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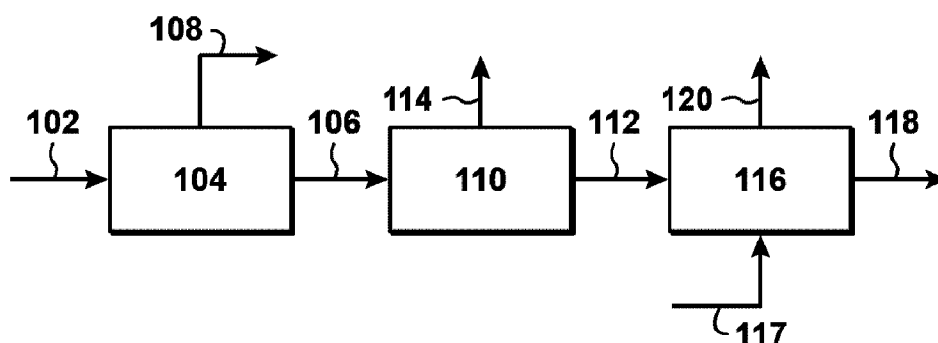
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(54) **Titre : VALORISATION D'UNE CHARGE D'ALIMENTATION D'HYDROCARBURES LOURDS ET PRODUCTION D'UNE FRACTION DE PAS**

(54) **Title: UPGRADING A HEAVY HYDROCARBON FEEDSTOCK AND PRODUCING A PITCH FRACTION**



(57) **Abbrégé/Abstract:**

A disclosed method comprises providing a heavy hydrocarbon feedstock comprising paraffinic froth treated bitumen and/or solvent de-asphalted bitumen; thermally cracking the heavy hydrocarbon feedstock to produce a cracked stream and a gas; distilling the cracked stream to produce a distillation bottoms stream and a naphtha and distillates stream; and de-asphalting the distillation bottoms stream to produce a pitch fraction and de-asphalted oil (DAO).

ABSTRACT

A disclosed method comprises providing a heavy hydrocarbon feedstock comprising paraffinic froth treated bitumen and/or solvent de-asphalted bitumen; thermally cracking the heavy hydrocarbon feedstock to produce a cracked stream and a gas; distilling the cracked stream to produce a distillation bottoms stream and a naphtha and distillates stream; and de-asphalting the distillation bottoms stream to produce a pitch fraction and de-asphalted oil (DAO).

UPGRADING A HEAVY HYDROCARBON FEEDSTOCK AND PRODUCING A PITCH FRACTION

BACKGROUND

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Field of Disclosure

[0001] The disclosure relates generally to the field of oil sand processing, and more particularly to heavy hydrocarbon feedstock upgrading.

Description of Related Art

10 [0002] This section is intended to introduce various aspects of the art, which may be associated with the present disclosure. This discussion is believed to assist in providing a framework to facilitate a better understanding of particular aspects of the present disclosure. Accordingly, it should be understood that this section should be read in this light, and not
15 necessarily as admissions of prior art.

[0003] Modern society is greatly dependent on the use of hydrocarbon resources for fuels and chemical feedstocks. Hydrocarbons are generally found in subsurface formations that can be termed “reservoirs”. Removing hydrocarbons from the reservoirs depends on numerous physical properties of the subsurface formations, such as the permeability of the
20 rock containing the hydrocarbons, the ability of the hydrocarbons to flow through the subsurface formations, and the proportion of hydrocarbons present, among other things. Easily harvested sources of hydrocarbons are dwindling, leaving less accessible sources to satisfy future energy needs. As the costs of hydrocarbons increase, the less accessible sources become more economically attractive.

25 [0004] Recently, the harvesting of oil sand to remove heavy oil has become more economical. Hydrocarbon removal from oil sand may be performed by several techniques. For example, a well can be drilled to an oil sand reservoir and steam, hot air, solvents, or a combination thereof, can be injected to release the hydrocarbons. The released hydrocarbons may be collected by wells and brought to the surface. In another technique, strip or surface

mining may be performed to access the oil sand, which can be treated with water, steam or solvents to extract the heavy oil.

[0005] Oil sand extraction processes are used to liberate and separate bitumen from oil sand so that the bitumen can be further processed to produce synthetic crude oil or mixed with diluent to form “dilbit” and be transported to a refinery plant. Numerous oil sand extraction processes have been developed and commercialized, many of which involve the use of water as a processing medium. Where the oil sand is treated with water, the technique may be referred to as water-based extraction (WBE) or as a water-based oil sand extraction process. WBE is a commonly used process to extract bitumen from mined oil sand.

[0006] One WBE process is the Clark hot water extraction process (the “Clark Process”). This process typically requires that mined oil sand be conditioned for extraction by being crushed to a desired lump size and then combined with hot water and perhaps other agents to form a conditioned slurry of water and crushed oil sand. In the Clark Process, an amount of sodium hydroxide (caustic) may be added to the slurry to increase the slurry pH, which enhances the liberation and separation of bitumen from the oil sand. Other WBE processes may use other temperatures and may include other conditioning agents, which are added to the oil sand slurry, or may operate without conditioning agents. This slurry is first processed in a Primary Separation Cell (PSC), also known as a Primary Separation Vessel (PSV), to extract the bitumen from the slurry.

[0007] In one WBE process, a water and oil sand slurry is separated into three major streams in the PSC: bitumen froth, middlings, and a PSC underflow (also referred to as coarse sand tailings (CST)).

[0008] Regardless of the type of WBE process employed, the process will typically result in the production of a bitumen froth that requires treatment with a solvent. For example, in the Clark Process, a bitumen froth stream comprises bitumen, solids, and water. Certain processes use naphtha to dilute bitumen froth before separating the product bitumen by centrifugation. These processes are called naphtha froth treatment (NFT) processes. Other processes use a paraffinic solvent, and are called paraffinic froth treatment (PFT) processes, to produce pipelineable bitumen with low levels of solids and water. In the PFT process, a paraffinic solvent is used to dilute the froth before separating the product, diluted bitumen, by

gravity. A portion of the asphaltenes in the bitumen is also rejected by design in the PFT process and this rejection is used to achieve reduced solids and water levels. In both the NFT and the PFT processes, the diluted tailings (comprising water, solids and some hydrocarbon) are separated from the diluted product bitumen.

5 **[0009]** Solvent is typically recovered from the diluted product bitumen component before the bitumen is delivered to a refining facility for further processing.

[0010] The PFT process may comprise at least three units: Froth Separation Unit (FSU), Solvent Recovery Unit (SRU) and Tailings Solvent Recovery Unit (TSRU). Mixing of the solvent with the feed bitumen froth may be carried out counter-currently in two stages
10 in separate froth separation units. The bitumen froth comprises bitumen, water, and solids. A typical composition of bitumen froth is about 60 wt. % bitumen, 30 wt. % water, and 10 wt. % solids. The paraffinic solvent is used to dilute the froth before separating the product bitumen by gravity. The foregoing is only an example of a PFT process and the values are provided by way of example only. An example of a PFT process is described in Canadian
15 Patent No. 2,587,166 to Sury.

[0011] From the PSC, the middlings, which may comprise bitumen and about 10-30 wt. % solids, or about 20-25 wt. % solids, based on the total wt. % of the middlings, is withdrawn and sent to the flotation cells to further recover bitumen. The middlings are processed by bubbling air through the slurry and creating a bitumen froth, which is recycled
20 back to the PSC. Flotation tailings (FT) from the flotation cells, comprising mostly solids and water, are sent for further treatment or disposed in an external tailings area (ETA).

[0012] Oil sands bitumen, produced in Western Canada, is extremely viscous (viscosity >100,000 cSt) and requires blending with a substantial amount of diluent (25-40 volume %) to meet pipeline viscosity specification. Diluent addition represents a significant
25 cost to bitumen producers. Due to the significant cost of diluent, as well as the bitumen/diluent (dilbit) blend's quality debit, partial upgrading of bitumen is desirable.

[0013] By definition, 'full' bitumen upgrading entails converting bitumen (via thermal or catalytic process, such as coking, hydrocracking, fluid catalytic cracking (FCC), etc.) into synthetic crude oil (SCO), which contains no resid (1050°F+) boiling range molecules.
30 'Partial' upgrading, on the other hand, is defined as any combination of processing steps to

convert bitumen/heavy oil to an oil product with sufficient fluidity to enable pipeline transport with significantly reduced (or no) diluent addition.

[0014] Table 1 provides pipeline specifications to transport crude oil from Alberta.

Table 1 – Pipeline specifications to transport crude oil from Alberta

Property	Specification
Viscosity	≤ 350 cSt at pipeline temp
Density, kg/m ³	≤ 940
Gravity °API	≥ 19
Base sediment & water	< 0.5 vol%
Olefin content	< 1 wt%

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[0015] Bitumen has an extremely low H/C ratio and can have up to 50% resid (1050F+) fraction. Carbon rejection methods (e.g. coking, deasphalting) are proven for upgrading, but come with challenges (e.g. lower liquid yields). Hydrogen addition methods (e.g. fixed-bed hydro-processing, slurry hydrocracking), on the other hand, increase yields but are expensive and require H₂ production and sulfur management facilities. These ancillary processes can cause upgrading to be economically infeasible (due to higher capital). Therefore, while full/partial upgrading provides significant quality uplift and produces a lower viscosity and density crude oil, the costs association with building an upgrader may be high or prohibitive. Thus, there remains a need for alternative methods of upgrading bitumen.

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SUMMARY

[0016] A disclosed method comprises providing a heavy hydrocarbon feedstock comprising paraffinic froth treated bitumen and/or solvent de-asphalted bitumen; thermally cracking the heavy hydrocarbon feedstock to produce a cracked stream and a gas; distilling the cracked stream to produce (i) a distillation bottoms stream and (ii) a naphtha and distillates stream; and de-asphalting the distillation bottoms stream to produce a pitch fraction and de-asphalted oil (DAO).

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[0017] The foregoing has broadly outlined the features of the present disclosure so that the detailed description that follows may be better understood. Additional features will also be described herein.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0018] These and other features, aspects and advantages of the disclosure will become apparent from the following description, appending claims and the accompanying drawing, which is briefly described below.

[0019] Figure 1 is a schematic of a process configuration of a disclosed process.

10 [0020] Figure 2 is a schematic of a process configuration of a disclosed process.

[0021] It should be noted that these figures are merely examples and no limitations on the scope of the present disclosure is intended thereby. Further, the figures are generally not drawn to scale, but are drafted for purposes of convenience and clarity in illustrating various aspects of the disclosure.

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DETAILED DESCRIPTION

[0022] For the purpose of promoting an understanding of the principles of the disclosure, reference will now be made to the features illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no
20 limitation of the scope of the disclosure is thereby intended. Any alterations and further modifications, and any further applications of the principles of the disclosure as described herein are contemplated as would normally occur to one skilled in the art to which the disclosure relates. It will be apparent to those skilled in the relevant art that some features that are not relevant to the present disclosure may not be shown in the drawings for the sake of
25 clarity.

[0023] At the outset, for ease of reference, certain terms used in this application and their meaning as used in this context are set forth below. To the extent a term used herein is not defined below, it should be given the broadest definition persons in the pertinent art have given that term as reflected in at least one printed publication or issued patent. Further, the
30 present processes are not limited by the usage of the terms shown below, as all equivalents,

synonyms, new developments and terms or processes that serve the same or a similar purpose are considered to be within the scope of the present disclosure.

[0024] Throughout this disclosure, where a range is used, any number between or inclusive of the range is implied.

5 **[0025]** A “hydrocarbon” is an organic compound that primarily includes the elements of hydrogen and carbon, although nitrogen, sulfur, oxygen, metals, or any number of other elements may be present in small amounts. Hydrocarbons generally refer to components found in heavy oil or in oil sand. However, the techniques described are not limited to heavy oils but may also be used with any number of other reservoirs to improve gravity drainage of liquids.

10 Hydrocarbon compounds may be aliphatic or aromatic, and may be straight chained, branched, or partially or fully cyclic.

[0026] “Bitumen” is a naturally occurring heavy oil material. Generally, it is the hydrocarbon component found in oil sand. Bitumen can vary in composition depending upon the degree of loss of more volatile components. It can vary from a very viscous, tar-like,

15 semi-solid material to solid forms. The hydrocarbon types found in bitumen can include aliphatics, aromatics, resins, and asphaltenes. A typical bitumen might be composed of:

19 weight (wt.) % aliphatics (which can range from 5 wt. % - 30 wt. %, or higher);
19 wt. % asphaltenes (which can range from 5 wt. % - 30 wt. %, or higher);
30 wt. % aromatics (which can range from 15 wt. % - 50 wt. %, or higher);

20 32 wt. % resins (which can range from 15 wt. % - 50 wt. %, or higher); and
some amount of sulfur (which can range in excess of 7 wt. %), the weight % based upon total weight of the bitumen.

In addition, bitumen can contain some water and nitrogen compounds ranging from less than 0.4 wt. % to in excess of 0.7 wt. %. The percentage of the hydrocarbon found in bitumen can

25 vary.

[0027] “Heavy oil” includes oils which are classified by the American Petroleum Institute (“API”), as heavy oils, extra heavy oils, or bitumens. The term “heavy oil” includes bitumen as well as lighter materials that may be found in a sand or carbonate reservoir. Heavy oil may have a viscosity of about 1,000 centipoise (cP) or more, 10,000 cP or more, 100,000

30 cP or more, or 1,000,000 cP or more. In general, a heavy oil has an API gravity between 22.3°

API (density of 920 kilograms per meter cubed (kg/m^3) or 0.920 grams per centimeter cubed (g/cm^3)) and 10.0° API (density of 1,000 kg/m^3 or 1 g/cm^3). An extra heavy oil, in general, has an API gravity of less than 10.0° API (density greater than 1,000 kg/m^3 or 1 g/cm^3). For example, a source of heavy oil includes oil sand or bituminous sand, which is a combination of clay, sand, water and bitumen.

[0028] “Fine particles” or “fines” are generally defined as those solids having a size of less than 44 microns (μm), as determined by laser diffraction particle size measurement.

[0029] “Coarse particles” are generally defined as those solids having a size of greater than 44 microns (μm).

[0030] The term “solvent” as used in the present disclosure should be understood to mean either a single solvent, or a combination of solvents.

[0031] The terms “approximately,” “about,” “substantially,” and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numeral ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and are considered to be within the scope of the disclosure.

[0032] The articles “the”, “a” and “an” are not necessarily limited to mean only one, but rather are inclusive and open ended so as to include, optionally, multiple such elements.

[0033] The term “paraffinic solvent” (also known as aliphatic) as used herein means solvents comprising normal paraffins, isoparaffins or blends thereof in amounts greater than 50 wt. %. Presence of other components such as olefins, aromatics or naphthenes may counteract the function of the paraffinic solvent and hence may be present in an amount of only 1 to 20 wt. % combined, for instance no more than 3 wt. %. The paraffinic solvent may be a C_4 to C_{20} or C_4 to C_6 paraffinic hydrocarbon solvent or a combination of iso and normal components thereof. The paraffinic solvent may comprise pentane, iso-pentane, or a combination thereof.

[0034] The production of higher value products materials from the lower (or lowest) value components of bitumen is valuable to improve the economics of bitumen upgrading. Disclosed herein is a process involving the processing of heavy hydrocarbon feedstocks, such as bitumen froth, bitumen, heavy crude oil and/or atmospheric and vacuum residues derived from these feedstocks to produce a non-combustion carbon product, such as high-performance and general purpose carbon fibers, carbon-carbon composites, and carbon foams. The process may use oil sand production and refinery processing units, including paraffinic froth treatment (PFT), visbreaking/coking, distillation, solvent deasphalting and/or hydroprocessing.

[0035] With reference to Figure 1, a disclosed method comprises providing a heavy hydrocarbon feedstock (102) comprising paraffinic froth treated bitumen and/or solvent de-asphalted bitumen; thermally cracking (104) the heavy hydrocarbon feedstock (102) to produce a cracked stream (106) and a gas (108); distilling (110) the cracked stream (106) to produce a distillation bottoms stream (112) and a naphtha and distillates stream (114); and de-asphalting (116) the distillation bottoms stream (112) to produce a pitch fraction (118) and de-asphalted oil (DAO) (120). A solvent (117) may be used for the de-asphalting (116) step.

[0036] The heavy hydrocarbon feedstock may comprise less than 14 wt. % C5-asphaltenes.

[0037] The process may further comprise upgrading a bitumen stream thereby reducing its viscosity and density to produce the heavy hydrocarbon feedstock. The upgrading may comprise paraffinic froth treatment (PFT) or solvent de-asphalting. The upgrading may comprise precipitating out 25-75% by weight of native C5-asphaltenes using a hydrocarbon solvent comprising pentanes.

[0038] The thermal cracking may be effected at a temperature of 400°C to 520°C for a period of 10 to 120 minutes. The thermal cracking may be effected using a visbreaker or a coker.

[0039] The distillation may be effected at a cut point of 270°C to 565°C.

[0040] The step of de-asphalting the distillation bottoms stream may comprise using a hydrocarbon solvent with a carbon number ranging from C5 to C8.

[0041] The step of de-asphalting the distillation bottoms stream may comprise using a solvent comprising pentanes, hexanes, heptanes, reformat, furfural, N-methylpyrrolidone, heavy coker gas oil, coker gas oil, light coker gas oil, light cycle oil, toluene, naphthalene, steam cracked gas oil, or a combination thereof. The step of de-asphalting the distillation bottoms stream may comprise a single de-asphalting step using a solvent with a carbon number of C5 to C8. The step of de-asphalting the distillation bottoms stream may comprise two de-asphalting steps in series to produce a pitch fraction with a reduced level of contaminants and/or impurities and/or higher molecular weight compounds. The two de-asphalting steps may comprise a first de-asphalting step using first solvent and a second de-asphalting step using a second solvent, wherein the second solvent has a lower solubility parameter than that of the first solvent.

[0042] The process may further comprise pyrolyzing the pitch fraction to produce a mesophase pitch or a modified isotropic pitch. The pyrolyzing may be effected at a temperature of 375°C to 500°C for a period of 10 to 180 minutes.

[0043] The process may further comprise converting the pitch fraction into a non-combustion carbon product. The non-combustion carbon product may be a carbon fiber, carbon-carbon composite, or carbon foam. The process may further comprise spinning, extruding, stabilizing, carbonizing, or surface treating the non-combustion carbon product. The process may further comprise melt blowing the mesophase pitch to produce a fiber mat or chopped fibers.

[0044] The process may further comprise sparging of a gas through the pitch fraction to volatilize light fractions.

[0045] The process may further comprise combining the naphtha and distillates stream with the DAO to produce a partially upgraded bitumen (PUB) stream. The PUB may have a viscosity less than 350 cSt at pipeline temperature.

[0046] The process may further comprise hydro-refining the naphtha and distillates stream for reducing an olefin content to produce a hydro-refined stream.

[0047] The process may further comprise a hydro-processing or oxidation step, before or after the thermal cracking step for reducing the sulfur content.

[0048] The process may further comprise filtering the cracked stream for reducing a particulate matter content.

[0049] A carbon fiber composite may comprise the carbon fiber described herein, and having a matrix material comprising a thermoset matrix, a thermoplastic matrix, cement, concrete, ceramic, a metal, a metal alloy, or a combination thereof. Examples of thermoset polymers are cyclopentadiene, dicyclopentadiene, epoxy, pitch, phenolic resins, vinylester, polyimide and polyesters. Examples of thermoplastic polymers are polyethylene, polypropylene, high-density polyethylene, linear low-density polyethylene, low-density polyethylene, polyamides, polyvinylchloride, polyetheretherketone, polyetherketoneketone, polyaryletherketone, polyetherimide and polyphenylene sulfide.

[0050] The heavy hydrocarbon feedstock may be in the form of bitumen froth produced via oil sands mining or diluted bitumen obtained via in-situ production, or the residue fraction derived from bitumen. The heavy hydrocarbon feedstock may be processed to produce a lower viscosity/density and higher quality upgraded bitumen stream that requires significantly less diluent to be blended (0-10 volume %) to meet pipeline specifications (for instance, per Table 1). The produced pitch stream may be used to manufacture higher value non-combustion materials (e.g. carbon fibers or carbon-carbon composites). The disposition of the lower (or lowest) value components of bitumen into these higher value products, compared to conventional petroleum coke or a solids waste stream, may improve the economics associated with upgrading bitumen/heavy oil. Moreover, it may reduce the carbon footprint and green-house gases associated with bitumen production/processing.

[0051] The heavy hydrocarbon feedstock, such as bitumen froth, bitumen, heavy crude oil and/or atmospheric and vacuum residues derived from these feedstocks may be processed to produce a variety of different non-combustion carbon products, including high-performance and general purpose carbon fibers, carbon-carbon composites, and carbon foams.

[0052] Light gas byproducts from thermal cracking (e.g. methane, ethane, ethylene, propane, propylene, butanes, butylenes) may be used as a plant fuel source.

[0053] With reference to Figure 2, a disclosed method adds hydro-refining and pyrolysis/conversion steps to Figure 1. With reference to Figure 2, a disclosed method

comprises providing a heavy hydrocarbon feedstock (202) comprising paraffinic froth treated bitumen and/or solvent de-asphalted bitumen; thermally cracking (204) the heavy hydrocarbon feedstock (202) to produce a cracked stream (206) and a gas (208); distilling (210) the cracked stream (206) to produce a distillation bottoms stream (212) and a naphtha and distillates stream (214); and de-asphalting (216) the distillation bottoms stream (212) to produce a pitch fraction (218) and de-asphalted oil (DAO) (220). A solvent (217) may be used for the de-asphalting (216) step. The naphtha and distillates stream (214) may be hydro-refined (222) for reducing an olefin content to produce a hydro-refined stream (224). The hydro-refined stream (224) may be combined with the DAO (220) to produce partially upgraded bitumen stream (226). The pitch fraction (218) may be pyrolyzed and converted (228) to a non-combustion product (230) as described herein.

[0054] The produced pitch fraction will have a certain wt.%, MCRT (Micro Carbon Residue Test), softening point, and mesophase content (for an isotropic pitch, mesophase content should = 0, or be very low at least). Upon additional pyrolysis, a modified isotropic pitch can form, which will have an MCRT, and TSP (Softening Point Temperature) greater than the original pitch fraction, but still 0 mesophase content. If pyrolysis goes further, a mesophase pitch can form which now has a mesophase content greater than 0 and a softening point and MCRT greater than the pitch fraction or the modified isotropic pitch. Quinoline insoluble (QI) can also be another property used to benchmark the pitch. Once the desired pitch has been formed, it can be converted to form a carbon article. This manufacture step may involve a pyrolysis step, optionally with stabilization step to convert the hydrocarbon molecules into a solid block of carbon, which does not flow.

[0055] Experimental

[0056] Experimental pilot and bench-scale units were used to generate pitch using bitumen as the feed. The data below demonstrate the ability of a process described herein to produce both isotropic and mesophase pitch materials suitable for a variety of applications, in particular carbon fiber production, while producing partially upgraded bitumen (PUB).

[0057] Pitch generated from PFT treated bitumen via:

[0058] Visbreaking the PFT treated bitumen at 430-435°C, 33 min (average equivalent reaction time (ERT) = 2600s at 800°F) followed by distillation to generate: a naphtha

distillate cut (<270°C), which was subsequently hydroprocessed; a gas oil cut; and a heavy resid cut (>480°C).

[0059] Deasphalting the heavy resid cut using C7 solvent at 220°C, 700psi, 6:1 solvent/oil (S/O) ratio, resulting in a pitch fraction and a DAO. The DAO was then blended with the hydroprocessed naphtha cut to generate a PUB.

[0060] The pitch fraction generated from the PFT treated bitumen using the visbreaking and deasphalting conditions specified above was analyzed for softening point and mesophase content (%) pre- and post-heat treatment (pyrolysis). The presence of mesophase was apparent following the application of heat treatment to the pitch.

[0061] The corresponding PUB generated from the PFT treated bitumen using the visbreaking and deasphalting conditions specified above showed a significant improvement in quality relative to the feed, as shown in Table 2. The PUB viscosity and density met the pipeline specifications without the need for diluent blending.

Table 2. PUB properties after upgrading

	PFT Bitumen	PUB
Yield (wt%)	-	86
Viscosity (cSt) at 10°C	125,000	<350
API Gravity (°)	8.6	19.0
Diluent req'd (v%)	30	0
Sulfur (wt%)	4.4	2.9
MCR (wt%)	11.4	4.0
TAN (mgKOH/g)	2.8	0.3

[0062] It should be understood that numerous changes, modifications, and alternatives to the preceding disclosure can be made without departing from the scope of the disclosure. The preceding description, therefore, is not meant to limit the scope of the disclosure. Rather, the scope of the disclosure is to be determined only by the appended claims and their equivalents. It is also contemplated that structures and features in the present examples can be

altered, rearranged, substituted, deleted, duplicated, combined, or added to each other. The scope of the claims should not be limited by particular embodiments set forth herein, but should be construed in a manner consistent with the specification as a whole.

CLAIMS:

1. A process comprising:
 - a. providing a heavy hydrocarbon feedstock comprising paraffinic froth treated bitumen and/or solvent de-asphalted bitumen;
 - b. thermally cracking the heavy hydrocarbon feedstock to produce a cracked stream and a gas, wherein the thermal cracking is effected using a visbreaker;
 - c. distilling the cracked stream to produce a (i) distillation bottoms stream and (ii) a naphtha and distillates stream; and
 - d. de-asphalting the distillation bottoms stream to produce a pitch fraction and de-asphalted oil (DAO).
2. The process of claim 1, wherein the heavy hydrocarbon feedstock comprises paraffinic froth treated bitumen.
3. The process of claim 1 or 2, wherein the heavy hydrocarbon feedstock comprises solvent de-asphalted bitumen.
4. The process of any one of claims 1 to 3, wherein the heavy hydrocarbon feedstock comprises less than 14 wt. % C5-asphaltenes.
5. The process of any one of claims 1 to 4, further comprising upgrading a bitumen stream thereby reducing its viscosity and density to produce the heavy hydrocarbon feedstock.
6. The process of claim 5, wherein the upgrading comprises paraffinic froth treatment (PFT) or solvent de-asphalting.
7. The process of claim 5 or 6, wherein the upgrading comprises precipitating out 25-75% by weight of native C5-asphaltenes using a hydrocarbon solvent comprising pentanes.

8. The process of any one of claims 1 to 7, wherein the thermal cracking is effected at a temperature of 400°C to 520°C for a period of 10 to 120 minutes.
9. The process of any one of claims 1 to 8, wherein the distillation is effected at a cut point of 270°C to 565°C.
10. The process of any one of claims 1 to 9, wherein the step of de-asphalting the distillation bottoms stream comprises using a hydrocarbon solvent with a carbon number ranging from C5 to C8.
11. The process of any one of claims 1 to 9, wherein the step of de-asphalting the distillation bottoms stream comprises using a solvent comprising pentanes, hexanes, heptanes, reformate, furfural, N-methylpyrrolidone, heavy coker gas oil, coker gas oil, light coker gas oil, light cycle oil, toluene, naphthalene, steam cracked gas oil, or a combination thereof.
12. The process of any one of claims 1 to 9, wherein the step of de-asphalting the distillation bottoms stream comprises a single de-asphalting step using a solvent with a carbon number of C5 to C8.
13. The process of any one of claims 1 to 11, wherein the step of de-asphalting the distillation bottoms stream comprises two de-asphalting steps in series to produce a pitch fraction with a reduced level of contaminants, impurities and/or higher molecular weight compounds.
14. The process of claim 13, wherein the two de-asphalting steps comprises a first de-asphalting step using a first solvent and a second de-asphalting step using a second solvent, wherein the second solvent has a lower solubility parameter than that of the first solvent.

15. The process of any one of claims 1 to 14, further comprising pyrolyzing the pitch fraction to produce a mesophase pitch.
16. The process of claim 15, wherein the pyrolyzing is effected at a temperature of 375°C to 500°C for a period of 10 to 180 minutes.
17. The process of any one of claims 1 to 14, further comprising pyrolyzing the pitch fraction to produce a modified isotropic pitch.
18. The process of claim 17, wherein the pyrolyzing is effected at a temperature of 375°C to 500°C for a period of 10 to 180 minutes.
19. The process of any one of claims 1 to 14, further comprising converting the pitch fraction into a non-combustion carbon product.
20. The process of claim 19, wherein the non-combustion carbon product is a carbon fiber, carbon-carbon composite, or carbon foam.
21. The process of any one of claims 1 to 14, further comprising spinning, extruding, stabilizing, carbonizing, or surface treating the pitch fraction.
22. The process of any one of claims 1 to 14, further comprising melt blowing the pitch fraction to produce a fiber mat or chopped fibers.
23. The process of any one of claims 1 to 14, further comprising sparging a gas through the pitch fraction to volatilize light fractions.
24. The process of any one of claims 1 to 23, further comprising combining the naphtha and distillates stream with the DAO to produce a partially upgraded bitumen (PUB) stream.

25. The process of claim 24, wherein the PUB has a viscosity less than 350 cSt at pipeline temperature, wherein the pipeline temperature is about 10°C.

26. The process of any one of claims 1 to 25, further comprising hydro-refining the naphtha and distillates stream for reducing an olefin content to produce a hydro-refined stream.

27. The process of any one of claims 1 to 26, further comprising a hydro-processing or oxidation step, before or after the thermal cracking step for reducing sulfur content.

28. The process of any one of claims 1 to 27, further comprising filtering the cracked stream to reduce particulate matter content.

29. A carbon fiber composite comprising the carbon fiber as defined in claim 20, and having a matrix material comprising a thermoset matrix, a thermoplastic matrix, cement, concrete, ceramic, a metal, a metal alloy, or a combination thereof.

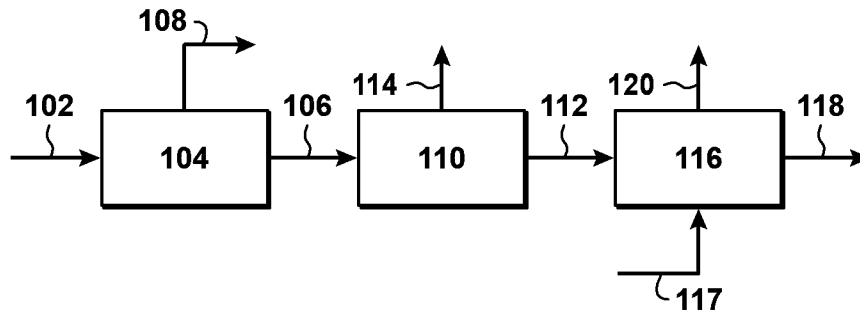


FIG. 1

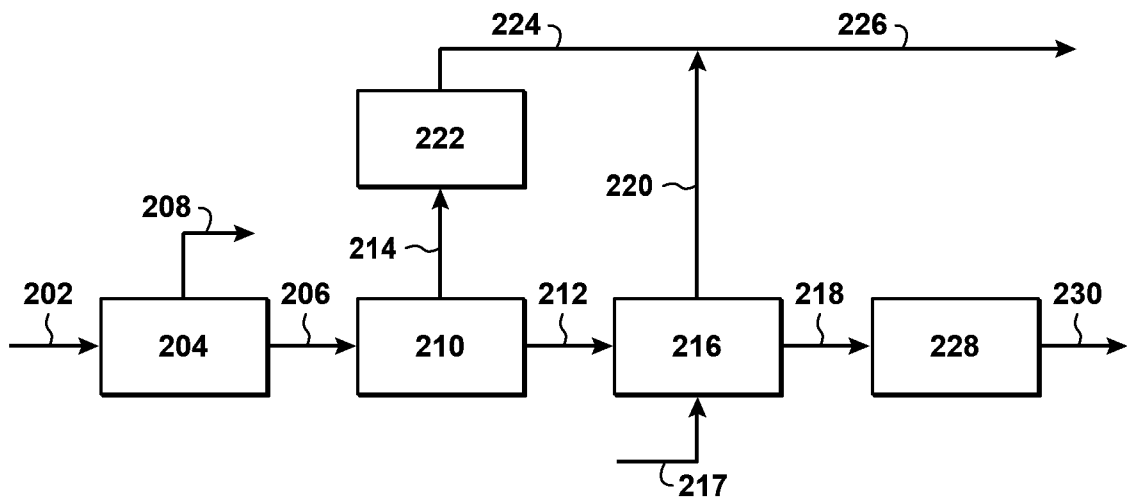


FIG. 2

