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(54) **A PROCESS FOR CRACKING A HYDROCARBON FEEDSTOCK COMPRISING MACAÚBA PALM OIL**

(57) The present invention relates to a process for producing a hydrocarbon composition, the process com-

prising the step of cracking a precursor feedstock comprising Macaúba palm oil.

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Description**Technical field**

[0001] The present invention relates to cracking processes of hydrocarbon feedstock.

Background

[0002] Steam cracking of hydrocarbons is and will continue to be the main industrial process to produce light olefins in the coming decades. In steam cracking plants known from the prior art, more than 90% of the CO₂ emissions can be directly related to the high energy consumption of the endothermic conversion in the cracking furnaces. Steam cracking accounts for a global emission of more than 300 million tons of CO₂ per annum. Enhancing heat transfer in the radiation section, using green energy, and reducing coke formation are key to substantially reduce CO₂ emissions.

[0003] Other approaches to increase sustainability is to use renewable or alternative feedstock. US 14/072,429 describes a process of producing bio-naphtha by steam cracking a renewable source of oils and fats. However, this process requires that the renewable source of oils and fats needs to be subjected to a refining treatment before being applied to the steam cracking step. Equal results have been achieved by Steven P. Pyl et al., "Biomass to olefins: Cracking of renewable naphtha", Chemical Engineering Journal, Vol. 176-177, 2011, p. 178-187. Reason for the preceding pretreatment step is that substances, which could act as potential catalyst poisons in reactions using parts of the product of the steam cracking process, are removed before the cracking process. This is beneficial as removal after the cracking process would be more complicated without at least partial and unintended modification of the product. Major potential catalyst poisons are sulfur and nitrogen.

[0004] Furthermore, during the operation of the steam-cracker using renewable hydrocarbon feedstocks, some equipment or processing units may suffer from accumulation of cokes residues. For example, the inner walls of cracking coils in the furnaces of steam-crackers suffer from cokes layer formation during operation. The same issue arises in the transfer line exchangers directly downstream to the furnaces. This deposition of coke has several adverse effects on the productivity of these reactors:

(1) Coke has a low thermal conductivity, so deposition of coke may lower the thermal efficiency of the system which will in turn require the fuel flow rate to be increased to maintain the same level of production, thus further increasing the coke deposition rate. Moreover, different coke deposition rates across a series of reactors suspended in a common furnace will prevent proper temperature control needed to maintain desired production selectivity. The low thermal conductivity of the cokes layer also results in higher tube metal temperatures, which may reach the design limits of the alloy that is used.

(2) Sustained deposition of coke may decrease the cross-sectional area of a reactor available for the feedstock gas resulting in a higher process gas velocity and a higher pressure drop over the reactor. To compensate for this pressure drop, the overall pressure inside the reactor will have to be increased, which inadvertently leads to reduced process selectivity towards light olefins because of an increased rate of secondary reactions between those olefins.

(3) Presence of coke decreases the carbon yield of the cracking process since all the carbon atoms that would otherwise be collected as light olefins are instead incorporated into the coke and are hence lost.

[0005] Hence, the coke must be removed periodically either by burn-off, or by mechanical means. If the coke has not been removed at the right time, unplanned production losses may be caused by reduced effectiveness or failure of assets. Similar coking, or more generally, fouling processes mitigate the efficiency of process equipment also in other chemical plants.

Summary of the Invention

[0006] Hence, the present solutions in the prior art to achieve higher sustainability of cracking processes by using renewable hydrocarbon feedstocks has the disadvantage of coking and/or of a more complex process due to necessary pretreatment steps.

[0007] Thus, it is an object of the present invention to provide a more sustainable and environment friendly process for providing light hydrocarbons, which has no tendency for coking, and which does not require a pretreatment step.

[0008] In this connection, a more environmentally friendly alternative preferably provides at least one, more preferably at least two, still more preferably at least three, and in particular at least four of the following impacts: reduced water demand, reduction of the loss of biodiversity, reduction of loss of habitats for local tribes, reduction of deforestation, improved

recovery of degraded areas and springs and watersheds, improved retention of moisture in the soil, improved resistance to temperature fluctuations and climate change.

[0009] It has surprisingly been found that at least one of these objects can be achieved by using a feedstock comprising an oil extracted from the Macaúba palm.

[0010] Thus, according to a first aspect, the present invention relates to a process for producing a hydrocarbon composition, the process comprising the step of cracking a precursor feedstock comprising Macaúba palm oil.

[0011] In the following, preferred embodiments of the above composition are described in further detail. It is to be understood that each preferred embodiment is relevant on its own as well as in combination with other preferred embodiments.

[0012] It is a particular advantage of the present invention that the Macaúba oil can be used in the cracking process without any further pretreatment step. Without wishing to being bound by theory it is believed that this is due to the low amount of sulfur and nitrogen to be found in the Macaúba oil.

[0013] In a first preferred embodiment **A1** of the first aspect of the invention, the Macaúba palm oil is obtained by extraction of the fruits, palm pulp, and/or palm kernel of the Macaúba palm, preferably *Acrocomia aculeata*, preferably is extracted from the palm pulp and/or the palm kernel of the Macaúba palm, preferably *Acrocomia aculeata*, more preferably is extracted from the palm kernel of the Macaúba palm, preferably *Acrocomia aculeata*.

[0014] In a second preferred embodiment **A2** of the first aspect of the invention, the step of cracking is selected from the list consisting of a pyrolysis, thermal cracking, or steam cracking.

[0015] In a third preferred embodiment **A3** of the first aspect of the invention, the step of cracking is carried out at a temperature in the range of from 700 °C to 900 °C, preferably of from 750 °C to 850 °C, and most preferably of from 780 °C to 820 °C.

[0016] In a fourth preferred embodiment **A4** of the first aspect of the invention, the precursor feedstock comprises a second source of hydrocarbons.

[0017] In a fifth preferred embodiment **A5** of the first aspect of the invention, the Macaúba oil of the precursor feedstock has not undergone a pretreatment step and/or refining step.

[0018] In a sixth preferred embodiment **A6** of the first aspect of the invention, the second source of hydrocarbons is selected from naphtha, gas oil, crude petroleum, liquified petroleum gas, and natural gas liquids, preferably is naphtha.

[0019] In a seventh preferred embodiment **A7** of the first aspect of the invention, the precursor feedstock consists of the second hydrocarbon source and the Macaúba palm oil.

[0020] In an eighth preferred embodiment **A8** of the first aspect of the invention, the Macaúba palm oil is present in the precursor feedstock in an amount of at least 5 wt.-% with respect to the total weight of the precursor feedstock, preferably at least 10 wt.-%, and most preferably at least 20 wt.-%.

[0021] In a second aspect the present invention relates to the use of a of Macaúba palm oil in a feedstock for a cracking process according to any of the preceding embodiments of the first aspect of the present invention.

[0022] In a third aspect the present invention relates to a composition obtainable by a process according to embodiments **A1** to **A8**, wherein the composition further comprises C5 to C9 hydrocarbons in an amount in the range of from 25 to 26 wt.-%, and C10 and higher hydrocarbons in an amount in the range of from 4 to 5 wt.-%.

[0023] In a first preferred embodiment **C1** of the third aspect of the present invention, the composition comprises acetylene in an amount in the range of from 0.1 to 0.2 wt. % (0.14), ethylene in an amount in the range of from 20 to 25 wt. % (22.30), and ethane in an amount in the range of from 4 to 5 wt.-%.

[0024] In a first preferred embodiment **C2** of the third aspect of the present invention, the composition further comprises propylene in an amount in the range of from 16 to 18 wt.-% (16.71), propane in an amount in the range of from 0.5 to 0.7 wt.-% (0.63).

[0025] In a first preferred embodiment **C3** of the third aspect of the present invention, the composition further comprises butatriene and/or vinylacetylene in an amount in the range of from 0.005 to 0.02 wt.-% (0.01), butadiene in an amount in the range of from 4 to 5 wt.-% (4.5), butylene in an amount in the range of from 6 to 7 wt.-% (6.66), and butane in an amount in the range of from 1 to 2 wt.-% (1.34)

[0026] In a first preferred embodiment **C4** of the third aspect of the present invention, the composition further comprises hydrogen in an amount in the range of from 0.5 to 0.8 wt.-%, methane in an amount in the range of from 12 to 13 wt.-%, carbon monoxide in an amount in the range of from 0.05 to 0.1 wt.-%, and carbon dioxide in an amount in the range of from 0.005 to 0.01 wt.-%.

Detailed Description of the Invention

[0027] Before describing in detail exemplary embodiments of the present invention, definitions which are important for understanding the present invention are given.

[0028] As used in this specification and in the appended claims, the singular forms of "a" and "an" also include the respective plurals unless the context clearly dictates otherwise. In the context of the present invention, the terms "about"

and "approximately" denote an interval of accuracy that a person skilled in the art will understand to still ensure the technical effect of the feature in question. The term typically indicates a deviation from the indicated numerical value of ± 10 %, preferably ± 8 %, more preferably ± 5 %, even more preferably ± 2 %. It is to be understood that the term "comprising" and "encompassing" is not limiting. For the purposes of the present invention the term "consisting of" is considered to be a preferred embodiment of the term "comprising of". If hereinafter a group is defined to comprise at least a certain number of embodiments, this is meant to also encompass a group which preferably consists of these embodiments only. Furthermore, the terms "first", "second", "third" or "(a)", "(b)", "(c)", "(d)" etc. and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein. In case the terms "first", "second", "third" or "(a)", "(b)", "(c)", "(d)", "i", "ii" etc. relate to steps of a method or use or assay there is no time or time interval coherence between the steps, i.e. the steps may be carried out simultaneously or there may be time intervals of seconds, minutes, hours, days, weeks, months or even years between such steps, unless otherwise indicated in the application as set forth herein above or below. It is to be understood that this invention is not limited to the particular methodology, protocols, reagents etc. described herein as these may vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention that will be limited only by the appended claims. Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art.

[0029] As used herein the term "does not comprise", "does not contain", or "free of" means in the context that the composition of the present invention is free of a specific compound or group of compounds, which may be combined under a collective term, that the composition does not comprise said compound or group of compounds in an amount of more than 0.8 % by weight, based on the total weight of the composition. Furthermore, it is preferred that the composition according to the present invention does not comprise said compounds or group of compounds in an amount of more than 0.5 % by weight, preferably the composition does not comprise said compounds or group of compounds at all.

[0030] When referring to compositions and the weight percent of the therein comprised ingredients it is to be understood that according to the present invention the overall amount of ingredients does not exceed 100% (± 1 % due to rounding).

[0031] The term "fatty acid" as used herein is directed to linear or branched, preferably linear, primary carboxylic acids. Fatty acids may comprise from 4 to 26 carbon atoms. According to the present invention, the term fatty acid encompasses saturated and unsaturated acids. The double bond of an unsaturated fatty acid can give either cis or trans isomers. Caprylic acid, capric acid, lauric acid, myristic acid, myristoleic acid, palmitic acid, palmitoleic acid, sapienic acid, stearic acid, oleic acid, elaidic acid, vaccenic acid, linoleic acid, linoelaidic acid, α -Linolenic acid, arachidic acid, arachidonic acid, eicosapentaenoic acid, erucic acid, behenic acid, docosahexaenoic acid, lignoceric acid, and cerotic acid should be named in this connection.

[0032] The prefix C_n-C_m indicates in each case the possible number of carbon atoms in the group.

[0033] The term "alkyl" as used herein denotes in each case a linear or branched alkyl group having usually from 1 to 30 carbon atoms, preferably 4 to 26 or of 1 to 6 or of 1 to 3 carbon atoms. Examples of an alkyl group are methyl, ethyl, n-propyl, iso-propyl, n-butyl, 2-butyl, iso-butyl, tert-butyl, n-pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 2,2-dimethylpropyl, 1-ethylpropyl, n-hexyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 1,1-dimethylbutyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 2,2-dimethylbutyl, 2,3-dimethylbutyl, 3,3-dimethylbutyl, 1-ethylbutyl, 2-ethylbutyl, 1,1,2-trimethylpropyl, 1,2,2-trimethylpropyl, 1-ethyl-1-methylpropyl, and 1-ethyl-2-methylpropyl.

[0034] The term "alkoxy" as used herein denotes in each case a linear or branched alkyl group which is bonded via an oxygen atom and has usually from 1 to 6 carbon atoms, preferably 1 to 2 carbon atoms, more preferably 1 carbon atom. Examples of an alkoxy group are methoxy, ethoxy, n-propoxy, iso-propoxy, n-butyloxy, 2-butyloxy, iso-butyloxy, tert.-butyloxy, and the like.

[0035] As used herein, the term "alkylene" refers to a linking linear or branched alkylene group having usually from 1 to 4 carbon atoms, e.g., 1, 2, 3, or 4 carbon atoms. The alkylene group bridges a certain group to the remainder of the molecule. Preferred alkylene groups include methylene (CH_2), ethylene (CH_2CH_2), propylene ($CH_2CH_2CH_2$) and the like. A skilled person understands that, if it is referred, e.g., to CH_2 that the carbon atom being tetravalent has two valences left for forming a bridge ($-CH_2-$). Similarly, when it is referred, e.g., to CH_2CH_2 , each carbon atom has one valence left for forming a bridge ($-CH_2CH_2-$). Furthermore, when it is referred, e.g., to $CH_2CH_2CH_2$, each terminal carbon atom has one valence left for forming a bridge ($-CH_2CH_2CH_2-$).

[0036] Further, a skilled person is aware that resonance structures of the oxidized forms may be possible. Saturated heterocycles include, unless otherwise indicated, in general 3- to 9-membered, preferably 4- to 8-membered or 5- to 7-membered, more preferably 5- or 6-membered monocyclic rings comprising 3 to 9, preferably 4 to 8 or 5 to 7, more preferably 5 or 6 atoms comprising at least one heteroatom, such as pyrrolidine, tetrahydrothiophene, tetrahydrofuran, piperidine, tetrahydropyran, dioxane, morpholine or piperazine.

[0037] The term "aryl" or "aromatic carbocycle" preferably includes 6-membered aromatic carbocyclic rings based on carbon atoms as ring members. A preferred example is phenyl.

[0038] The term "oil palm" as used herein denotes a species of palm, which is also known as "*Elaeis guineensis*". It is the principal source of "palm oil".

[0039] The term "coconut tree" as used herein denotes a member of the palm tree family (*Arecaceae*) and is also referred to as *Cocos nucifera*. It is the principal source for "coconut oil".

[0040] The term "Macaúba palm" as used herein denotes a species of palm. Exemplary species are known as "*Acrocomia aculeata*" (also known as "macaíba", "boicaiuva", "macaúva", "coco-de-catarro", "coco-baboso", and "coco-de-espinho"), "*Acrocomia hassleri*", and "*Acrocomia toté*". Macaúba palms can grow high, e.g., up to about 15 m. The Macaúba fruit comprises pulp and kernel.

[0041] The term "pulp" as used herein refers to inner flesh of a fruit.

[0042] The term "kernel" as used herein is interchangeable with "seed" or "almond".

[0043] The term "cleaning composition" as used herein encompasses home care formulation, industrial care formulation, and institutional care formulation. Home care formulations are typically used by private consumers, whereas industrial care formulations are typically used by the industry, and institutional care formulations are typically used in e.g., clinics and nursing homes. It is however also possible that the respective formulations can be used in different areas than intended. Hence, the institutional care formulation may also be used by private consumers or the industry and vice versa. Typically cleaning compositions are e.g., for the laundry, dishwashing, hard surface cleaning, food service and kitchen hygiene, food and beverage processing, commercial laundry, sanitation, institutional cleaning, industrial cleaning, and vehicle and transportation care.

[0044] The term "liquid" as used herein also encompasses semi-solid conditions, wherein the fluid has an increased viscosity (e.g., creamy, gels, ointments).

[0045] The term "crop formulation" as used herein encompasses pesticide formulations, fungicide formulations, and herbicide formulations.

[0046] The term "oil yield in tons per hectare per year" as used herein is directed to the oil derived from the fruit of the plant via e.g., extraction, wherein the fruit comprises the pulp and the kernel. It refers to the oil produced per hectare. It is to be understood that the value refers to the oil yield obtained from a monoculture, wherein the plants are cultivated under standard conditions, which depend on the respective plant and are known to the skilled person. Hence, in the event that the plant is not cultivated in a monoculture (e.g., on a cattle field), the respective value for this particular cultivation may be reduced. Typically, oil palm has an oil yield in tons per hectare per year of about 3.8 t/ha/yr, rapeseed has an oil yield in tons per hectare per year of about 0.8 t/ha/yr, sunflower has an oil yield in tons per hectare per year of about 0.7 t/ha/yr, and soya has an oil yield in tons per hectare per year of about 0.6 t/ha/yr.

[0047] The term "monoculture" as used herein denotes the practice of growing one plant, e.g., Macaúba palm, in a field at a time. On the example of Macaúba palm, about 500 to about 600 palms can be planted per hectare. In this connection, it is preferred that the minimum distance between the tress is about 3.5 to 4.5 meters. This number varies depending on e.g., the soil. The growing of the Macaúba plants is described in the following. In the first year, growth is slower, as the major development occurs below the soil. Hence, the plant itself grows about 80 to 100 cm. From the second year onwards, when the plant size is approximately 100 to 150 cm), growth is faster and there is an increased development of the aerial part of the plant. A fully mature plant providing the claimed oil yield per hectare per year is about 5 to 6 years old.

[0048] The water consumption of the Macaúba plant is 50% lower than of palm. Macaúba plantations can be located in regions with a minimum rainfall of 1.200 mm per year.

[0049] The term "amphoteric" as used herein means that the compound contains an acidic and a basic moiety.

[0050] The term "agroforestry" as used herein denotes a land use management system in which trees or shrubs are grown around or among other plant such as other trees or other shrubs or crops or pastureland. It is to be understood that not only one further plant can be present in agroforestry. On the example of Macaúba palm, e.g., about 250 to about 360 or about 325 to about 350, trees can be planted per hectare. In this connection, suitable crops that may be planted together with Macaúba palm are exemplarily beans, mandioca, corn, cereals, sunflower, peanut, rapeseed, soya, and mixtures thereof.

[0051] The term "silvopastoral" as used herein denotes a land use management system in which trees and optionally forages are planted within the grazing of domesticated animals. On the example of Macaúba palm, e.g., about 275 to about 450 or about 375 to about 400, trees can be planted per hectare.

[0052] The term "steam cracking process" refers to a chemical reaction wherein one or more carbon bonds contained within a precursor feedstock are broken by thermal energy to split the large molecules of a precursor feedstock into shorter, preferably unsaturated molecules of a product. The term "pyrolysis" refers to a thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen); it is a form of thermolysis and comprises any terms which may be considered related or synonymous by those skilled in the art. More details on steam cracking may be found in Zimmermann, H. and Walzl, R. (2009). Ethylene. In Ullmann's Encyclopedia of Industrial Chemistry, (Ed.). https://doi.org/10.1002/14356007.a10_045.pub3, which is hereby incorporated in its entirety by reference.

[0053] The term "precursor feedstock" refers to a group of organic compounds which are supplied to the reactor where they undergo a thermochemical decomposition to be transformed into a product; preferably the precursor feedstock

comprises hydrocarbons that are split into (light) olefins by a steam cracking process. Examples of suitable precursor feedstock may be selected from the group comprising: ethane, propane, butane, LPG, (renewable) naphtha, light gas oil, vacuum gas oil, gas condensates up to, (hydrotreated) crude oil, and so on, and/or co-cracking of combinations thereof. Any feedstock exhibiting coking (depositions) would particularly benefit from the present invention.

[0054] The term "product" refers to a group of organic compounds that are obtained from the reactor after a thermochemical reaction has transformed the precursor feedstock. Preferably the product comprises (light) olefins obtained from hydrocarbons broken by a steam cracking process. Examples of desired product may be selected from the group comprising: ethylene, propylene, benzene, butadiene, and so on, and/or combinations thereof.

[0055] The term "reactor" as used herein refers to a device or structure according to the present invention for containing a chemical reaction; preferably said chemical reaction involves steam cracking for olefin production. The term "inner wall" as used herein refers to the surface area comprised within the reactor structure; preferably in contact with the space wherein a chemical reaction takes place. The term "outer wall" as used herein refers to the surface area comprised outside the reactor structure; preferably with the space wherefrom thermal energy is supplied to the reactor. Examples of varying shapes of reactor tubes may be found in van Goethem, M. W. M.; Jelsma, E., Numerical and experimental study of enhanced heat transfer and pressure drop for high temperature applications. Chem. Eng. Res. Des. 2014, 92 (4), 663-671, which is hereby incorporated in its entirety by reference.

[0056] The term "furnace" as used herein, also known as "oven", refers to a device or structure comprising one or more reactors according to the present invention for containing a chemical reaction; preferably said chemical reaction involves steam cracking for olefin production. The furnace is adapted to be suitable for (very) high-temperature heating. The general structure of a furnace is known in the art and may further comprise one or more structures configured for heating and heat distribution; for example, heating place or fireplace, a chimney, connector pipes, and so on. More details on furnace designs suitable for steam cracking may be found in Zimmermann, H. and Walzl, R. (2009). Ethylene. In Ullmann's Encyclopedia of Industrial Chemistry, (Ed.). https://doi.org/10.1002/14356007.a10_045.pub3, which is hereby incorporated in its entirety by reference.

[0057] The term "naphtha" as used herein denotes mixtures of hydrocarbons in the boiling range of 30 to 200 °C. Thereby, preferred embodiments of naphtha describe light naphthas (boiling range 30 to 90 °C), heavy naphthas (boiling range 90 to 180 °C), full range (FR) naphthas (boiling range 30 to 200 °C), and special cuts (C₆-C₈ raffinates). A natural-cut full-range naphtha contains more than 100 individual components, which can be detected individually by gas chromatography (GC). Characterization is typically based on boiling range, density, and content of paraffins (n-alkanes), isoalkanes, olefins, naphthenes, and aromatics (PIONA analysis) by carbon number. More details on naphtha may be found in Zimmermann, H. and Walzl, R. (2009). Ethylene. In Ullmann's Encyclopedia of Industrial Chemistry, (Ed.). https://doi.org/10.1002/14356007.a10_045.pub3, which is hereby incorporated in its entirety by reference.

[0058] One advantage of the present invention is that the carbon footprint of a cracking process for cracking a hydrocarbon feedstock can be significantly reduced without affecting the reliability of the cracking process, in particular without introducing coking into the process.

[0059] Another advantage of the present invention is that by addition of the Macaúba palm oil to the hydrocarbon feedstock to be cracked, the C₁₀₊ fraction of the resulting hydrocarbon composition can be significantly increased.

[0060] As indicated above, the present invention relates in one embodiment to a process for cracking a precursor feedstock comprising Macaúba palm oil.

[0061] Preferably, Macaúba palm oil is obtained by extraction of the fruits, palm pulp, and/or palm kernel of the Macaúba palm. In a preferred embodiment, the Macaúba palm is *Acrocomia hassleri*, *Acrocomia totei*, and/or *Acrocomia aculeata*, and in particular *Acrocomia aculeata*.

[0062] In a preferred embodiment, the Macaúba palm oil is extracted from the Macaúba kernel, preferably wherein the Macaúba palm is *Acrocomia hassleri*, *Acrocomia totei*, and/or *Acrocomia aculeata* and the oil is extracted from more preferably *Acrocomia hassleri* kernel, *Acrocomia totei* kernel, and/or *Acrocomia aculeata* kernel, and in particular wherein the Macaúba palm is *Acrocomia aculeata* and the oil is extracted from *Acrocomia aculeata* kernel.

[0063] In another preferred embodiment, the Macaúba palm oil is extracted from the Macaúba pulp, and in particular wherein the Macaúba palm is *Acrocomia aculeata* and the oil is extracted from *Acrocomia aculeata* pulp.

[0064] In another preferred embodiment, the Macaúba palm oil is extracted from the Macaúba pulp and kernel, and in particular wherein the Macaúba palm is *Acrocomia aculeata* and the oil is extracted from *Acrocomia aculeata* pulp and kernel.

[0065] In a preferred embodiment, the Macaúba palm can sufficiently grow under tropical and subtropical conditions.

[0066] In a preferred embodiment, the Macaúba palm can sufficiently grow in regions from the 30th parallel north to the 28th parallel south, preferably from the 25th parallel north to the 25th parallel south.

[0067] In a preferred embodiment, the Macaúba palm sufficiently grows at a temperature range of 18 to 30 °C, more preferably of 20 to 28 °C. In this connection it is to be understood that the temperature range is the average temperature over one year. Hence, the Macaúba palm is preferably less vulnerable to temperature fluctuation.

[0068] The term "sufficiently grow" as used herein denotes that the claimed oil yield is achievable under standard

cultivation.

[0069] In addition, particularly oil palms need tropical conditions and preferred temperatures between about 24 to 28 °C, monthly rainfalls of at least 100 mm/m², and a humidity between about 50 to 70%. These factors limit the possibility of a profitable cultivation.

[0070] In a preferred embodiment, the Macaúba palm provides a reduced water demand.

[0071] In a preferred embodiment, cultivating the Macaúba palm provides a reduction of the loss of biodiversity.

[0072] In a preferred embodiment, cultivating the Macaúba palm provides a reduction of loss of habitats for local tribes.

[0073] In a preferred embodiment, cultivating the Macaúba palm provides a reduction of deforestation.

[0074] In a preferred embodiment, cultivating the Macaúba palm provides an improved recovery of degraded areas and/or springs and watersheds.

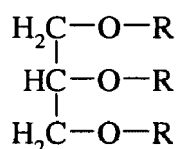
[0075] In a preferred embodiment, the cultivating Macaúba palm provides an improved retention of moisture in the soil.

[0076] In this connection it is to be understood that the above-outlined reductions or improvements are compared to plants, in particular palms, having an oil yield in tons per hectare per year of less than 6 t/ha/yr, preferably compared to the Macaúba palm.

[0077] In a preferred embodiment, the Macaúba palm oil is the crude oil, i.e., not further treated after the extraction from the Macaúba palm.

[0078] In another preferred embodiment, the Macaúba palm oil is the filtered oil, i.e., wherein the crude oil is first filtered by any known in the art filtering systems and then used in the process. A suitable filtration process is e.g., press filtration.

[0079] Macaúba palm oil is a vegetable oil. Vegetable oils are mixtures of triglycerides having the following formula:



wherein residues R are carboxyl groups of fatty acids. Vegetable oils are generally characterized by their distribution of carbon chain length of the fatty acids esterified with the triglycerol moiety.

[0080] In a preferred embodiment, the Macaúba palm oil comprises at least 45 wt.-% based on the total weight of the Macaúba palm oil, of C₄-C₂₂ fatty acids, preferably C₆-C₂₀ fatty acids, more preferably C₈-C₁₈ fatty acids, even more preferably C₁₆-C₁₈ fatty acids, and in particular C₁₀-C₁₆ fatty acids, C₁₂-C₁₄ fatty acids.

[0081] In a preferred embodiment, the Macaúba palm oil comprises at least 85 wt.-% based on the total weight of the Macaúba palm oil, of C₄-C₂₂ fatty acids, preferably C₁₀-C₂₂ fatty acids, more preferably C₁₂-C₂₀ fatty acids, and in particular C₁₂-C₁₈ fatty acids.

[0082] In a preferred embodiment, the Macaúba palm oil comprises at least 10 wt.-% of C₁₆ fatty acids and at least 75 wt.-% of C₁₈ fatty acids, each based on the total weight of the Macaúba palm oil.

[0083] In a preferred embodiment, the Macaúba palm oil comprises 10 to 25 wt.-% of C₁₆ fatty acids and 75 to 90 wt.-% of C₁₈ fatty acids, each based on the total weight of the Macaúba palm oil.

[0084] In a preferred embodiment, the Macaúba palm oil comprises at least 80 wt.-%, preferably at least 90 wt.-%, and in particular at least 95 wt.-%, based on the total weight of the Macaúba palm oil, of C₁₂-C₁₄ fatty acids.

[0085] In a preferred embodiment, the Macaúba palm oil comprises at least 80 wt.-%, preferably at least 90 wt.-%, and in particular at least 95 wt.-%, based on the total weight of the Macaúba palm oil, of C₁₂-C₁₈ fatty acids.

[0086] In a preferred embodiment, the Macaúba palm oil comprises at least 2 wt.-% of C₁₀ fatty acids, at least 35 wt.-% of C₁₂ fatty acids, at least 5 wt.-% of C₁₄ fatty acids, and at least 4 wt.-% of C₁₆ fatty acids, each based on the total weight of the Macaúba palm oil.

[0087] In a preferred embodiment, the Macaúba palm oil comprises 3 to 7 wt.-% of C₈ fatty acids, 2 to 6 wt.-% of C₁₀ fatty acids, 35 to 45 wt.-% of C₁₂ fatty acids, 5 to 13 wt.-% of C₁₄ fatty acids, and 4 to 10 wt.-% of C₁₆ fatty acids, each based on the total weight of the Macaúba palm oil.

[0088] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₈ fatty acids, based on the total weight of the Macaúba palm oil.

[0089] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₀ fatty acids, based on the total weight of the Macaúba palm oil.

[0090] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₂ fatty acids, based on the total weight of the Macaúba palm oil.

[0091] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₄ fatty acids, based on the total weight of the Macaúba palm oil.

[0092] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₆ fatty acids, based on the total weight of the Macaúba palm oil.

[0093] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₈ fatty acids, based on the total weight of the Macaúba palm oil.

[0094] In a preferred embodiment, the Macaúba palm has an oil yield in tons per hectare per year in the range of at least 7 t/ha/yr, preferably at least 8 t/ha/yr.

[0095] In a preferred embodiment, the Macaúba palm has an oil yield in tons per hectare per year in the range of 6 to 30 t/ha/yr, preferably 7 to 20 t/ha/yr, more preferably of 8 to 15 t/ha/yr or of 8 to 12 t/ha/yr or of 8 to 11 t/ha/yr.

[0096] In a preferred embodiment, the Macaúba palm oil comprises

1 to 20 wt.-% of a C₈ fatty acid,

1 to 8 wt.-% of a C₁₀ fatty acid,

30 to 48 wt.-% of a C₁₂ fatty acid,

5 to 15 wt.-% of a C₁₄ fatty acid,

4 to 13 wt.-% of a C₁₆ fatty acid,

15 to 42 wt.-% of a C₁₈ fatty acid, and

0 to 5 wt.-% of a C₂₀ fatty acid,

each based on the total weight of the Macaúba palm oil. Said Macaúba palm oil is preferably extracted from Macaúba kernel.

[0097] In a preferred embodiment, the Macaúba palm oil comprises

3 to 7 wt.-%, preferably 4 to 6 wt.-%, of a C₈ fatty acid,

2 to 6 wt.-%, preferably 3 to 5 wt.-%, of a C₁₀ fatty acid,

36 to 46 wt.-%, preferably 38 to 42 wt.-%, of a C₁₂ fatty acid,

6 to 13 wt.-%, preferably 8 to 11 wt.-%, of a C₁₄ fatty acid,

5 to 11 wt.-%, preferably 6 to 9 wt.-%, of a C₁₆ fatty acid,

25 to 40 wt.-%, preferably 30 to 38 wt.-% of a C₁₈ fatty acid, and

0 to 4 wt.-%, preferably 0 to 3 wt.-%, of a C₂₀ fatty acid,

each based on the total weight of the Macaúba palm oil. Said Macaúba palm oil is preferably extracted from Macaúba kernel.

[0098] In a preferred embodiment, the Macaúba palm oil comprises

0 to 5 wt.-%, preferably 0 to 3 wt.-%, and in particular 0 to 2 wt.-%, of a C₁₀ fatty acid,

0 to 6 wt.-%, preferably 0 to 5 wt.-%, and in particular 1 to 4 wt.-%, of a C₁₂ fatty acid,

0 to 6 wt.-%, preferably 0 to 5 wt.-%, and in particular 1 to 4 wt.-%, of a C₁₄ fatty acid,

10 to 35 wt.-%, preferably 13 to 32 wt.-%, and in particular 15 to 30 wt.-%, of a C₁₆ fatty acid,

55 to 85 wt.-%, preferably 60 to 80 wt.-%, and in particular 65 to 75 wt.-%, of a C₁₈ fatty acid,

0 to 4 wt.-%, preferably 0 to 3 wt.-%, and in particular 0 to 2 wt.-%, of a C₂₀ fatty acid,

each based on the total weight of the Macaúba palm oil. Said Macaúba palm oil is preferably extracted from Macaúba pulp.

[0099] In a preferred embodiment, the Macaúba palm oil comprises

0.1 to 10 wt.-% of a C₆ fatty acid,

1 to 20 wt.-% of a C₈ fatty acid,

1 to 8 wt.-% of a C₁₀ fatty acid,

30 to 48 wt.-% of a C₁₂ fatty acid,

5 to 15 wt.-% of a C₁₄ fatty acid,

4 to 13 wt.-% of a C₁₆ fatty acid,

15 to 42 wt.-% of a C₁₈ fatty acid, and

0 to 5 wt.-% of a C₂₀ fatty acid,

each based on the total weight of the Macaúba palm oil. Said Macaúba palm oil is preferably extracted from Macaúba kernel.

[0100] In a preferred embodiment, the Macaúba palm oil comprises

0.2 to 4 wt.-%, preferably 0.4 to 1.5 wt.-%, of a C₆ fatty acid,

3 to 7 wt.-%, preferably 4 to 6 wt.-%, of a C₈ fatty acid,

2 to 6 wt.-%, preferably 3 to 5 wt.-%, of a C₁₀ fatty acid,
 36 to 46 wt.-%, preferably 38 to 42 wt.-%, of a C₁₂ fatty acid,
 6 to 13 wt.-%, preferably 8 to 11 wt.-%, of a C₁₄ fatty acid,
 5 to 11 wt.-%, preferably 6 to 9 wt.-%, of a C₁₆ fatty acid,
 25 to 40 wt.-%, preferably 30 to 38 wt.-% of a C₁₈ fatty acid, and
 0 to 4 wt.-%, preferably 0 to 3 wt.-%, of a C₂₀ fatty acid,
 each based on the total weight of the Macaúba palm oil. Said Macaúba palm oil is preferably extracted from Macaúba kernel.

[0101] In a preferred embodiment, the Macaúba palm oil comprises at least 45 wt.-% based on the total weight of the Macaúba palm oil, of C₄-C₂₂ fatty acids, preferably C₆-C₂₀ fatty acids, more preferably C₈-C₁₈ fatty acids, even more preferably C₈-C₁₆ fatty acids, C₁₆-C₁₈ fatty acids, and in particular C₁₀-C₁₆ fatty acids, C₁₂-C₁₄ fatty acids.

[0102] In a preferred embodiment, the Macaúba palm oil comprises at least 85 wt.-% based on the total weight of the Macaúba palm oil, of C₄-C₂₂ fatty acids, preferably C₁₀-C₂₂ fatty acids, more preferably C₁₂-C₂₀ fatty acids, even more preferably C₁₂-C₂₀ fatty acids, and in particular C₁₂-C₁₈ fatty acids.

[0103] In a preferred embodiment, the Macaúba palm oil comprises at least 10 wt.-% of C₁₆ fatty acids and at least 75 wt.-% of C₁₈ fatty acids, each based on the total weight of the Macaúba palm oil.

[0104] In a preferred embodiment, the Macaúba palm oil comprises 10 to 25 wt.-% of C₁₆ fatty acids and 75 to 90 wt.-% of C₁₈ fatty acids, each based on the total weight of the Macaúba palm oil.

[0105] In a preferred embodiment, the Macaúba palm oil comprises at least 80 wt.-%, preferably at least 90 wt.-%, and in particular at least 95 wt.-%, based on the total weight of the Macaúba palm oil, of C₁₂₋₁₄ fatty acids.

[0106] In a preferred embodiment, the Macaúba palm oil comprises at least 80 wt.-%, preferably at least 90 wt.-%, and in particular at least 95 wt.-%, based on the total weight of the Macaúba palm oil, of C₁₂₋₁₈ fatty acids.

[0107] In a preferred embodiment, the Macaúba palm oil comprises at least 2 wt.-% of C₁₀ fatty acids, at least 35 wt.-% of C₁₂ fatty acids, at least 5 wt.-% of C₁₄ fatty acids, and at least 4 wt.-% of C₁₆ fatty acids, each based on the total weight of the Macaúba palm oil.

[0108] In a preferred embodiment, the Macaúba palm oil comprises 3 to 7 wt.-% of C₈ fatty acids, 2 to 6 wt.-% of C₁₀ fatty acids, 35 to 45 wt.-% of C₁₂ fatty acids, 5 to 13 wt.-% of C₁₄ fatty acids, and 4 to 10 wt.-% of C₁₆ fatty acids, each based on the total weight of the Macaúba palm oil.

[0109] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₈ fatty acids, based on the total weight of the Macaúba palm oil.

[0110] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₀ fatty acids, based on the total weight of the Macaúba palm oil.

[0111] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₂ fatty acids, based on the total weight of the Macaúba palm oil.

[0112] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₄ fatty acids, based on the total weight of the Macaúba palm oil.

[0113] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₆ fatty acids, based on the total weight of the Macaúba palm oil.

[0114] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₁₈ fatty acids, based on the total weight of the Macaúba palm oil.

[0115] In a preferred embodiment, the Macaúba palm oil comprises 0.2 to 4 wt.-% of C₆ fatty acids, 3 to 7 wt.-% of C₈ fatty acids, 2 to 6 wt.-% of C₁₀ fatty acids, 35 to 45 wt.-% of C₁₂ fatty acids, 5 to 13 wt.-% of C₁₄ fatty acids, and 4 to 10 wt.-% of C₁₆ fatty acids, each based on the total weight of the Macaúba palm oil.

[0116] In a preferred embodiment, the Macaúba palm oil comprises at least 90 wt.-% of C₆ fatty acids, based on the total weight of the Macaúba palm oil.

[0117] In a preferred embodiment, the Macaúba palm oil comprises at least 95 wt.-%, based on the total weight of the Macaúba palm oil, of C₁₂₋₁₄ fatty acids, and further comprises 36 to 46 wt.-%, preferably 38 to 42 wt.-%, of a C₁₂ fatty acids, and 6 to 13 wt.-%, preferably 8 to 11 wt.-%, of a C₁₄ fatty acids, each based on the total weight of the Macaúba palm oil.

[0118] The step of cracking of the process of the present invention is preferably selected from the list consisting of pyrolysis, thermal cracking, or steam cracking. Most preferably, the step of cracking is a step of steam cracking.

[0119] Preferably, the Macaúba oil of the precursor feedstock has not undergone any further pretreatment step and/or refinement step.

[0120] In a steam cracking step, a gaseous or liquid hydrocarbon feed like naphtha, LPG, propane, or ethane is diluted with steam and briefly heated in a furnace in the absence of oxygen. The reaction occurs rapidly: the residence time is on the order of milliseconds. Flow rates approach the speed of sound. After the cracking temperature has been reached, the gas is usually quenched to stop the reaction in a transfer line heat exchanger or inside a quenching header using quench oil.

[0121] A precursor feedstock is usually introduced as a stream and is heated by heat exchange against flue gas in the convection section. Subsequently or in parallel, the heated precursor feedstock is mixed with steam and further heated to reach a first cracking temperature. Preferably, the first cracking temperature is in the range of from 500 to 680 °C, more preferably 550 to 630 °C.

[0122] In a subsequent step, the heated and steam treated stream enters a reactor, preferably a tubular reactor, most preferably a radiant tube or radiant coil. Under controlled residence time, temperature profile, and partial pressure, the stream is heated in the reactor from 500 to 680 °C to a temperature in the range of from 700 °C to 900 °C, more preferably of from 750 °C to 850 °C, and most preferably of from 780 °C to 820 °C, for 0.1-0.5 s. During this short reaction time hydrocarbons in the feedstock are cracked into smaller molecules, ethylene, other olefins, and diolefins are the major products. Since the conversion of saturated hydrocarbons to olefins in the radiant tube is highly endothermic, high energy input rates are needed. The reaction products leaving the reactor are preferably cooled to 550 to 650 °C within 0.02-0.1 s to prevent degradation of the highly reactive products by secondary reactions.

[0123] The resulting product mixtures are preferably subsequently separated into the desired products by using a sequence of separation and chemical-treatment steps. The cooling of the cracked gas is preferably carried out in the transfer-line exchanger by vaporization of highpressure boiler feed water (BFW, p ¼ 6-12 MPa).

[0124] The product is usually a mixture of hydrocarbon, the composition of which can be mainly adjusted by three parameters: residence time of the stream in the reactor, partial pressure of the stream, temperature and temperature profiles within the reactor.

[0125] Typically, a long residence time favors the so called secondary reactions, thereby producing secondary products, which are C₄₋₇₊ products and aromatics, whereas a short residence time increases the yields of the so called primary products, such as ethylene and propylene, but also acetylene, hydrogen, and methane.

[0126] Since most of the secondary products result from reactions in which the number of molecules decreases, increasing the pressure favors the secondary products. One function of the steam present in the system is to reduce the hydrocarbon partial pressure and thus favor the formation of primary products. Thus, lower partial pressure or higher steam concentrations lead to higher yields of primary products.

[0127] Oligomerization involved in the reactions leading to the secondary products are favored by lower temperatures. Therefore, higher temperatures are applied in case primary products should be achieved. Preferably, in the reactor the temperature of the reactant increases continuously from the inlet to the outlet. Typical inlet temperatures are 500 to 680 °C. Typical outlet temperatures are 775 to 875 °C.

[0128] Preferably, in the process according to the present invention, the step of cracking is carried out at a coil outlet pressure of 1.65 to 2.25 bar. Also preferably, the ratio of the weight of steam to the weight of precursor feedstock is in the range of from 0.4 to 0.5. Increased steam dilution lowers the hydrocarbon partial pressure, thereby enhancing olefin yield. It also reduces the partial pressure of high-boiling, high-molecular-mass aromatics and heavy tarry materials, reducing the deposition of coke in the reactor.

[0129] The step of cracking typically uses high temperatures. Preferably, in the process according to the present invention, the step of cracking is carried out at a temperature in the range of from 700 °C to 900 °C, more preferably of from 750 °C to 850 °C, and most preferably of from 780 °C to 820 °C. This range is in particular useful for cracking the precursor feedstock of the present invention comprising Macaúba palm oil.

[0130] Preferably, the precursor feedstock comprises a second source of hydrocarbons. More preferably, the second source of hydrocarbons is selected from naphtha, gas oil, crude petroleum, liquified petroleum gas, and natural gas liquids. Most preferably the second hydrocarbon source is naphtha. Hence, preferably, the Macaúba palm oil is diluted in the second hydrocarbon source. Preferably, the Macaúba palm oil is present in the precursor feedstock in an amount of at least 5 wt.-% with respect to the total weight of the precursor feedstock, preferably at least 10 wt.-%, and most preferably at least 20 wt.-%. Typically, the Macaúba palm oil is present in the precursor feedstock in an amount of not higher than 90 wt.-% with respect to the total weight of the precursor feedstock, more preferably not higher than 80 wt.-%, and most preferably not higher than 40 wt.-%.

[0131] If the amount of Macaúba palm oil is too low, the sustainability effect will not be significant. On the other hand, if the amount of Macaúba palm oil is too high, the melting point of the precursor feedstock is decreased. Most preferably, the precursor feedstock consists of the second hydrocarbon source and the Macaúba palm oil. Hence, most preferably, no other components are present in the precursor feedstock.

[0132] Hence, the present invention is related with the use of Macaúba palm oil in a precursor feedstock for a cracking process according to any of the preceding embodiments.

[0133] As shown in the examples, the product produced by the process of the present invention has a specific composition. It is most remarkable that the C₁₀₊ amount is higher than for pure naphtha. Hence, preferably, the composition obtainable by the process of the present invention has a higher amount of C₁₀₊ hydrocarbons than a composition produced by a similar process without Macaúba palm oil. More preferably, the composition obtainable by the process according to present invention comprises C₅ to C₉ hydrocarbons in an amount in the range of from 25 to 26 wt.-%, and C₁₀ and higher hydrocarbons in an amount in the range of from 4 to 5 wt.-%.

[0134] More preferably, the composition obtainable by the process of the present invention comprises acetylene in an amount in the range of from 0.05 to 0.8 wt.-%, preferably 0.1 to 0.2 wt.-%, ethylene in an amount in the range of from 20 to 30 wt.-%, preferably 20 to 25 wt.-%, and ethane in an amount in the range of from 3 to 6 wt.-%, preferably 4 to 5 wt.-%.

[0135] Even more preferably, the composition obtainable by the process of the present invention further comprises propyne in an amount in the range of from 0.5 to 1.3 wt.-%, propylene in an amount in the range of from 16 to 18 wt.-%, propane in an amount in the range of from 0.5 to 0.7 wt.-%.

[0136] The composition obtainable by the process of the present invention further preferably comprises butatriene and/or vinylacetylene in an amount in the range of from 0.005 to 0.02 wt.-%, butadiene in an amount in the range of from 3 to 6 wt.-%, preferably 4 to 5 wt.-%, butylene in an amount in the range of from 4 to 7 wt.-%, preferably 6 to 7 wt.-%, and butane in an amount in the range of from 1 to 2 wt.-%.

[0137] Finally, the composition obtainable by the process of the present invention further preferably comprises hydrogen in an amount in the range of from 0.5 to 0.8 wt.-%, methane in an amount in the range of from 12 to 13 wt.-%, carbon monoxide in an amount in the range of from 0.05 to 0.1 wt.-%, and carbon dioxide in an amount in the range of from 0.005 to 0.01 wt.-%.

[0138] Typically, the composition obtainable by the process of the present invention further comprises benzene in an amount in the range of from 5 to 7 wt.-%, toluene in an amount in the range of from 2 to 4 wt.-%, xylenes in an amount in the range of from 0.8 to 1.2 wt.-%, ethylbenzene in an amount in the range of from 0.6 to 0.8 wt.-%, and/or styrene in an amount in the range of from 0.8 to 1.1 wt.-%,

[0139] Moreover, the composition obtainable by the process of the present invention further comprises methylacetate in an amount in the range of from 0.15 to 0.19 wt.-%, and propadiene in an amount in the range of from 0.1 to 0.15 wt.-%.

Experimental Part

[0140] The present invention is further illustrated by the following examples.

Calculation Methods

a) Calculations

[0141] Simulations were performed using the Spyro Suite 7 software, which is a program for offline simulation of steam cracking furnace operations. This program allows engineers to predict the product yields for a wide range of hydrocarbon feedstocks at any operating conditions.

b) Reactor geometry

[0142] The calculations were carried out for a geometry being of the single-pass Millisecond type, with a reactor diameter of 30.2mm and length of 10.56m.

c) Composition of the naphtha

[0143] The composition of the naphtha as used in the examples is indicated in Table 1.

Table 1

Component	wt.-%
C ₄	0.06
C ₅	0.95
benzol	0.03
further C ₆	0.22
toluol	0.03
further C ₈	0.46
C ₁₃	0.26
C ₁₄	0.06
C ₁₅	0.10

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(continued)

Component	wt.-%
C ₁₆	17.99
C ₁₇	0.51
C ₁₈	1.07
C ₁₉	2.47
C ₂₀	18.82
C ₂₁	0.34
C ₂₂	4.17
C ₂₃	7.78
C ₂₄	1.68
C ₂₅	27.32
C ₂₆	0.17
C ₂₇	0.30
C ₂₈	1.30
C ₂₉	0.36
C ₃₀ + higher	13.57

d) Composition of the Macaúba palm oil

[0144] The composition of the Macaúba palm oil as used in the examples is indicated in Table 2.

Table 2

Component	wt.-%
i-Pentane	0.56
Isoprene	0.015
n-C ₆	0.013
Benzene	0.021
other C ₆	0.013
Toluene	0.189
other C ₇	0.041
n-C ₈	0.027
other C ₈	0.014
C ₁₂	0.801
C ₁₃	0.125
Anthracene	0.028
other C ₁₄ -	0.827
C ₁₅ -	0.101
Fluoranthene	0.301
Pyrene	0.223
other C ₁₆	7.797
C ₁₇	0.381
C ₁₈	1.56

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(continued)

Component	wt.-%
C ₁₉	0.213
C ₂₀	2.006
C ₂₁	4.232
C ₂₂	0.607
C ₂₃	0.918
C ₂₄	0.118
C ₂₅	0.258
C ₂₇	1.357
C ₂₈	0.107
C ₂₉	0.917
C ₃₀ + higher	76.232

Examples

[0145] In Comparative Example 1 (CE1) the cracking process has been calculated with pure naphtha as precursor feedstock, while in Inventive Example 1 (IE1), 10 wt.-% Macaúba palm oil were added to the feedstock. In both examples a COT of 800 °C has been used.

[0146] Table 3 lists the obtained results: It can be seen that the composition of the cracked feedstock has higher C₁₀+ amounts in case Macaúba palm oil is used for the feedstock. Furthermore, the examples show that no coking occurs during cracking even though no pretreatment step has been performed. Hence, adding Macaúba palm oil to the feedstock reduces the carbon footprint of a cracking process without disturbing the cracking process. Furthermore, it can be seen that species based on sulfur and/or nitrogen are not present in the composition of the cracked feedstock.

Table 3: Resulting composition of the cracked feedstock of CE1 and IE1

		CE1		IE1	
		wt%	mol. %	wt%	mol. %
Hydrogen	H ₂	0.717919	11.59700 0	0.682520	11.199000
Methan	CH ₄	12.70900 0	25.79900 0	12.21300 0	25.183000
Ethin	C ₂ H ₂	0.149136	0.186537	0.146931	0.186679
Ethene	C ₂ H ₄	22.04600 0	25.59200 0	22.30400 0	26.301000
Ethane	C ₂ H ₆	4.182000	4.529000	4.217000	4.639000
Methylacetate	C ₃ H ₆ O ₂	0.218830	0.177881	0.213151	0.176000
Propadiene	C ₃ H ₄	0.145837	0.118547	0.142052	0.117293
Propene	C ₃ H ₆	16.78300 0	12.98900 0	16.71400 0	13.140000
Propane	C ₃ H ₈	0.633621	0.467956	0.635690	0.476895
Butatriene / Vinylacetylene	C ₄ H ₄	0.018640	0.011657	0.018642	0.011843
Butadiene	C ₄ H ₆	4.501000	2.710000	4.581000	2.802000
Butene	C ₄ H ₈	6.810008	3.958000	6.661000	3.927000
Butane	C ₄ H ₁₀	1.434000	0.803623	1.348000	0.767214
C ₅ to C ₉	C ₅₋₉	26.58300 0	10.45100 0	25.77600 0	10.313000
C₁₀ and higher	C₁₀+	2.966000	0.503540	4.253000	0.652223
Carbon monoxide	CO	0.085832	0.099791	0.086071	0.101648

(continued)

		CE1		IE1	
		wt%	mol. %	wt%	mol. %
Carbon dioxide	CO ₂	0.008435	0.006241	0.008429	0.006336

Claims

1. A process for producing a hydrocarbon composition, the process comprising the step of cracking a precursor feedstock comprising Macaúba palm oil.
2. The process according to claim 1, wherein the Macaúba palm oil is obtained by extraction of the fruits, palm pulp, and/or palm kernel of the Macaúba palm, preferably *Acrocomia aculeata*, preferably is extracted from the palm pulp and/or the palm kernel of the Macaúba palm, preferably *Acrocomia aculeata*, more preferably is extracted from the palm kernel of the Macaúba palm, preferably *Acrocomia aculeata*.
3. The process according to claims 1 or 2, wherein the step of cracking is selected from the list consisting of a pyrolysis, thermal cracking, or steam cracking.
4. The process according to any of the preceding claims, wherein the Macaúba oil of the precursor feedstock has not undergone a pretreatment step and/or refining step.
5. The process according to any of the preceding claim, wherein the step of cracking is carried out at a temperature in the range of from 700 °C to 900 °C, preferably of from 750 °C to 850 °C, and most preferably of from 780 °C to 820 °C.
6. The process according to any of the preceding claims, wherein the precursor feedstock comprises a second source of hydrocarbons.
7. The process according to claim 6, wherein the second source of hydrocarbons is selected from naphtha, gas oil, crude petroleum, and liquified petroleum gas, preferably is naphtha.
8. The process according to claims 6 or 7, wherein the precursor feedstock consists of the second hydrocarbon source and the Macaúba palm oil.
9. The process according to claims 6 to 7, wherein the Macaúba palm oil is present in the precursor feedstock in an amount of at least 5 wt.-% with respect to the total weight of the precursor feedstock, preferably at least 10 wt.-%, and most preferably at least 20 wt.-%.
10. Use of Macaúba palm oil in a feedstock for a cracking process according to any of claims 1 to 9.
11. A composition obtainable by a process according to claims 1 to 9, wherein the composition further comprises C₅ to C₉ hydrocarbons in an amount in the range of from 25 to 26 wt.-%, and C₁₀ and higher hydrocarbons in an amount in the range of from 4 to 5 wt.-%.
12. The composition according to claim 11, wherein the composition comprises acetylene in an amount in the range of from 0.1 to 0.2 wt.-%, ethylene in an amount in the range of from 20 to 25 wt.-%, and ethane in an amount in the range of from 4 to 5 wt.-%.
13. The composition according to claims 11 or 12, wherein the composition further comprises propylene in an amount in the range of from 16 to 18 wt.-%, propane in an amount in the range of from 0.5 to 0.7 wt.-%.
14. The composition according to any of the preceding claims 11 to 13, wherein the composition further comprises butatriene and/or vinylacetylene in an amount in the range of from 0.005 to 0.02 wt.-%, butadiene in an amount in the range of from 4 to 5 wt.-%, butylene in an amount in the range of from 6 to 7 wt.-%, and butane in an amount in the range of from 1 to 2 wt.-%.

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15. The composition according to any of the preceding claims 11 to 14, wherein the composition further comprises hydrogen in an amount in the range of from 0.5 to 0.8 wt.-%, methane in an amount in the range of from 12 to 13 wt.-%, carbon monoxide in an amount in the range of from 0.05 to 0.1 wt.-%, and carbon dioxide in an amount in the range of from 0.005 to 0.01 wt.-%.

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EUROPEAN SEARCH REPORT

Application Number

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		8 February 2024	Ruiz Martínez, C
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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