

LIPID MATERIAL PURIFYING PROCESS

TECHNICAL FIELD

The present disclosure generally relates to purifying lipid materials. The disclosure relates particularly, though not exclusively, to an alkaline purification process for treating lipid material containing impurities, specifically chlorine containing impurities.

BACKGROUND

This section illustrates useful background information without admission of any technique described herein representative of the state of the art.

There is an ongoing need to reduce greenhouse gas emissions and/or carbon footprint. Accordingly, interest towards products having biogenic carbon content and biogenic origin for transportation fuels and/or petrochemical products has been growing.

In order to utilize very low-quality biogenic feedstocks to their full potential, there is a clear need for new efficient pre-processing and pre-treatment methods to reduce the amount of harmful impurities in challenging feedstocks. This includes biogenic feedstocks with higher contents of chlorine containing impurities, such as used cooking oil (UCO).

Organic chlorine can be found in waste oils such as UCO and brown grease (BG). The chemical composition of these organic chlorine compounds is not fully known. Studies to investigate the chemical nature of the organic chlorine compounds have revealed removal thereof from the lipid material matrix being challenging. Example compounds, such as 3-MCPD or chlorinated FFAs cannot be removed by conventional pretreatment processes.

Chlorine containing impurities cause problems in hydroprocessing in the presence of hydrogen, where chlorine reacts to HCl causing corrosion. In addition, when nitrogen is present, ammonium chloride may precipitate under these conditions. There is hence a need for purification treatments enabling removal of chlorine containing impurities from feeds to hydroprocessing.

SUMMARY

It is an aim to solve or alleviate at least some of the problems related to prior art. An aim is to provide a process for treating lipid material to remove impurities, specifically chlorine containing impurities, in an efficient and simple manner on an industrial scale. A further aim is to provide a flexible and efficient system for treating lipid material for removal of chlorine impurities before bleaching and/or degumming. A yet further aim is to facilitate use of

biogenic feedstocks with high chlorine impurity contents in industrial scale upgrading processes.

The appended claims define the scope of protection. Any examples and technical descriptions of apparatuses, systems, products and/or processes in the description and/or drawings not covered by the claims are presented as examples useful for understanding the invention.

A method for purifying lipid material, said method comprising the steps of

- i) providing a lipid material feed (a),
 - ii) preparing a mixture (b) by mixing feed (a) with an alkali,
 - 10 iii) heat-treating the mixture (b) at a temperature of at least 200 °C, such as from 200 to 325 °C, preferably of at least 220 °C, such as from 220 to 325 °C, more preferably of at least 270°C, such as from 270 to 300 °C, most preferably of at least 280 °C, such as from 280 to 290 °C,
 - iv) phase-separating a heat-treated mixture from step (iii) to obtain a heat-treated purified lipid material (c) and a reject containing inorganic chlorine,
 - 15 v) optionally subjecting the purified heat-treated lipid material (c) to a treatment at acidic conditions to obtain a further purified lipid material (d),
 - vi) recovering the heat-treated purified lipid material (c) from treatment of step iv) and/or the further purified lipid material (d) from treatment of step v).
- 20 According to a second example aspect there is provided a use of the purified lipid material obtained from the method according to the first aspect in at least one hydroprocessing.

According to a third example aspect there is provided a process for providing renewable hydrocarbons, comprising x) purifying a lipid material to obtain a heat-treated purified lipid material (c) and/or further purified lipid material (d) according to the first aspect, and y) 25 subjecting the heat-treated purified lipid material (c) and/or the further purified lipid material (d) to hydroprocessing, preferably catalytic hydroprocessing, to obtain at least one renewable hydrocarbon.

Different non-binding example aspects and embodiments have been illustrated in the foregoing. The embodiments in the foregoing are used merely to explain selected aspects 30 or steps that may be utilized in different implementations. Some embodiments may be presented only with reference to certain example aspects. It should be appreciated that corresponding embodiments may apply to other example aspects as well.

BRIEF DESCRIPTION OF THE FIGURES

Some example embodiments will be described with reference to the accompanying figures, in which:

Fig. 1 shows schematically a system and process according to an example embodiment of the present method;

Fig. 2 shows schematically a further system and process according to an example embodiment of the present method;

Fig. 3 shows experimental results to study the alkali dosing in the present process. Said results were obtained with a crude UCO feed where alkali solution was dosed in different amounts followed by heat-treating and phase-separating the reject containing inorganic chlorine by centrifugation and filtration. As a reference is given a sample where only water was added (H_2O) instead of alkali solution followed by heat-treating and phase-separation of the reject;

Fig. 4. shows experimental results to study the heat-treating time in the present process, more specifically, the effect of the duration of the heat-treating on impurity levels of an UCO feed with five-fold stoichiometric NaOH dosing;

Fig 5. shows experimental results to study the effect of the present process on different lipid materials. Three different feeds: two UCOs and one BG sample were subjected to heat-treating with five-fold stoichiometric NaOH dosing followed by centrifugation;

Fig. 6 shows experimental results to study the effect of treatment temperature. Temperatures at 150 °C and below do not provide effective chlorine removal with heat treatment from the lipid material; and

Fig. 7 shows experimental results to study the different phase-separation methods. In the experiments phase-separation methods were varied while alkali dosing and heat-treating conditions remained the same. Phase-separation methods studied were filtration with a paper filter (F(2 μm)), filter aid filtration (F(FA)), centrifugation, water wash (ww), degumming (DEG), bleaching (BL) and combinations thereof.

DETAILED DESCRIPTION

In the following description, like reference signs denote like elements or steps.

All standards referred to herein are the latest revisions available at the filing date, unless otherwise mentioned.

As used herein, "lipid material feed" refers to the feed which is intended to be converted to hydrocarbons or other valuable products, but which contains too much chlorine for feeding to the processes as such. Further, under the conditions of said processes chlorine reacts to produce harmful derivatives, such as corrosive gases or deposits. Hence, the lipid material must be purified. Lipid material feed (a) contemplated herein typically comprises organic chlorine. A threshold could be that the lipid material comprises chlorine more than 20 wppm calculated as elemental chlorine of the total weight of the lipid material.

The lipid materials used as feed to the present method include but are not limited to the lipid material feed (a) that contains no more than about 2 wt-% water, generally no more than about 1 wt-% water, such as from 0.1 to 1 wt-% water, preferably no more than about 5 wt-% of the total weight of the lipid material. Given as wppm, typically the lipid material feed (a) contains no more than about 20000 wppm, generally no more than about 10000 wppm, preferably no more than about 5000 ppm, such as from about 1000 to about 10000 wppm water, of the total weight of the lipid material.

In general, it is advantageous to keep the water content in the lipid material (a) both as feed and as intermediate(s), such as the mixture (b) in step ii), during the heat-treatment in step iii), and during the treatment at acidic conditions in step iv), as low as possible. Water with the lipid material and impurities therein tends to form emulsions. Emulsions disturb processes and when removed, lead to lipid material losses. Further, low water content throughout the present method is beneficial through avoidance of wastewater and better pressure control at elevated temperatures.

As used herein, chlorine refers generally to element Cl, either as a heteroatom in organic compounds, or as an ion, in a salt or in an aqueous solution. When any amounts of chlorine are referred to in this description, they are calculated as elemental chlorine in a sample regardless of the chemical compound or form they originate from.

As used herein, organic chlorine refers to any compounds where chlorine is covalently bound. Hence, it is not removable from lipid materials as described here by e.g., water wash or any similar and simple means. In the context of the present disclosure, the method as described here converts at least some of the organic chlorine into inorganic chlorine, which then can be removed from the lipid material by e.g., filtration, centrifugation or water washing.

Correspondingly, inorganic chlorine refers to chlorine present as charged ions, i.e. not covalently bound to carbon and hence as opposite to organic chlorine. Typically, inorganic chlorine is present in aqueous solutions as dissolved ions, or it might precipitate or

crystallize as salts. Inorganic chlorine is here also referred to as chloride ions or chloride salts. As solids, it is most typically present as salts with metals, monovalent or divalent, such as NaCl or KCl as common examples. Analytically organic and inorganic chlorine may be distinguished from one another by analytical arrangements recovering inorganic chlorine due to its solubility to water.

Typical lipid materials comprise waste and recycle oils, typically combinations thereof. Such lipid materials typically contain initially both organic and inorganic chlorine of which the latter is easily removed. However, the present method has now been shown to convert at least part of the organic chlorine into inorganic chlorine. Typical examples of lipid materials, with high organic chlorine contents are used cooking oil (UCO), brown grease (BG), and algae oils.

The present method may be used for removal of chlorine from any lipid material, namely plant oils, plant fats, animal fats, animal oils, fish fats, fish oils, waste fats, waste oils, residue fats, residue oils, a fatty acid distillate, acidulated soapstock, mold oils, rapeseed oil, canola oil, colza oil, babassu oil, carinata oil, coconut butter, muscat butter oil, sesame oil, maize oil, poppy seed oil, cottonseed oil, soy oil, laurel seed oil, jatropha oil, palm kernel oil, camelina oil, tall oil, fraction of tall oil, crude tall oil, tall oil pitch, sunflower oil, corn oil, technical/distillers corn oil, soybean oil, hemp seed oil, olive oil, linseed oil, cottonseed oil, mustard oil, mustard seed oil, peanut oil, castor oil, coconut oil, palm oil, crude palm oil, palm seed oil, palm fatty acid distillate, a sludge originating from plant oil production, palm oil mill effluent, arachis oil, castor oil, coconut oil, archaeal oil, bacterial oil, fungal oil, protozoal oil, algal oil, seaweed oil, oils from halophiles, poultry fat, dry rendered poultry fat, brown grease, used cooking oil, suet, lard, tallow, blubber, recycled alimentary fats, acid oil, train oil, spent bleaching earth oil, lignocellulosic based feeds, materials produced by genetic engineering, and biological materials produced by microbes, or any combinations or mixtures thereof. The present method is particularly suitable for lipid materials which have been in contact with salty environments, such as salt water or salted foodstuff or salt has been added directly to the lipid material, e.g. for preservation purposes.

In respect of feedstocks, "used cooking oil (UCO)" refers to oils and fats that have been used for cooking or frying in the food processing industry, in restaurants, in fast food providers, and at consumer level, such as in households.

By the term "Brown Grease" is intended to mean any material of fat, oil, grease, solids, and water separated from wastewater e.g. by a grease interceptor (grease trap) and collected for use as a fuel feedstock.

As used herein, hydrocarbons refer to compounds consisting of carbon and hydrogen. Examples of hydrocarbons include paraffins, including n-paraffins and i-paraffins, naphthenes, aromatics, and olefins (alkenes). Oxygenated hydrocarbons refer herein to hydrocarbons comprising covalently bound oxygen. Examples of oxygenated hydrocarbons
5 include tri-, di-, and monoglycerides, fatty acids and alkyl-esters of fatty acids (e.g. methyl- or ethyl-ester of fatty acids).

As used herein, paraffins refer to non-cyclic alkanes, i.e., non-cyclic, open chain saturated hydrocarbons that are linear (normal paraffins, n-paraffins) or branched (isoparaffins, i-paraffins). In other words, paraffins refer herein to n-paraffins and/or i-paraffins.

10 In the context of the present disclosure, olefins refer to unsaturated, linear, branched, or cyclic hydrocarbons, excluding aromatic compounds. In other words, olefins refer to hydrocarbons having at least one unsaturated bond, excluding unsaturated bonds in aromatic rings.

Naphthenes refer herein to cycloalkanes or cycloalkenes containing at least one cyclic
15 structure, with or without side chains, including also compounds having one or more olefinic bonds in the cyclic structure and/or in a side chain, but excluding compounds with any aromatic ring structure(s).

Aromatics refers herein to hydrocarbons containing at least one aromatic ring structure, i.e. cyclic structure having delocalized, pi bonds satisfying the Hückel ($4n + 2$) rule.

20 As used herein, the term renewable refers to compounds or compositions that are obtainable, obtained, derivable, derived, or originating from plants, animals and/or microbes, including compounds or compositions obtainable, obtained, derivable, derived, or originating from fungi and/or algae, in full or in part, whether these compounds or compositions are in their virgin, recycled or reclaimed form. As used herein, renewable
25 compounds or compositions may comprise gene manipulated compounds or compositions. Renewable feedstocks, components, compounds, or compositions may also be referred to as biological feedstocks, components, compounds, or compositions, or as biogenic feedstocks, components, compounds, or compositions.

As used herein, the term fossil refers to compounds or compositions that are obtainable,
30 obtained, derivable, derived, or originating from naturally occurring non-renewable compositions, such as crude oil, petroleum oil/gas, shale oil/gas, natural gas, or coal deposits, and the like, and combinations thereof, including any hydrocarbon-rich deposits that can be utilized from ground/underground sources.

Said renewable, and fossil compounds or compositions are considered differing from one another based on their origin and impact on environmental issues. Therefore, they may be treated differently under legislation and regulatory framework. Typically, renewable, and fossil compounds or compositions are differentiated based on their origin and information thereof provided by the producer.

Chemically the renewable or fossil origin of any organic compounds, including hydrocarbons, can be determined by a suitable method for analyzing the content of carbon from renewable sources e.g. DIN 51637 (2014), ASTM D6866 (2020), or EN 16640 (2017). Said methods are based on the fact that carbon atoms of renewable or biological origin comprise a higher number of unstable radiocarbon (^{14}C) atoms compared to carbon atoms of fossil origin. Therefore, it is possible to distinguish between carbon compounds derived from renewable or biological sources or raw material and carbon compounds derived from non-renewable or fossil sources or raw material by analyzing the ratio of ^{12}C and ^{14}C isotopes. Thus, a particular ratio of said isotopes can be used as a "tag" to identify a renewable carbon compound and differentiate it from non-renewable carbon compounds. The isotope ratio does not change during chemical reactions. Therefore, the isotope ratio can be used for identifying renewable compounds, components, and compositions and distinguishing them from non-renewable, fossil materials in reactor feeds, reactor effluents, separated product fractions, and various blends thereof. Numerically, the biogenic carbon content can be expressed as the amount of biogenic carbon in the material as a weight percent of the total carbon (TC) in the material (in accordance with ASTM D6866 20 (2020) or EN 16640 (2017)).

In the present context, the term renewable preferably refers to a material having a biogenic carbon content of more than 50 wt-%, especially more than 60 wt-% or more than 70 wt-%, preferably more than 80 wt-%, more preferably more than 90 wt-% or more than 95 wt-%, even more preferably about 100 wt-%, based on the total weight of carbon in the material (EN 16640 (2017)).

According to a first example aspect, herein is provided a method for purifying lipid material, said method comprising the steps of

- i) providing a lipid material feed (a),
- ii) preparing a mixture (b) by mixing feed (a) with an alkali,
- iii) heat-treating the mixture (b) at a temperature of at least 200 °C, such as from 200 to 325 °C, preferably of at least 220 °C, such as from 220 to 325 °C, more preferably

of at least 270 °C, such as from 270 to 300 °C, most preferably of at least 280 °C, such as from 280 to 290 °C,

iv) phase-separating a heat-treated mixture from step (iii) to obtain a heat-treated purified lipid material (c) and a reject containing inorganic chlorine,

5 v) optionally subjecting the heat-treated purified lipid material (c) to a treatment at acidic conditions to obtain a further purified lipid material (d),

vi) recovering the heat-treated purified lipid material (c) from step iv), and/or the further purified lipid material (d) from treatment of step v).

10 The present inventors have found the present method providing efficient chlorine removal from lipid materials. The lower chlorine contents in the heat-treated purified lipid material and/or the further purified lipid material (d) obtained and recovered from the method are advantageous in the further upgrading process steps involving hydrogen. The present purification method helps to avoid corrosion caused by the hydrogen chloride forming from the chlorine present under conditions containing hydrogen.

15 Experimentally, very promising results were obtained as to the chlorine removal. According to an embodiment, the purified lipid material, hence the heat-treated purified lipid material (c), the further purified lipid material (d), or a combination thereof, contains at least about 10 wt-%, preferably at least about 20 wt-%, more preferably at least about 25 wt-%, most preferably at least about 60 wt-%, less chlorine calculated as elemental chlorine than the
20 lipid material (a).

Prior to step ii) the lipid material feed (a) may be subjected to removal of solid impurities. Advantageously the lipid material feed (a) is subjected to removing solid impurities, and optionally excess water, from the lipid material feed (a). Solid impurities removed in this step include e.g. salts, protein residues, bone meal, fibers, carbohydrates, and/or sand.

25 The removal of solid impurities may be accomplished by any phase separation method suitable for removing solid impurities from lipid materials, including, but not limited to, settling, centrifuging, filtering, and any combination of those, preferably centrifuging and/or filtering.

30 It is particularly preferred to accomplish the removal of solid impurities by filtering the lipid material feed (a) with a filter aid, i.e. filter aid filtration (FAF). Examples of suitable filter aid materials include, but are not limited to, any material comprising or consisting of mineral, silicon, and/or cellulose based material, e.g. diatomaceous earth, diatomite, perlite, bentonite, palygorskite, kaolin, kaolinite, silica in various crystalline or amorphous

configurations, sepiolite, magnesium silicate, silicon, aluminum oxide based materials, zinc oxide based materials, neutral bleaching earth, activated carbon, activated charcoal, cellulose fibers, or any combinations thereof. The filter aid material may be activated by means known in the art.

- 5 Advantageously the lipid material feed (a) is dried before filter aid filtration to avoid leaching of metal from the filter aid material.

Alternatively, the lipid material feed (a) is centrifuged in this step. This is beneficial as both excess water and solid impurities can be removed from the lipid material feed (a).

- 10 After the removal of solid impurities the lipid material feed (a) advantageously comprises less than 0.5 wt%, such as 0 to 0.2 wt%, insoluble impurities of the total weight of the lipid material feed (a). Generally lowering the amount of insoluble impurities in the lipid material feed (a) below 0.1 wt%, renders the lipid material feed (a) suitable for successful downstream treatment enabling smooth downstream phase-separation operations following the further purification steps such as filtration in a subsequent bleaching step.

- 15 The amount of insoluble impurities may be determined according to ISO 663:2017.

- In the present method the lipid material is first treated with alkali in step ii), which is referred here as alkali addition or alkali treatment, wherein a mixture is prepared by mixing the lipid material feed with an alkali. The lipid material where alkali has been provided is here referred to as mixture (b). The alkali may be selected from common bases used in industrial processes. According to an embodiment, the alkali in step ii) is selected from NaOH, KOH, LiOH, or any combination thereof. Preferably the alkali addition (in moles) is relatively small, such as approximately 2x (two-fold), 3x, 4x, 5x, 6x, 7x, 8, 9x, 10x in relation to the organic chlorine content in moles of the feed. In the experiments conducted NaOH as 5x (five-fold) dosing in relation to the moles of organic Cl proved to be an efficient reagent for this step.

- 25 According to an embodiment, the alkali in step ii) is provided as an aqueous solution. The aqueous solution of the alkali contributes in the treatment to easier dosing, mixing and distribution of the reagent to the lipid material. In the aqueous solution, the alkali content may be from 5 to 50 wt-%, such as about 6 wt-%, about 10 wt-% or about 50 wt-% of the total weight of the aqueous solution. Even though the aqueous alkali solution is relatively diluted, the total amount of the aqueous solution remains low because the dosing finds basis in the organic chlorine contents of the lipid material. In the heat-treating following the alkali addition, the low water content provides benefits over prior art processes, such as lower pressure heat treatment (HT) reactor setup lowering costs. Further advantages are related

to wastewater generated and water phase-separation when discarding the reject containing inorganic chlorine.

Notwithstanding whether any water originates from the lipid material feed or from the alkali addition, according to a preferred embodiment an upper limit for the total water content in the mixture (b) may be defined. Accordingly, the mixture advantageously contains less than 10 wt%, preferably less than 5 wt%, such as 0.25 wt% to 2 wt%, preferably less than 1 wt%, more preferably no more than 0.5 wt% water of the total weight of the mixture. Again, keeping the water content low contributes to avoidance of emulsions and allows lower processing pressure, in particular when the water content is kept in less than 1 wt%, or preferably in less than 0.5 wt% water of the total weight of the mixture.

Generally, it is advantageous to boost the contact and transfer between the alkali and lipid material during the alkali treatment. Accordingly, in preferred embodiments, mixing is provided.

According to a specific embodiment, in step ii) the alkali may be added as a solid, such as technical grade or reagent grade pellets, lentils or flakes, where the alkali content (wt/wt) is typically about 98 %, about 97 % or like, such as from 95 to 99 %. Solid alkali may dissolve at least partly in the small amount of water present in the lipid material when the mixing is efficient.

According to an embodiment, mixing may be conducted by steam. Steam provides both heat and mixing thereby accelerating the reactions between the organic chlorine compounds in the lipid material and the alkali. It further contributes to the desired low water content of the lipid material.

After providing alkali to the lipid material in step ii) the mixture (b) is subjected in step iii) to a heat-treating at a temperature of at least 200 °C such as from 200 to 325 °C, preferably of at least 220 °C, such as from 220 to 325 °C, more preferably of at least 270 °C, such as from 270 to 300 °C, most preferably of at least 280 °C, such as from 280 to 290 °C. The combination of alkali treatment step ii) and heat-treating step iii) converts at least part of the chlorine present in the lipid material as different organic chlorine compounds into inorganic chlorine compounds, typically chlorides. Said inorganic chlorine compounds are easier to remove and discard from the lipid material than said organic chlorine compounds. Temperatures below 200 °C do not provide effective chlorine removal with alkaline treatment from the lipid material. At temperatures above 325 °C thermal cracking of the components may be observed.

The heat-treating step iii) may be carried out at a pressure of 100 - 5100 kPa(a), 150 - 5100 kPa(a), 200 - 600 kPa(a), or 300 - 500 kPa(a). Elevating the pressure minimizes losses of lipid material in the heat-treatment step.

5 According to an embodiment, under the heat-treating conditions, in step iii), the present method has a residence time from 5 to 120 minutes. A man skilled in the art is able to adjust the temperature and residence time appreciating that at higher temperatures a shorter residence time is sufficient.

10 The heat-treating step iii) may be performed in any suitable reactor wherein the indicated conditions may be achieved. Examples of suitable reactors include mixed reactors and/or pipe reactors. Further, the heat-treating step iii) may be performed in one or more batches and/or in continuous mode.

15 After the heat-treating in step iii) the heat-treated purified lipid material (c) is recovered, and chlorine containing waste discarded in step iv). Phase-separating is based on the lipid material forming a phase of its own, an oily phase, from which any chlorine containing aqueous and/or solid reject may be removed by ordinary separation unit processes. Accordingly, the term "phase-separating" as used herein and hereafter refers both to liquid-liquid and liquid-solid phase separation.

20 Different phase-separation means are available and have been tested for the phase-separating in step iv). Hence, the phase-separation means in step vi) advantageously comprises filtration, centrifugation, settling, or any combination thereof.

25 In embodiments, where the inorganic chlorine is discarded in an aqueous phase, the oily phase and the aqueous phase as a reject, are separated by conventional oil/water separation means, such as decanting, centrifugation, settling or the like. The reject, hence, a chlorine containing wastewater may be sent to common industrial wastewater treatment. Systems and procedures for treatment of wastewaters containing inorganic salts are common and simple to construct. Aqueous phase is a good medium and transporter for rejects. Inorganic chlorine salts are typically very soluble in aqueous media enabling effective removal thereof even in relatively small water contents.

30 According to an embodiment the phase-separation of the heat-treated mixture in step iv) is preceded by drying, in particular evaporation, under conditions capable of removing water vapor from said heat-treated mixture. However, the evaporation conditions are controlled so that low-boiling components, such as low-boiling fatty acids of the lipid material are not lost. At least part of the water may be removed separately from chlorine impurities whereby

a relatively chlorine free aqueous stream may be recovered from the condensate. By evaporation, the volume of the chlorine containing waste stream may be decreased either by decreasing the volume of the chlorine containing aqueous stream or by removal of substantially all water, precipitating the chlorine impurities as a solid waste.

- 5 According to an embodiment containing evaporation, the evaporation conditions comprise at least one of temperature from 50 to 130 °C, and pressure from 1-100 kPa(a). As an example, a combination of temperature of 105 °C and pressure of 8 kPa(a) could be applied to evaporation.

- 10 Alternatively, according to an embodiment, the reject containing inorganic chlorine from the phase-separation in step iv) is further treated to recover the chloride salt as a precipitate, preferably as a solid chloride salt. Compared to embodiments, where aqueous rejects are treated, the volumes of solid rejects are decreased and hence volume of the equipment may be smaller.

- 15 In embodiments of the present method, the recovery of inorganic chlorine as a precipitate may be based on filtration, centrifugation, settling, or a combination thereto. Recovery as a precipitate is advantageous because of low oil loss therein, water treatments or water wash may suffer from emulsion formation which is seen as loss of the lipid material. Further, treatment of high volumes of wastewater (recycle system and cleaning of the waters) is avoided.

- 20 The reject containing inorganic chlorine from the phase-separation in step iv) comprises at least one chloride salt, preferably NaCl, KCl and/or LiCl. Said salts are common, not harmful, have high solubility in aqueous media, and precipitate and even crystallize easily.

- 25 After the alkali addition ii) and the heat-treating iii), the heat-treated purified lipid material (c) has a metal content, which might be undesirable for some catalytic processes. According to an embodiment, the process contains a step v) of subjecting the heat-treated purified lipid material (c) to a treatment at acidic conditions to obtain a further purified lipid material (d).

- 30 According to an embodiment, the acidic conditions in step v) are provided by addition of acidic reagent or contacting the heat-treated purified material with acidic solid material. As an embodiment, the acidic conditions may be provided by treating the heat-treated purified lipid material (c) with an acidic aqueous solution. An acidic aqueous solution is relatively easy to administer and mix to the heat-treated purified lipid material (c). Further, in case the

method provides aqueous rejects or wastewaters from the earlier steps and the existing wastewater treatment infrastructure may receive the rejects from this step as well.

According to a preferred embodiment, the treatment at acidic conditions in step v) comprises bleaching and/or acid degumming. Step v) typically further comprises phase-separating the obtained further treated mixture from step to obtain the further purified lipid material and a reject containing impurities and possibly utilized reagents.

The term "bleaching" as used herein refers to any process aiming at minimizing the content of impurities, such as pigments (e.g. carotenoids and chlorophylls), metals and/or phosphorus, in the treated material. Bleaching typically involves mixing the material to be treated with an acid and/or an absorbent material. In an embodiment where the treatment at acidic conditions to obtain a further purified lipid material (d) in step v) comprises bleaching, it is carried out in the presence of an acid, such as citric acid and/or phosphoric acid and/or acidic or acid activated adsorbent. Further, when the step v) comprises bleaching, it is typically carried out in the presence of a small amount of water. Advantageously bleaching earth or other adsorbent such as silica can be added to the heat-treated purified lipid material (c) in step v) to adsorb impurities, such as metals and/or phosphorus. The temperature of the bleaching can be for example in the range from 80 to 100 °C. After this, the bleached product is typically dried and filtered to remove the solids together with the impurities.

The term "degumming" as used herein refers to any process aiming at minimizing the content of phospholipids, or other metal and phosphorus containing impurities, in the treated material. In an embodiment where the treatment at acidic conditions to obtain a further purified lipid material (d) in step v) comprises degumming, it is carried out in the presence of acid, such as phosphoric acid and/or citric acid and water at elevated temperature i.e. degummed. The temperature of the degumming can be for example in the range from 30 to 90 °C. The formed gums may subsequently be separated from the degummed product by phase-separation, preferably by centrifugation, and the degummed product may be dried.

It is particularly advantageous to remove any inorganic chlorine before bleaching or degumming, because typically under bleaching or degumming conditions when utilizing acids or acidic adsorbent any chlorine could react and form organic chlorine containing compounds, which again are difficult to remove from lipid materials. Therefore, the present method is particularly advantageous as a treatment preceding bleaching or degumming. On the other hand, the combination of the alkali addition and heat-treating followed by phase-

separation of the present method together with acid degumming or, with bleaching have shown to provide a heat-treated purified lipid material (c) and/or the further purified lipid material (d) with low phosphorus and low metal contents in addition to low chlorine content.

5 The heat-treated purified lipid material (c) and/or the further purified lipid material (d) may then be subjected to a post-treatment comprising hydroprocessing.

In the presence of hydrogen, organic chlorine containing compounds would form corrosive HCl, which can now be diminished or avoided through the present lipid material purifying process.

10 Consequently, according to a second example aspect, herein is provided a use of the heat-treated purified lipid material (c) and/or the further purified lipid material (d) obtained from the purification method as described in the foregoing, as a feed to at least one catalytic hydroprocessing to obtain renewable hydrocarbons.

15 Further, according to a third example aspect, herein is provided a process for providing renewable hydrocarbons, comprising x) purifying a lipid material to obtain heat-treated purified lipid material (c) and/or further purified lipid material (d) according to the first aspect, and y) subjecting the heat-treated purified lipid material (c) and/or the further purified lipid material (d) to hydroprocessing, preferably catalytic hydroprocessing, to obtain at least one renewable hydrocarbon.

20 The lipid material is the lipid material as defined in the foregoing. Preferably the lipid material may comprise streams known for their high chlorine content, such as algae oil, UCO and/or BG.

25 The hydroprocessing, preferably catalytic hydroprocessing, may be any upgrading process employing hydrogen and where the lipid material may be used as the process feed, optionally with a co-feed. For example, the hydroprocessing may be an upgrading process to obtain liquid transportation fuel components, solvents, technical fluids, such as electrotechnical fluids, fatty alcohols, cracking feedstocks, such as feedstocks for thermal cracking and/or catalytic cracking, and/or base chemicals for different syntheses. Preferably the hydroprocessing is catalytic hydroprocessing.

According to an embodiment a co-feed of fossil origin is fed to catalytic hydroprocessing.

30 The hydroprocessing may comprise altering molecular weight, removal of heteroatoms, altering degree of saturation, rearranging molecular structure, or any combination thereof. The hydroprocessing comprises preferably altering molecular weight of the process feed or any intermediate stream or intermediate product derivable or derived therefrom, removal of

heteroatoms from the process feed or any intermediate stream or intermediate product derivable or derived therefrom, altering degree of saturation of the process feed or any intermediate stream or intermediate product derivable or derived therefrom, rearranging molecular structure of the process feed or any intermediate stream or intermediate product derivable or derived therefrom, or any combination thereof.

In certain preferred embodiments, the hydroprocessing comprises hydrotreatment, isomerization, and/or cracking, preferably hydrodeoxygenation (HDO), hydroisomerization (HI), and/or hydrocracking (HC), of the process feed or an intermediate stream or intermediate product derivable or derived therefrom, optionally followed by fractionation.

In certain preferred embodiments, the catalytic hydroprocessing comprises catalytic hydroprocessing converting the lipid material to one or more liquid transportation fuel components. The process comprises subjecting the process feed to hydroprocessing comprising hydrodeoxygenation, hydroisomerization, and optionally hydrocracking, followed by fractionation of the hydroprocessing effluent and recovery of one or more liquid transportation fuel component(s) from the fractionation.

According to an embodiment the catalytic hydrotreating comprises one or more of hydrodeoxygenation, hydroisomerisation, hydrocracking, hydrodenitrogenation, hydrodesulfurisation, hydrodehalogenation, hydrodearomatisation or hydrogenation of double bonds. High metal content in the feed tends to inactivate catalysts typically used in these processes. Considering this, it is specifically beneficial that the content of the alkali metal hydroxides may be kept relatively low in step ii), and or are reduced or removed by treatment at acidic conditions.

The catalytic hydroprocessing may occur in the presence of a catalyst selected from Pd, Pt, Ni, Co, Mo, Ru, Rh, W, or any combination of these, such as CoMo, NiMo, NiW, CoNiMo, NiMoW or together with SAPO-11, SAPO-41, ZSM-22, ZSM-23, ZSM-12, ZSM-48, ZSM-5, beta zeolites, ferrierite and mixtures thereof, such as Pt/SAPO-11/Al₂O₃, Pt/ZSM-22/ Al₂O₃, Pt/ZSM-23/Al₂O₃, Pt/SAPO-11/SiO₂, optionally on a support, wherein the support comprises preferably alumina and/or silica.

Further, the heat-treated purified lipid material (c) and/or the further purified lipid material (d) obtained from the purification method as described in the foregoing may be used as a feed to produce fatty acids, and/or soaps.

Schematic presentation

Fig. 1 shows schematically a purification system 100 and process according to an example embodiment.

In Fig. 1, a lipid material (marked with a) comprising organic chlorine impurities is fed to a reactor 100 equipped with a mixer. As an alternative arrangement, the mixer could be in a pipe. Alkali is added via line 121 and mixed to the lipid material. The heat-treating takes place in reactor 200 and the heat-treated mixture is separated into phases in separator 210. In Fig. 1 the reject containing inorganic chlorine is discarded via line 122. The heat-treated purified lipid material c may be recovered from separator 210 directly via line 123 or subjected to a further treatment step in reactor 300 under acidic conditions. To said reactor 300, acid is fed via line 124 and the reject is discarded via line 125. The further purified lipid material d is then recovered via line 126.

In Fig. 2, the system is otherwise like in Fig. 1, but the phase-separation 210 of the heat-treated mixture is preceded by evaporator 201 under conditions capable of removing water from said heat-treated mixture. Water vapor is discarded via line 131. In the evaporator, the conditions comprise a temperature from 50-130 °C, and/or pressure from 1-100 kPa(a).

EXAMPLES

The following examples are provided to better illustrate the claimed invention and are not to be interpreted as limiting the scope of the invention. To the extent that specific materials are mentioned, it is merely for purposes of illustration and is not intended to limit the invention. In figures 3-7 the left-hand-side y-axis provides contents for Cl and P (shown as columns), whereas the metal contents (dots) are given in the scale of the right-hand-side y-axis.

Feeds

Feeds used in examples included two used cooking oil samples (UCO-1 and UCO-2), and one brown grease sample (BG-1). UCO-2 sample was filtered with filter aid prior to treatment. BG sample was centrifuged prior to treatment. The samples were obtained from commercial sources.

Analysis methods

The feeds and the products were analyzed for phosphorus and metals as well as total chlorides and organic chlorides in order to determine the amount of impurities.

Concentration of phosphorus and metals

The concentration of phosphorus and metals was analyzed from all samples by first digesting the sample with acids in a microwave oven to obtain a clear water/acid matrix (assessed visually), then diluting it to a known amount and analyzing it against the acid based calibration using ICP-MS/MS (tandem Inductively Coupled Plasma Mass Spectrometry). Metals detected by the method include Li, B, Na, Mg, Al, P, K, Ca, Ti, V, Ch, Mn, Fe, Co, Ni, Cu, Zn, As, Mb, Cd, Sn, and Ba.

Amount of chlorine

The amount of total chlorine was analyzed from all samples with an elemental combustion analyzer according to Microcoulometric detection technique UOP799-08. Sample is burned in a furnace and the formed hydrogen chloride gas is determined with coulometric titration. Determination limit is 1 ppm and the result is given at the precision of 1 ppm. Departing from the standard, the sample is weighed directly into the sample cup (no syringe injection).

The amount of organic chlorine was analyzed from all samples with an elemental combustion analyzer according to ASTM D4929-22, Test method B. Accordingly, sample is distilled to 204°C and distillate is washed with KOH solution and water and is filtered afterwards. Sample is combusted in a furnace and produced hydrogen chloride gas is detected by microcoulometric titration. The detection limit is 1 ppm and results are reported with 1 ppm precision. Departing from the standard, distillation is replaced by shaking with hot water to remove inorganic halides.

Water content

The water content of all the samples was determined according to ASTM D6304-20, procedure C. The method is based on a coulometric Karl Fischer titration.

The examples conducted may be summarized as follows.

NaOH/KOH used in tests: 6 wt-%, 10 wt-% or 20 wt-% aqueous solution depending on the dosing needed.

Dosing of NaOH/KOH: 30-800 wppm of NaOH/KOH to the total weight of the feed in tests (depending on feed organic Cl concentration and dosing used: 1-10 x stoichiometric amount of alkali metal hydroxides to organic Cl in feed).

Heat-treating (HT) conditions tested: 85 °C, 150 °C, 220 °C and 280 °C for 30 min in MultiParr stirred pressure reactor system (45 ml reactors) or Parr stirred pressure reactor (1 litre). Initial pressure 300 kPa(a) (nitrogen) -> max pressure 450 kPa(a) in 280 °C test.

The nitrogen gas atmosphere was used to ensure air removal from the reactor before heating the mixture.

The heat-treated material was treated (phase-separated) to remove the chlorine containing reject and the recovered oil phase was analyzed for the final chlorine content. In examples 5 1 - 4 centrifugation followed by paper filtration or sole paper filtration was used to remove the reject. Abbreviation F refers to filtration in the tables and figures.

Comparative example 1: Bleaching of UCO (no alkali addition or heat-treating)

UCO-1 sample was purified by bleaching as follows. A sample was heated to 85 °C. Citric acid (2400 wppm to the total weight of the sample, added as 50 wt-% water solution) and 10 0.15 wt-% water was added and mixed thoroughly for 5 min. After that, acidic bleaching earth 1 wt-% was added and mixing continued for 20 min. The mixture was dried (105 °C/ 8 kPa(a)) and filtered through a precoat of bleaching earth at 105 °C. The results show that the main part of inorganic Cl compounds present in the UCO sample were converted during the bleaching treatment at acidic conditions to organic chlorine compounds (feed contained 15 47 wppm total Cl of which 27 wppm organic Cl, bleached product contained 42 wppm total Cl of which all 42 wppm was organic Cl).

Example 1. Different alkali dosings to HT

The effect of different alkali dosing in the present process was tested by additions of 0x (water), 1x, 3x and 10x dosing of metal hydroxides in relation to the organic Cl molar content 20 of the UCO-1 sample used. Both NaOH and KOH were tested. The water content was kept constant in all tests.

The experiment was conducted in MultiParr (45 ml reactor). UCO sample (25 g) and water or alkali solution was added to the reactor, reactor flushed with nitrogen and initial pressure of 300 kPa(a) (nitrogen) was set to ensure absence of air. The added water was 0.25 wt-% 25 in all of the tests (total moisture ca. 0.5 wt-%). The reactor was heated to target temperature (280 °C) under stirring (500 rpm) and kept at target temperature for 30 min before cooling to 80 °C. The heat-treated material was separated by centrifugation and filtration through 0.45 µm paper filter to remove the inorganic chlorine containing reject.

The analysis results for the feed and the centrifuged and filtered HT products after treatment 30 with different additions are presented in Figure 3. The treatment including addition of sufficient alkali solution to the feed followed by HT resulted in 65-85% removal of organic Cl (4-10 wppm in product with 3-10x NaOH/KOH dosing). Both NaOH and KOH were effective in chlorine removal. HT without any alkali, i.e. conducted with only water, resulted

in very small reduction (22%) in chlorine contents. Metals content in the product increased when alkali addition was performed, as more metal was added as hydroxide. Therefore, based on these results a five-fold (5x) dosing of alkali (NaOH) was chosen for further tests.

Example 2. Test with different HT treatment times.

5 The effect of the duration of the heat-treating was studied in a Parr reactor (1 litre) with a UCO-1 sample (650 g) to which five-fold NaOH dosing in relation to the organic Cl molar content of the UCO sample was added. The impurity levels were measured for different samples, namely: 1) crude feed used in test, 2) centrifuged and filtered feed (80 °C, as a comparison), 3-5) filtered samples taken during the heat-treating (HT) and at the end (30
10 min).

The results provided in Figure 4 for the intermediate samples taken during an HT test at 280 °C show a clearly increased effectiveness in organic Cl removal with increasing treatment time. Comparison of the contents of the total (47 wppm) and the organic (27 wppm) chlorine in the initial feed and after centrifugation and filtration (0.45 um filter), total
15 Cl (28 wppm) and organic Cl (27 wppm), reveals firstly, how the inorganic chlorine is easily removed by simple procedures, such as heating to 80 °C and centrifugation and filtration, but not the organic chlorine. However, when the combined alkali and heat-treating according to the present method were applied, the chlorine content, also the organic chlorine content, was effectively lowered by simple filtration (2 um paper filtration), and it
20 directly correlated with the treatment time (0, 15 and 30 min).

Example 3. Alkaline heat treatment (HT) with different feeds.

Three samples were heat-treated with five-fold dosing of NaOH in relation to the organic chlorine molar content was applied to study the chlorine removal efficiency from different feeds. BG-1 sample was centrifuged prior to treatment due to high water and solid content
25 of the crude BG sample. UCO-2 sample was obtained by filtering a crude UCO sample with filter aid. After addition of the alkali (5x NaOH added as 11 or 20 wt-% aqueous solution depending on dosing), the samples were treated for 30 minutes at 280 °C followed by centrifugation and filtration (0.45 um). All three different feeds: both UCOs and the BG sample showed significant lowering of the chlorine contents.

30 Table 1 and Figure 5 present the result for said two UCO samples and one BG sample.

Table 1. **Alkaline (NaOH) HT with different feeds**

	UCO-1, Feed	UCO-1, Product	BG-1, Feed	BG-1, Product	UCO-2, Feed	UCO-2, Product
Tot Cl (ppm)	46.5	11.8	72.4	33.3	149.7	53.2
Org Cl (ppm)	26.9	10.8	69.9	23.2	145.7	51.2
P (ppm)	30.9	15.8	120.5	91.6	5.1	1.7
Metals (ppm)	138	169	1295	1403	26	472
Org Cl reduction		60%		67%		65%

For one of the samples (UCO-2), the initial organic chlorine content was very high, almost 150 ppm, which was impressively lowered to around 50 ppm with the treatment according to the present method. The alkaline HT followed by phase-separation resulted in 60-67% reduction in organic Cl in the different samples.

5 Example 4. Effect of treatment temperature.

Alkaline heat-treating with five-fold dosing of NaOH in relation to the organic chlorine molar content was applied to study the chlorine removal efficiency at different temperatures from UCO-1. The chosen temperatures were 85 °C, 150 °C, 220 °C, 280 °C, and treatment time 30 min at target temperature. The results presented in Table 2 and Figure 6 show that at lower temperatures of 85 °C and 150 °C the inorganic Cl is converted to organic form and can no longer be removed by phase-separation (centrifugation and filtration with 0.45 um paper filter), at 220 °C conversion of inorganic Cl to organic form is no longer seen but a slight decrease in organic Cl of the product, and at 280 °C the organic Cl is clearly converted to inorganic form and hence can be removed by phase-separation.

15 Table 2. Effect of treatment temperature. HT product analyzed after centrifugation and filtration.

	UCO-1, Feed	85 °C HT, Product	150 °C HT, Product	220 °C HT, Product	280 °C HT, Product
Cl (ppm)	46.5	43.5	38.4	26.8	11.8
Org Cl (ppm)	26.9	41.2	37	26.2	10.8
P (ppm)	30.9	13.3	14.3	21.5	15.8
Metals (ppm)	138	147	159	216	169

Example 5. Effect of different phase-separation methods on the total Cl reduction.

According to specific embodiments of the present method, the heat-treated purified lipid material from which at least some of the chlorine is discarded, may optionally be further treated under acidic conditions. As in previous examples, the alkaline heat-treating of UCO-1 with five-fold dosing of NaOH in relation to the organic chlorine molar content at 280 °C for 30 min was applied to study the chlorine removal efficiency followed by different phase-separations.

Total chlorine, organic chlorine, phosphorus and total metal content were measured for the samples of the feed before the treatment according to the present method (Feed) and after. The results are presented in Table 3 and in Figure 7. Figure 7 shows the effect of different phase-separations for the heat-treated product: filtration (F(2 um)), centrifugation (C), water washing (by mixing in 10 wt-% water + settling, (ww)), degumming (addition of 4000 wppm citric acid + 2.5 wt-% water, 2 min high shear mixing and 15 min slow mixing followed by centrifugation, DEG), bleaching (see comparative example BL), filtration (through a filter aid cake, F(FA)) followed by bleaching or water wash followed by bleaching. Based on the results, filtration, centrifugation or water washing are effective ways to remove the inorganic Cl in the heat-treated product resulting in total Cl reduction of 80-83% (96-99% inorganic Cl reduction).

Treatment of the heat-treated product that has not undergone a phase-separation step (removal of chlorine containing reject) was seen to convert at acidic conditions (degumming (DEG), bleaching (BL)) some of the inorganic Cl present in the sample back to organic form (increase in organic Cl: HT prod 8 wppm -> deg/BL prod 27/29 wppm). When the heat-treated product was first filtered (through a filter aid cake, (F(FA)) or water washed (ww) and then bleached (see Figure 7, 'HT prod F(FA) + BL' and 'HT prod ww+ BL') good Cl removal was seen. Hence, good removal of inorganic Cl was needed before going to acidic treatment (degumming or bleaching) that can be used as a polishing step for removal of metals and P.

Table 3. Results for different phase-separations for the heat-treated product.

	UCO-1, Feed	DEG Prod (comparative)	BL Prod (comparative)	HT + F(2um) Prod	HT + C Prod	HT + ww Prod	HT + F(FA) Prod	HT + F(FA) + BL Prod	HT + ww + BL Prod
Tot Cl (ppm)	46.5	31.4	31.5	6.6	9.4	7.7	19.1	9.7	7.4
Org Cl	26.9	27.1	29.4	6.3	7.9	7.3	7.9	10	7.5

(ppm)									
P (ppm)	30.9	2.4	2.4	8	8.6	7.7	11.3	2	3.3
Metals (ppm)	138	14.9	14.5	149	139	89	170	33	1.2
Total Cl reduction		32 %	32 %	86 %	80 %	83 %	59 %	79 %	79 %
Org Cl reduction		0 %	-9 %	77 %	71 %	73 %	71%	63 %	63 %
Inorg Cl reduction		78 %	88 %	99 %	96 %	99 %		101 %	101 %

Compared to prior art processes the present method is advantageous as it is a method for reducing the level of organic chlorine in crude unpurified lipid material feedstock. The treatment is done with a small chemical addition (only 5 times stoichiometric amount of alkali to Cl has been needed for good result) and can be done with low water content giving benefits over prior art.

Various embodiments have been presented. It should be appreciated that in this document, words comprise, include, and contain are each used as open-ended expressions with no intended exclusivity.

The foregoing description has provided by way of non-limiting examples of particular implementations and embodiments a full and informative description of the best mode presently contemplated by the inventors for carrying out the invention. It is however clear to a person skilled in the art that the invention is not restricted to details of the embodiments presented in the foregoing, but that it can be implemented in other embodiments using equivalent means or in different combinations of embodiments without deviating from the characteristics of the invention.

Furthermore, some of the features of the afore-disclosed example embodiments may be used to advantage without the corresponding use of other features. As such, the foregoing description shall be considered as merely illustrative of the principles of the present method, and not in limitation thereof. Hence, the scope of the invention is only restricted by the appended patent claims.

CLAIMS

1. A method for purifying lipid material, said method comprising the steps of
 - i) providing a lipid material feed (a),
 - ii) preparing a mixture (b) by mixing feed (a) with an alkali,
 - 5 iii) heat-treating the mixture (b) at a temperature of at least 200 °C, such as from 200 to 300 °C,
 - iv) phase-separating a heat-treated mixture from step (iii) to obtain a heat-treated purified lipid material (c) and a reject containing inorganic chlorine,
 - v) optionally subjecting the heat-treated purified lipid material (c) to a treatment at
 - 10 acidic conditions to obtain a further purified lipid material (d),
 - vi) recovering the heat-treated purified lipid material (c) from treatment of step iv) and/or the further purified lipid material (d) from treatment of step v).
2. The method according to claim 1, wherein said alkali in step (ii) is selected from NaOH, KOH, LiOH or a combination thereof.
- 15 3. The method according to any one of the preceding claims, wherein the alkali in step (ii) is provided as an aqueous solution.
4. The method according to any one of the preceding claims, wherein the heat-treating step iii) is carried out at a pressure of 100 - 5100 kPa(a), 150 - 5100 kPa(a), 200 - 600 kPa(a), or 300 - 500 kPa(a).
- 20 5. The method according to any one of the preceding claims, wherein the step iii) has a residence time at said conditions from 5 to 120 minutes.
6. The method according to any one of the preceding claims, wherein the phase-separation of the heat-treated mixture in step iv) is preceded by evaporation under conditions capable of removing water from said heat-treated mixture.
- 25 7. The method according to claim 6, wherein the evaporation conditions comprise at least one of temperature from 80-130 °C and pressure from 1-100 kPa(a).
8. The method according to any one of the preceding claims, wherein the lipid material feed (a) contains no more than about 2 wt-% water, generally no more than about 1 wt-% water, such as from 0.1 to 1 wt-% water.
- 30 9. The method according to any one of the preceding claims, wherein the lipid material feed (a) is subjected to removal of solid impurities prior to step ii).

10. The method according to claim 9, wherein the removal of solid impurities comprises at least one phase separation method selected from settling, centrifuging, filtering, and any combination thereof, preferably centrifuging and/or filtering.
- 5 11. The method according to claim 9 or 10, wherein the removal of solid impurities comprises filtering the lipid material feed (a) with a filter aid.
12. The method according to claim 9 or 10, wherein solid impurities are removed by filter aid filtration (FAF).
- 10 13. The method according to claim 11 or 12, wherein the filter aid material comprises at least one selected from any material comprising or consisting of mineral, silicon, and/or cellulose based material.
14. The method according to claim 13, wherein the filter aid material comprises at least one selected from diatomaceous earth, diatomite, perlite, bentonite, palygorskite, kaolin, kaolinite, silica in various crystalline or amorphous configurations, sepiolite, magnesium silicate, silicon, aluminum oxide based materials, zinc oxide based
15 materials, neutral bleaching earth, activated carbon, activated charcoal, cellulose fibers, or any combinations thereof.
15. The method according to any of claims 11 – 14, wherein the lipid material feed (a) is dried before filter aid filtration to avoid leaching of metal from the filter aid material.
- 20 16. The method according to any of claims 9 – 15, wherein the lipid material feed (a) comprises less than 0.5 wt%, such as 0 to 0.2 wt%, preferably 0.1 wt% insoluble impurities of the total weight of the lipid material feed (a).
17. The method according to claim 16, wherein the amount of insoluble impurities is determined according to ISO 663:2017.
- 25 18. The method according to any one of the preceding claims, wherein the reject containing inorganic chlorine from the phase-separation in step iv) comprises at least one chloride salt, preferably NaCl, KCl, LiCl or a combination thereof.
19. The method according to any one of the preceding claims, wherein the reject containing inorganic chlorine from the phase-separation in step iv) is further treated to recover the chloride salt as a precipitate, preferably as a solid chloride salt.
- 30 20. The method according to any one of the preceding claims, wherein the treatment at acidic conditions in step v) is selected from bleaching and degumming.

21. The method according to any of the preceding claims, wherein the treatment at acidic conditions in step v) comprises bleaching.
22. The method according to any one of the preceding claims, wherein the feed comprises at least one feed selected from used cooking oil (UCO), brown grease (BG), and combinations thereof.
23. The method according to any of the preceding claims, wherein the phase-separating means in step iv) comprises filtration, centrifugation, settling or any combination thereof.
24. The method according to any of the preceding claims, wherein the heat-treated purified lipid material (c) and/or the further purified lipid material (d) contains at least about 10 wt-%, preferably at least about 20 wt-%, more preferably at least about 25 wt-%, most preferably at least about 60 wt-%, less chlorine calculated as elemental chlorine than the lipid feed material (a).
25. The method according to any of the preceding claims, wherein the heat-treated purified lipid material (c) and/or the further purified lipid material (d) is further subjected to a post-treatment comprising hydroprocessing.
26. Use of the heat-treated purified lipid material (c) or the further purified lipid material (d) obtained from the method according to any of the claims 1-24 as a feed to at least one hydroprocessing, preferably to catalytic hydroprocessing to obtain renewable hydrocarbons.
27. The use according to claim 26 wherein a co-feed of fossil origin is fed to the hydroprocessing, preferably to catalytic hydroprocessing.
28. The use according to claim 27, wherein the catalytic hydroprocessing comprises one or more of hydrodeoxygenation, hydroisomerisation, hydrocracking, hydrodenitrogenation, hydrosulfurisation, hydrodehalogenation, hydrodearomatisation or hydrogenation of double bonds.
29. The use according to claim any of claims 26 - 28, wherein the catalytic hydroprocessing occurs in the presence of a catalyst selected from Pd, Pt, Ni, Co, Mo, Ru, Rh, W, or any combination of these, such as CoMo, NiMo, NiW, CoNiMo, NiMoW or together with SAPO-11, SAPO-41, ZSM-22, ZSM-23, ZSM-12, ZSM-48, ZSM-5, beta zeolites, ferrierite and mixtures thereof, such as Pt/SAPO-11/Al₂O₃, Pt/ZSM-22/ Al₂O₃, Pt/ZSM-23/Al₂O₃, Pt/SAPO-11/SiO₂, optionally on a support, wherein the support comprises preferably alumina and/or silica.

30. A process for providing renewable hydrocarbons, comprising
x) purifying a lipid material to obtain heat-treated purified lipid material (c) and/or the
further purified lipid material (d) as claimed in any one of claim 1 to 25, and
y) subjecting the heat-treated purified lipid material (c) and/or the further purified
lipid material (d) to hydroprocessing, preferably catalytic hydroprocessing, to obtain
at least one renewable hydrocarbon.
31. The process according to claim 30, wherein a co-feed of fossil origin is fed to the
hydroprocessing, preferably to catalytic hydroprocessing.
32. The process according to claim 30 or 31, wherein the catalytic hydroprocessing
comprises one or more of hydrodeoxygenation, hydroisomerisation, hydrocracking,
hydrodenitrogenation, hydrodesulfurisation, hydrodehalogenation,
hydrodearomatisation or hydrogenation of double bonds.
33. The process according to any of claims 30 - 32, wherein the catalytic
hydroprocessing occurs in the presence of a catalyst selected from Pd, Pt, Ni, Co,
Mo, Ru, Rh, W, or any combination of these, such as CoMo, NiMo, NiW, CoNiMo,
NiMoW or together with SAPO-11, SAPO-41, ZSM-22, ZSM-23, ZSM-12, ZSM-48,
ZSM-5, beta zeolites, ferrierite and mixtures thereof, such as Pt/SAPO-11/Al₂O₃,
Pt/ZSM-22/ Al₂O₃, Pt/ZSM-23/Al₂O₃, Pt/SAPO-11/SiO₂, optionally on a support,
wherein the support comprises preferably alumina and/or silica.