10 ppm depending on what is included in the list of metals.

Q: In the degumming step, which is preferred, citric acid or phosphoric acid?

A: Citric acid.

Q: What is the difficulty in removing organic chlorides? Any impact if we don't remove organic chloride?

A: Organic chlorides are present in many different types of compounds in the oil/fat. The chloride is bound to the rest of the molecule and cannot be washed out, unlike inorganic chlorides. In case of some polarity of the organic chloride molecule there can be some removal in the adsorption section. There is no impact on the PTU if the organic chlorides are not removed.

Q: How does the PTU differ from traditional alkali refining and bleaching?

A: The main difference is that we do not want to reduce the FFA content of the feedstock. So instead of alkali refining the oil we degum the oil. This removes contaminants but does not remove any FFA. Adsorption process is similar to bleaching.

Q: How can you handle 3000 tpd in one line? Can the components like vessels, pumps, heat exchangers, centrifuges handle such a large capacity?

A: 3000 tpd is a large capacity for an edible oil plant but a small to medium capacity for a petrochemical refinery. There are limitations to equipment size, so we need to use multiple components in parallel for high-capacity units.

Q: Alfa Laval enzymatic degumming is using only Novonesis enzyme, or open to others enzyme supplier?

A: A customer can choose to use other types of enzymes, however the Alfa Laval performance guarantee is tied to the Novonesis enzyme or an enzyme with equal or better performance.

Q: Can wet degumming/water degumming take care of chloride? Hence eliminating the chloride mitigation step.

A: Water degumming is not suitable for use in a pre-treatment as it does not remove sufficient P and metals.

Q: Can you talk more about "almost" zero effluent in PTUs?

A: If a wastewater evaporation unit is included in the PTU then we generate clean water from the wastewater. This clean water can be recycled and used again in the PTU. For some items of equipment, we still like to use a small amount of fresh water so that is why we currently do not say zero liquid effluent discharge. This is also an area of ongoing development.

Q: Can you go into more details on the waste streams from HVO? E.g. what quality is the wastewater? What are the characteristics of spent earth and how to best handle this material?

A: Wastewater usually contains up to 3% fatty matter. The spent earth is a clay containing up to 25% oil. We normally recommend that the spent earth is either burnt for example in a cement powder factory or sent to a biogas unit.

Q: What % of yield losses can be expected from the HVO process?

A: Yield depends on the amount of impurities in the feedstock. A typical range is from 94% to 98%.

Q: What are the typical materials used for pipes, valves and valve types in the PTU unit?

A: Typical construction materials are 316 or 304 stainless steel.

Q: What is the source of polyethylene in animal fat and used cooking oil (UCO)?

A: Typical sources of polyethylene from animal fats may include items such as ears tags that pass into the rendering process to separate oil from the waste. Another source is the polyethylene packaging material from packaged meat that has passed its last use-by date. Because UCO is an undefined product, there may be residues in UCO from other waste oils.

Q: Which of the contaminants are more harmful to the HVO process?

A: Of key importance are phosphatides and metals. In general, hydrotreating catalyst can deactivate via two mechanisms: (1) pressure drop, or (2) loss of catalyst activity. Phosphatides tend to cause pressure drop as they build upon on the catalyst particle in the trickle bed reactor. This reduces the void space and creates premature loss of catalyst life.

Q: Except FFA removal, what are the main differences in plant configuration between pretreatment for biodiesel and pretreatment for HVO?

A: The main difference in plant configuration are the chloride and polyethylene removal sections (if needed) and the bleaching (adsorption) section used in HVO pretreatment plants. The HVO process generally occurs at temperatures above 350°C in a fixed or trickle bed reactor, which means it is much more sensitive to impurities compared to the liquid phase reaction in the fatty acid methyl esters (FAME) process. Pretreatment therefore needs to be finetuned to a higher degree to remove impurities.

Q: How do you treat spent adsorbent (general treatment) to meet regulations?

A: In most locations, landfill is not an option. Some plants can deliver the spent adsorbent, which holds about 23% oil and has value as fuel, to cement producers to burn as a support fuel. Furthermore, some companies reclaim the adsorbed oil through solvent extraction as their core business.

Q: What is difference between wet degumming and dry degumming?

A: Wet degumming assumes that gums are separated from the oil by means of centrifuge. Dry degumming is used for oil with low amount of P in crude oil (like palm oil 30-50ppm), removal can therefore be combined with bleaching without having a negative impact on the clay filtration process.

Q: What are the minimum and maximum design capacities of a PTU (speaking of production rate)?

A: The minimum is largely set by the main PTU unit; the high CAPEX demand requires a certain minimum size to be economical, probably about 3000-5000 bpd. There is, in theory, no upper limit because there is a certain capacity for parallel lines. More likely, the upper limit will be set by the feedstock supply chain as well as other logistics and infrastructure.

Q: We've seen enzyme additions to the pretreatment process of vegetable oils and biodiesel feedstocks have demonstrated lower losses (higher yields) and lower gum volumes.

A: Correct, we have a long list of references for enzymatic deep degumming in pretreatment for fatty acid methyl ester biodiesel, particularly applicable for soybean oil feedstocks. The PLA-type enzymes produce lysophospholipids that are more water soluble and will reduce emulsion. This results in deeper P removal as well as lower oil losses.

Q: Does Alfa Laval have experience in designing HVO pretreatment units with used cooking oil as its feedstock?

A: Yes, we do. We have some pretreatment units in service and/or are currently designing units that use UCO as feedstock.

Q: If 100% CPO is used as feedstock, can the special degumming section be eliminated and instead move directly to the adsorption section? The acid gums collected in the spent adsorbent?

A: Indeed, due to the low phosphorous (P) content in CPO, only the adsorption unit is required. Although used cooking oil (UCO) also has a low P content, it is not advisable only to have an adsorption section since other impurities may interfere with the adsorption process.

Q: If used cooking oil that has P content below 50 ppm, can the special degumming process be eliminated?

A: The gums will be absorbed by bleaching clay and separated by the filter. Therefore, the clay will be used for gums absorption. Removal of methyl ester is the primary task of clay since wet degumming is not too effective here. Therefore, we potentially can use less clay by applying wet degumming, and this clearly has benefits for P > 50 ppm.

Biogas and wastewater

Q: Can the SBE and wastewater be used to generate biogas?

A: We know of cases where SBE has been used for generating biogas. In principle the oily wastewater can also be biologically processed for biogas generation.

Q: What about wastewater treatment/evaporation given that the wastewater contains impurities such as metal, chlorides, P, etc.?

A: Here the choice of materials of construction for the wastewater evaporation unit is critical. While material selection is important, we also have a mobile test facility where we can test the evaporation efficiency of your specific wastewater steam.

Q: The PTU effluent will still have solids, how does this affect the evaporation process?

A: The real wastewater does not normally contain solids, so this does not present a problem for the evaporation system. The waste from the first separator in degumming can contain solids but this is usually kept separate from the wastewater.

Q: The PTU effluent can have a COD as high as 150,000 ppm, how can this be reduced to acceptable levels?

A: The answer to this question is similar to the previous one. If treating just wastewater then the COD level is usually less than 100,000 ppm.

Zero Liquid Discharge (ZLD) and costs

Q: Discuss the benefits of zero liquid discharge technology, what are the extra costs and is it justified?

A: There is a synergy with the HVO unit generating excess heat to drive the multi-effect evaporation unit. For specifics on CAPEX and OPEX please contact us.

Q: Can you share some ballpark figures on how the OPEX and CAPEX of PTU impacts the overall HVO unit?

A: Please contact us for details. In general, a rough approximation is that the PTU OPEX AND CAPEX would at least be an order of magnitude smaller than the HVO unit, since the HVO unit is operating at high temperature (about 350°C) and high pressure (40–70 bar). The HVO unit also requires associated units such as hydrogen unit, sour gas treatment, etc.

Chloride mitigation

Q: With chemical refining there are also two steps of washing? What is the efficiency for chloride mitigation?

A: We do not want to refine the oil (= remove FFA) as this is a loss. Instead, we degum the oil to remove contaminants and leave the FFA unchanged. When we wash the oil, either in chloride mitigation or in degumming, we typically remove over 90% of the inorganic chlorides.

Q: Does chloride mitigation remove both organic and inorganic chlorides?

A: No, only removal of inorganic chlorides is guaranteed.

Q: What is the chloride spec and how is it removed?

A: Fats and oils contain both inorganic and organic chlorides. Inorganic chlorides are removed by washing the oil/fat with water or acidified water. Organic chlorides are usually not removed in the PTU as the organic chloride compounds vary in their nature and polarity.

Q: What challenges do you face when removing chloride, especially in used cooking oil. How much can you reduce the chloride (Cl) concentration?

A: As described, only the inorganic chlorides can be removed. The organic chlorides may be removed, but only to a limited extent. If the resulting chloride content exceeds allowable limits with regard to corrosion, this should be dealt with by mixing the feedstocks, more frequent equipment inspection or other mitigation measures.

Q: Can the chlorine mitigation step also remove organic chlorine?

A: No, not in the chloride removal unit based on a water wash at suitable degree of mixing, residence time, temperature and pH. This phase focuses on removal of inorganic chlorides. To the extent chlorides show the polarity, there can be some removal during the adsorption step, but much depends on the individual organic chloride molecule and the surface properties of the adsorbent.

Q: In which stage would the organic chloride be removed?

A: Organic chlorides are not removed constantly in the PTU, depends on the nature of the organic chloride compound.

Q: If organic chlorides are not reduced what alternate process is available to reduce organic chlorides?

A: At present there is no good method for removing organic chlorides consistently, depends on the nature of the organic chloride compound.

Q: What is the level of organic chloride in UCO? Is it possible to remove organic chloride from UCO?

A: There are not any good representative values for organic chloride in UCO and removing organic chlorides from UCO is only possible to a limited extent. Elevated organic chloride levels in a batch of UCO are best dealt with by mixing in the material in low concentrations in a chloride-free feedstock to reduce concentrations so that they fall below the allowable chloride limit in the pretreated feedstock.

Metals and contaminants removal

Q: In which process steps are metals in used cooking oil removed?

A: Metals are removed in both the degumming and adsorption steps.

Q: What are the key concern contaminants in pyrolysis oil?

A: Pyrolysis oils contain solid particles, phosphorous and trace metal elements that need to be removed to meet requirements of downstream processing.

Q: Which specific metals are more relevant and more common?

A: Those would be metals typical for crude fats and oils in the group of Cu, Fe, Mn, Co, Cr, Cd, Ni, and Zn. Occasionally also Pb from external sources. Please refer to "Determination of some inorganic metals in edible vegetable oils by inductively coupled plasma atomic emission spectroscopy."

Q: How does the removal of metals actually occur?

A: Metals are partially removed through the acid treatment in the degumming section (organic metal salts to inorganic, water-soluble salts). A water wash removes most of those salts, and residual, polar organometallic compounds are removed through adsorption in the adsorption section.

Q: What will be the guarantee of the removal on sulphur and nitrogen in term of percentage?

A: We typically remove about 50% of the sulphur and somewhere between 40 to 60% of the nitrogen depending on the quality of the feedstock.

Q: What is the sulphur reduction percentage after the adsorption? Some feedstock does have high sulphur content?

A: As you may know, CoMo- or NiMo-based hydrotreating catalysts have hydrodesulfurization (HDS) and hydrodenitrogenation (HDN) activity, so normally this is not a critical contaminant.

Feedstock handling and flexibility

Q: Do Alfa Laval see any concerns in the PTU in handling incoming feedstock that comes from atmospheric tank (with no nitrogen blanketing) and hence is oxidised?

A: No concerns, most of these oils have already seen plenty of oxygen before arriving at the pretreatment site.

Q: Can Alfa Laval's system pretreat acid oil? Especially P content?

A: We cannot process 100% acid oils, but they can be processed as part of a blended feedstock.

Q: Can 90% fatty acid oil be processed using the hydrotreating process?

A: Yes, it is possible. However, due care needs to be exercised with regard to corrosion/metallurgy. This is especially true in retrofit situations where an existing hydrotreater in a smaller refinery is being retrofitted for HVO fuel production.

Q: How do you deal with high free fatty acid (FFA) products like the recovered oil phase from palm oil mill effluent (POME)?

A: There are essentially two ways to deal with FFA products: (1) design the pretreatment plant, particularly the HVO plant with metallurgy that is able to handle such high acidity feedstock, and (2) blend the POME oil with other lower FFA feedstocks before treatment.

Q: Can you treat animal fat (category 1) to HVO or co-processing specs?

A: As category 1 animal fat is classified as a "very high-risk material" due to the risk of TSEs (transmissible spongiform encephalopathies), it is not commonly treated in this way; instead, it is burned directly for heat/electricity production.

Q: Given there are no defined specifications for some feedstocks, do you need to test the feedstock to be able to provide guarantees?

A: For many feedstocks, there are defined specifications (soy, rapeseed oil, tallow, palm oil, distilled corn oil) for UCO, and specifications will be set for design of the unit. Should a feedstock fall outside the design range, processing generally can be handled by blending the feedstock with other feedstock so that the feedstock blend is well below the design specifications for the unit.

Q: Is it reasonable to expect 1 wppm P in a pretreated feed?

A: Please refer to the table from the HVO supplier's requirements shared during the webinar. It is possible to reach 1 wppm P or lower for certain feedstocks, but guaranteed levels most often correspond to the technology supplier's requirements.

Q: With the same quantity and quality of pure vegetable oil, how much can the production (%) of HVO and HEFA be?

A: This question should be directed to one of HVO technology licensors as it is outside of our area of expertise.

Q: Does Alfa Laval offer a full spectrum of algae oil from extraction, dewatering, purification to be HEFA plant ready?

A: Alfa Laval is involved in many of the steps you mentioned. This involves several different departments so I need to check to see exactly what we can offer.

PTU Equipment and process

Q: Are there any new developments on Alfa Laval key components for PTUs such as separators, reactors, mixers, etc?

A: We are continuously working on improving the performance of the equipment that is used in our PTU.

Q: Can you talk more about those key components in PTU?

A: There are many key components in the PTU, those would be the equipment in the process sections where there is Alfa Laval proprietary knowledge embedded in their specification, design, manufacture and use for this application.

Q: How do you see the heat treatment process by other vendors to replace adsorption section?

A: There are alternative solutions on the market. Some are unproven; others are in operation.

Q: What is the main purpose of a centrifugal separator if gums can be adsorbed in the bleaching process?

A: The centrifuge removes the bulk of the impurities, especially any compounds containing phosphorus. If the centrifuge is not used, then the adsorption material consumption and associated oil loss would be prohibitively high.

Q: How long does it take to procure all equipment in Alfa Laval's HVO PTU package? Is there any equipment that will be specified as a long lead item?

A: Please contact us for details. The procurement time will depend on Incoterms sourcing strategy, plant location, etc. However, in any case, our HVO PTU package has shorter lead times than the main HVO unit (in case such a unit is planned at the same time). Should you require particularly short delivery times if pretreatment is required for an existing hydrotreater in a co-processing scenario, Alfa Laval can tailor sourcing and execution to accommodate shorter delivery times.

Q: What are the typical capacities of the PTU in a single train?

A: A single train PTU can be customized, but the size of a single block is 1,500 tpd.

Q: What is the maximum capacity of your module (tons, litres/hour)?

A: Contact us for details. As mentioned in the answer of Q40 on capacity, a single train PTU can be customized, but the size of a single block is 1,500 tpd.

Q: What is the typical plot area required for each stage, i.e., chloride mitigation, polyethylene removal, special degumming, and adsorption?

A: Please contact us for details. The plot areas for each stage depends upon the capacity and on how many sections will be included.

Q: In the degumming step, how does one deal with the variations between different feedstocks in terms of design flexibility, parallel trains, etc.?

A: Please contact us for details because the answer to this question requires a lengthy discussion. Alfa Laval has vast experience in treating feedstocks that vary in composition. In the case of processing a blend, some suitable average must be applied.

Adsorption/Bleaching

Q: Does Alfa Laval offer wet bleaching process, i.e. adding water and bleaching earth in the bleaching step?

A: Our absorption section consists of two stages.

Q: Is there any fixed-bed solution for the adsorption/bleaching processes that avoids the use of typical filters in this step?

A: A fixed-bed solution is not viable for these processes because it would quickly experience fouling.

Q: What is the catalyst used? How does one treat the spent catalyst to comply with environmental regulations?

A: During pretreatment, no heterogeneous catalyst is in use. However, the addition of acid in the degumming section leads to a homogeneous reaction with organic metal salts such that those become water soluble. When using enzymatic degumming (particularly relevant for soybean oil), the enzymes act as natural catalysts making phosphatides more water soluble. Finally, the adsorbent used in the adsorption section (slurry reactors) has many characteristics of catalysts, such as pore diffusion in and out of the porous adsorbent, competitive surface adsorption, and to some extent chemical reactions on the surface of these commonly acid-activated bleaching clays. You may say that the adsorption sections serve as a guard bed for the HVO catalyst. Spent adsorption material, with approximately 23–25% residual oil, can be disposed of locally – for instance, to biogas plants. Check with edible oil refineries in your country to determine appropriate disposal outlets.

Q: Is the bleaching earth (BE) recyclable? What is the average consumption of BE, and does the amount of BE required depend on the oil type?

A: No, bleaching earth/adsorbent is not recycled. Consumption can vary from 0.5 to 2 wt% relative to the oil flow. Yes, the oil flow does impact consumption. In general, it should be adjusted to the required adsorption duty. Part of the ongoing plant optimization should be to minimize the BE consumption for a given oil quality, always making sure that the pretreated oil quality meets specifications.

Q: After spent adsorbent extraction, how is the remaining solid waste handled? For instance, for the cases you mentioned in Indonesia or Malaysia?

A: Common outlets for handling solid waste are biogas facilities. Please check outlets in local edible oil refineries in your country.

Q: Does Alfa Laval offer options for spent adsorbent oil extraction?

A: No, Alfa Laval does not, but we can help provide our customers with contacts to such companies.

Q: Is filter aid or precoating mandatory for treating palm oil?

A: Assuming the worst quality crude palm oil (CPO) is entering the plant, we believe it is highly advisable to use filter aids and precoating.

Waste handling and disposal

Q: Are there any options for gum monetization, i.e. application of gum?

A: Not really, apart from as a feedstock for a biogas unit.

Q: Is the waste filter aid material sent to landfill?

A: Landfill used to be an outlet for waste, but as mentioned previously, many regions no longer permit waste to be sent to landfill. There are several good alternative outlets mentioned in the answer to Q16.

Q: After spent adsorbent extraction, how is the remaining solid waste handled? For instance, for the cases you mentioned in Indonesia or Malaysia?

A: Common outlets for handling solid waste are biogas facilities. Please check outlets in local edible oil refineries in your country.

Bacteria and biological concerns

Q: What about removal of bacteria from animal fats?

A: Bacteria is not an issue for feedstock entering HVO pretreatment systems. The HVO processes operate at temperatures above 200°C (392°F) so any bacteria present will die. In any case, bacteria are not an issue in the HVO products (renewable fuels or feedstock to the petrochemical industry).

Q: How do you handle bacteria removal in animal fats during this process?

A: Bacteria will be removed through the acid treatment and the water wash, and subsequently treated in the filtration section of the adsorption process.

Competitors and market position

Q: Can you address why Alfa Laval technology or technical support is better positioned than other PTU suppliers?

A: We regard the overall Alfa Laval offering as being the better value combination of solid technology basis, performance figures, PTU field experience, service offerings including lab and pilot plant services, regional/local presence and competence.

Q: I work at a consultancy/design firm and clients usually like to approach multiple PTU suppliers, who would be your competitors in the pretreatment field?

A: There is no supplier who can provide both process know-how and critical equipment for the PTU. In other words, for feedstock flexibility and for future modifications only require a single speaking partner. On top of that, Alfa Laval takes a holistic view of the whole HVO complex, not only the PTU.

Miscellaneous/Other

Q: When phosphoric acid required in an acid mixer? In the adsorption section?

A: Both citric and phosphoric acid can be used in an acid mixer. In some cases, citric acid is preferred due to its chelating capabilities. Additional acid is not added in the adsorption section.

Q: Will there be fouling issues if a heater is positioned after the degumming reactor? If yes, what is the best method to mitigate these issues?

A: No, fouling issues are not common. A Cleaning-in-Place system can be provided if unusual fouling occurs.

Q: What is the allowable limit for phosphorus (P) in that situation?

A: 30 ppm of P (max 50 ppm) can be used as a limit to determine whether or not to use wet degumming. This limit is also valid for UCO.