PROCESS FOR PRODUCING FUEL

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ABSTRACT

A fuel is produced from bitumen by precipitating a substantial portion of asphaltenes from bitumen by contacting the bitumen with a lower alkane solvent. Suitable burners include a fluidized bed boiler, a circulating fluidized bed boiler and a pitch boiler which utilize either pre-combustion sulfur sorbents or post-combustion flue gas desulfurization. The sulfur in emissions can be used to produce sulfuric acid. The process uses a low cost fuel, generates steam, power and sulfuric acid and meets all emission requirements for SO₂, NOₓ and PM.
PROCESS FOR PRODUCING FUEL

FIELD OF THE INVENTION

0002 This invention relates to a process for producing fuel from bitumen.

0003 More specifically, the invention relates to an integrated process in which heavy oil or bitumen produced from both "in situ" or surface oil sands mines is solvent de-asphalted to yield a de-asphalted oil and an asphaltene fraction, which is used as fuel in a boiler to replace expensive natural gas, reduce energy costs and reduce or obviate the need for diluents to make the de-asphalted oil pipelable. In particular the invention will substantially reduce energy and diluent costs and improve the economics of producing bitumen. In addition, produced de-asphalted oil will be of higher quality, lower viscosity, reduce sulphur, nitrogen, Conradson carbon, nickel and vanadium.

BACKGROUND OF THE INVENTION

0004 Since Canadian conventional oil production is dwindling and both synthetic crude and bitumen production are on the rise there is a need to reduce the energy costs of bitumen production and the use of expensive diluents for transporting bitumen to refineries by pipeline.

0005 As conventional oil deposits dwindle, upgradable fuel derived therefrom has become increasingly more expensive to produce. The search for inexpensive fuel sources is an on-going problem. Bitumen or tar sand deposits (oil sands) found in areas of Western Canada such as the Athabasca, Cold Lake and Peace River areas of Alberta, and other places in the world (Venezuela, U.S.A., China, Russia) represent a largely unused source of raw crude oil, typically in the form of bitumen. The bitumen is produced from either oil sands (surface mines) or "in situ" by steam assisted gravity drainage “SAGD”, cyclic steam stimulation “CSS” and other production techniques using steam. The bitumen from oil sands or in situ production includes a mixture of maltenes, aromatics, resins and asphaltene compounds in varying amounts, the least valuable component being the asphaltene. Extracting bitumen from oil sands and other deposits is difficult and requires hot water or steam injection to liquefy the high viscosity bitumen for transport to a surface processing plant. The process of steam production requires continuous use of often expensive fuels and thus an inexpensive, readily available fuel is highly desirable.

0006 Several processes have been described addressing the above-identified problems including those described, e.g. in U.S. Pat. Nos. 6,536,523; 6,524,469; 6,511,937; 6,357,526; 5,085,029; 4,755,278; 4,634,520; 4,283,231; 4,042,027 and 4,036,732.

0007 The processes described in the prior art suffer from a number of important drawbacks. The processes are complex, involving multiple separate steps, which are not fully integrated. Moreover, the processes involve pre-treating the bitumen which may be expensive, requiring many reagents and diluents, specialized equipment and prior manipulation of the crude bitumen. None of the processes offers an affordable solution to the reduction of production costs of heavy oil producers who rely on expensive fuel such as natural gas to generate the high pressure steam needed to extract the low viscosity bitumen found in different places such as in the Athabasca region of Alberta, Canada. Existing processes do not meet the need for reduced fuel and diluent dependency in the production of a partially upgraded bitumen stream and a precipitate of asphaltenes. Asphaltenes are low value hydrocarbons useful as a fuel in the field. The removal of the heavier portions of the bitumen does improve the viscosity of the de-asphalted oil and accordingly a much lower amount of expensive diluents is needed to make the produced bitumen pipelable to the market.

0008 Thus there is a need for an improved process for generating fuel from bitumen to reduce energy cost and use of expensive diluents.

SUMMARY OF THE INVENTION

0009 Accordingly, the present invention relates to a process for producing fuel from bitumen comprising the step of: flashing the gas oil fraction out of bitumen, de-asphalting the bitumen, and precipitating a substantial portion of the asphaltenes from bitumen by contacting the bitumen with a lower alkane solvent.

0010 The inventor discovered that unprocessed bitumen (from both from oil sands and “in situ”) processes can be efficiently de-asphalted to produce higher quality de-asphalted oil and asphaltenes which can be used as a liquid or solid fuel for producing steam. The bitumen is merely dehydrated and desalted, flashed to remove the gas oil fraction and then de-asphalted. The process is cost effective and produces high quality fuel, that is of higher BTU (British Thermal Unit) content than coal or pet coke with lower amounts of ash than coal. These characteristics make asphaltenes an ideal fuel to be transported in solid form as granules, or in a hot liquid form, or as a water slurry or as a water or oil emulsion. Moreover, fluidized bed boiler, FBD (bubbling fluidized bed), CFBC circulating fluidized bed or OTSG (once through boiler, CFB boilers) or OTSG boiler with FGD (flue gas de-sulfurization) units burn asphaltenes in a clean manner and generate much less emissions than coal. Alternatively the boilers can be used either with a sulfuric acid plant or preferably with a SNOX™ or WSA™ unit for cleaning emissions of SO₂, NOx and PM while producing commercial grade, sulfuric acid. Removing SO₂, NOx and PM in the gas phase after combustion has additional benefits: reduced needs for sulfur sorbents, reduced production of ashes and gypsum, improved thermal efficiency of boiler. In addition the removal of pollutants allows for the production of sulfuric acid of commercial grade; the most common and basic chemical.

0011 Moreover, the process is fully integrated and can be used on site without the need for additional processing units. Since the process uses raw, unprocessed bitumen, it significantly decreases costs by reducing the amount of pretreatment with organic solvents. The process of the present invention significantly improves oil quality, and significantly lowers oil viscosity thereby permitting easier pumpability of the oil through standard pipelines. Organic and inorganic contaminants are reduced in the oil which improves the value of the de-asphalted oil.
In accordance with the present invention, there is provided a process for producing fuel from crude bitumen including the steps of precipitating a substantial portion of asphaltene from bitumen by contacting the bitumen with a lower alkane solvent to yield an asphaltene fraction and a de-asphalted oil fraction essentially free of asphaltene which can be processed further, upgraded or mixed with diluent for shipment to market.

The asphaltene fraction can be injected while hot into a fluidized bed boiler, preferably an OTSG CFB (once through circulating fluidized bed boiler) where combustion occurs in the presence of a sulfur absorbent such as limestone and/or lime to remove sulfur.

The boiler is used to generate high pressure steam that will first go through a steam turbine to generate electricity and steam for an SAGD, CSS or low pressure oil sand process.

Once through the turbine, the steam can be extracted at a back pressure needed for use in a SAGD, CSS or OILSANDS or other steam extraction process which may be developed in the future.

The asphaltene fraction can be used as a hot liquid in the combustion process or alternatively can be pelletized for storage, transport or use as a solid fuel in the combustion step. Alternatively, hot liquid asphaltene can be mixed with various surfactants and solvents to obtain a liquid fuel similar to bunker "C" fuel or residual fuel that can be stored, transported, pumped and used in the combustion process. The process can use coal, bottom of the barrel residues or petroleum coke stored on the site of oil sands mines as fuels for boilers. Logistics and costs will dictate which fuel or combination to be used, because fluidized bed boilers are fuel flexible.

Fluidized bed boilers can be replaced by downshot boilers if petroleum coke is used as fuel, or pitch boilers if the asphaltene stream is used as fuel. In both cases, a sulfuric acid plant to remove SO₂ and NOₓ will be required to meet emission requirements.

Alternatively, steam can be used directly in SAGD, CSS pads without the need to cogenerate power.

Alternatively, the CFB boiler can operate without the addition of limestone or lime sorbent. Instead of producing gypsum a sulfuric acid plant or SNOX® or other process know to the art to remove sulfur can be used for the back end. The benefits will be reduced cost for limestone, higher thermal efficiency and better emissions, since 95-98% of both SO₂ and NOₓ will be removed. Prior processes failed to include the production of sulfuric acid as an efficient way to meet emissions requirement for SO₂, NOₓ and PM. The use of a sulfuric acid plant at the back end allows for higher thermal efficiency of the boiler, reduced need for limestone and reduced production of gypsum. In northern Alberta transportation costs are high, the use of limestone is expensive and production of gypsum increase costs. The production of marketable sulfuric acid disposes of sulfur in the most economical and permanent manner. No stockpiles of sulfur or gypsum will be created as a result of this invention. The use of a sulfuric acid plant makes it possible to remove SO₂, NOₓ and PM without using water. The added benefit of not using limestone and making sulfuric acid instead of gypsum makes the water chemistry much simpler, because the pH of water is not affected by limestone and other contaminants. The resulting ash from the sulfuric acid process is water free and totally inert so that they can be disposed of safely.

**DETAILED DESCRIPTION OF THE INVENTION**

As used herein, the term "lower alkane" when used in connection with a solvent refers to a branched or straight chain acyclic alkyl group containing four to about ten carbon atoms, preferably four to about seven carbon atoms, and preferably five carbon atoms. Examples of suitable solvents include n-butane, iso-pentane, n-pentane, n-hexane, n-heptane, and mixtures thereof.

Crude bitumen can come from many sources, examples of which include in situ SAGD (steam assisted gravity drainage) pads, surface mines. The present invention uses raw bitumen produced from either SAGD pads or CSS (cyclic steam stimulation) steam flooding or bitumen obtained from froth treatment at oil sands mines. Alternatively the present invention uses coal, petroleum coke from stored pads or existing or future cokers located at upgraders or refinery sites.

It is well known by those skilled in the art that crude bitumen removed from SAGD pads and the like contains water and salt which must be removed before further processing. Many dehydration and desalting processes are known, such as that disclosed U.S. Pat. No. 6,536,523, the contents of which are hereby incorporated by reference. The salt content post desalting is typically 0.01% w/w.

The heavy oil or bitumen is flashed to remove the gas on fraction that will be mix with the de-asphalted fraction. The residue will enter the de-asphalting step, the lower alkane solvents are mixed with the crude bitumen so that asphaltene precipitates and separates from de-asphalted oil (DAO). Typically, the solvents are used alone, but may be used as mixtures thereof.

The lower alkane solvents iso-pentane, n-pentane and hexane are usually selected, because during de-asphalting they are efficient at removing a large portion of the asphaltene and small portion of resin components, but do not remove all of the resin components, which are typically found in suspension, together with maltene and aromatic compounds in the crude bitumen.

The portion of asphaltene separated is typically 10-20% w/w of crude bitumen, and the amount of precipitated resins is between 15 and 25% w/w of the total amount of the asphaltenes precipitated or 5-10% of w/w of the initial bitumen. Typically the amount of precipitated asphaltene is 15-20% w/w of the bitumen and more than 90% of the asphaltene present in the crude oil. A small amount of resins will also be precipitated along with the asphaltene.

For asphaltenes that are useful in roofing and the like, or indeed for transportation, a small amount of resin in the asphaltene is desirable. Therefore, a portion of the resin component may be co-precipitated with the asphaltene. Typically, the portion of the resin is less than 10% w/w. For co-precipitating the resin component, n-butane is typically the chosen lower alkane solvent, which is mixed with another of the lower alkane solvents.
Typically, the precipitation step takes place in a de-asphalting unit such as a ROSETM, SOLVAHTM, DEMEXMT or a similar unit, the operation of which is known to those skilled in the art.

The asphaltene exits the de-asphalting unit as a hot liquid and is fed to a combustion unit. In order, to ease handlability, the hot asphaltene can be pelletized or mixed with water to form an emulsion. Alternatively, hot asphaltene can be mixed with dispersants and solvents to yield an oil based emulsion.

The combustion unit can be a standard Benson type boiler such as a once-through steam generator boiler (OTSG). More specialized combustion units include a circulating fluidized bed boiler (CFB), a bubbling fluid bed boiler (BBF) a fluidized bed boiler (FB) or an OTSG CFB boiler. Alternatively the combustion units can be a standard drum type of boiler that will produce 100% quality steam and cost less to purchase than OTSG (once through steam generating units). Water quality will be an issue that will be solved by using higher quality water treatments such as ZLD (zero liquid discharge) or other techniques known to the art.

Depending upon which combustion unit is chosen, a number of further processing steps can take place. With the Benson boiler, burning the asphaltene produces toxic flue gases such as sulfur dioxide. Typically, the Benson boiler or OTSG has a flue gas desulfurization (FGD) unit attached thereto which mixes the sulfur dioxide with hydrogen to produce less toxic hydrogen sulfide. Alternatively a scrubber unit may be used to remove sulfur. With fluidized bed boilers, limestone and lime may be added to produce commercially useful gypsum. Typically, the combustion units use available sources of fuel, such as petroleum coke or coal.

According to an alternative embodiment of the present invention, de-asphalted oil is produced from crude bitumen by the steps of:

(a) salt and water is removed through dehydration & water removal in process known by those skilled in the art.

(b) the dehydrated and desalted bitumen is flashed the remove the gas oil fraction in process know by those skills in the art.

(c) removing asphaltalenes from bitumen by contacting the bitumen with a lower alkane solvent; and

(d) removing a substantial portion of de-asphalted oil “DAO” produced in step (c), the DAO oil being substantially free of asphaltalenes.

(e) Adding the flashed out gas oil fraction obtained in step (B) to the DAO de-asphalted oil fraction of step D that will be of lower viscosity, higher quality than the original bitumen.

The residual de-asphalted oil (DAO) may be further processed by adding diluents such as natural gas liquid “NGL” or other liquid diluent or synthetic crude which improves the pumpability of the DAO and increases its accessibility to oil pipelines. As another option, the DAO may be further upgraded by dewaxing and deacidification (so called total acid number (TAN) removal). The resulting upgraded DAO has substantially improved viscosity, typically less than 350 cSt, which improves pumpability of the DAO without the need of diluents. Table 1 summarizes the pipeline specifications as of June 2004 for crude oil in Alberta.

<table>
<thead>
<tr>
<th>Density @ 15° C.</th>
<th>940 kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>(RVP) Reid Vapor Pressure</td>
<td>103 kPa</td>
</tr>
<tr>
<td>Viscosity @ 11° C.</td>
<td>350 mm²/s or cSt</td>
</tr>
<tr>
<td>(BS &amp; W) Bottom Sediment &amp; Water</td>
<td>0.5% v/v</td>
</tr>
<tr>
<td>Bromine number</td>
<td>10 gr BR/100 gr</td>
</tr>
<tr>
<td>Olefin content</td>
<td>1.0% v/v</td>
</tr>
</tbody>
</table>

An important aspect of the present invention is the low cost generation of electricity for use on a site or for sale to the electricity grid. To this end, the invention provides a process for generating steam, which comprises feeding asphaltalenes to a fluidized bed boiler where it is burned in an upward flow of combustion air. Fuel ash and unburned fuel carried from the furnace are collected by a solids separator and returned to bottom of the furnace. Limestone is used as a sulphur sorbent which is also fed to the bottom of the furnace. Furnace temperature is maintained in the range of 1500-1700°C of using a suitable heat absorbing surface. The combustion process allows for:

fuel flexibility because the relative low furnace temperatures are below the ash softening temperature for nearly all fuels allowing a given furnace to handle a wide range of fuels

low SO₂ emissions because limestone is such an effective sulphur sorbent in the 1500-1700°C of temperature range, SO₂ removal efficiency for CFB is 95% and higher,

low NOₓ emissions, because the low furnace temperature and combustion temperature plus the staging of air feed to the furnace produce very low NOₓ emissions, and

high combustion efficiency in the furnace because the long solids residence time plus the vigorous solid gas contact and sanding caused by the fluidized airflow result in a high combustion efficiency even with fuels which are difficult to burn.

During the combustion of asphaltalenes and the sulphur contained therein the following reactions occur when limestone is injected into the furnace:

oxidation of sulphur S+O₂→SO₂
limestone is calcinated to form calcium oxide CaCO₃→CaO+CO₂→425 Kcal/kg (of CO₂)
sulfur dioxide reacts with solid CaO: SO₂+½O₂+CaO→CaSO₄ (solid)→3740 Kcal/kg (ofs)
The resulting calcium-sulphate (gypsum) based ashes are chemically stable and easily disposed. This ash can be used as a raw material for cement manufacturing, soil stabilisation, or road based or store in pads.

The steam produced can be fed into a steam turbine to generate electricity to be sold to an electricity supplier. Alternatively, the process may be circular such that the steam generated may be fed back into the SAGD pads to aid removal of oil sands therefrom.
Another lower cost alternative to limestone as sulfur sorbent consists of using either standard boilers or fluidized bed boilers to burn the high sulfur fuel in the most efficient manner, and to connect the boiler to a sulfuric acid plant to clean up and remove the SO₂ and NOₓ in the gas phase. The inventor discovered that removing the pollutants (SO₂, NOₓ, PM) following combustion provides more flexibility, reduce emissions of SO₂, NOₓ and PM, and increased boiler efficiency by 15-20% compared to others technologies. The results of this alternative combustion process:

- **[0050]** fuel flexibility because the relative low furnace temperatures are below the ash softening temperature for nearly all fuels allowing a given furnace to handle a wide range of fuels.
- **[0051]** low SO₂ emissions because up to 98%-99% of SO₂ is removed.
- **[0052]** low NOₓ emissions because the low furnace temperature and combustion temperature prevents the staling of air feed to the furnace producing very low NOₓ emissions. In addition the denox step remove 95% of NOₓ.
- **[0053]** high combustion efficiency in the furnace because the long solids residence time plus the vigorous solid gas contact and sanding caused by the fluidized airflow result in a high combustion efficiency even with fuels which are difficult to burn fuels.
- **[0054]** High thermal efficiency as sulphuric acid production is endothermic.
- **[0055]** As embodiment for this invention the combustion of asphaltenes and the sulphur contain therein, the following reaction occur when combustion of sulphur compound in a furnace equipped with WSA/SNOXTM plant.

The gas then enters the reactor, which contains one, two, or more catalyst beds, depending on the SO₂ content and the desired degree of conversion. Since reaction in the reactor is exothermic the gas is cooled between the beds in order to favorise the SO₂/SO₃ equilibrium. After the last conversion stage the gas is cooled, whereby the SO₃ reacts with the water vapour to form gas phase sulphuric acid as shown above.

**[0056]** In Northern Alberta the distances make transportation of limestone expensive and the production of gypsum and waste water problematic from an environmental point of view.

**[0057]** This invention allows the use of low cost fuels, to burn in the most efficient manner, producing steam and power and meeting the stringent emissions norms. A sulfuric acid plant helps reduce SO₂ by 99%, NOₓ by 95-97% and PM by 99%, and improves thermal efficiency from 34-36% to 41-44%, because production of sulfuric acid is endothermic.

**[0058]** Higher efficiency means reduced fuel use, and reduced emissions since less fuel is burned. In addition, the use of water is reduced to zero and the production of ashes and gypsum is reduced by 60-80%. The ashes are inert and do not interfere with the water chemistry of oil sands tailings.

**[0059]** An integrated system for carrying out the process of the invention includes a dehydration/desalting unit for receiving the crude bitumen from oil sands, and dehydrating and desalting the oil sand before transporting to the de-asphalting unit. Optionally, if the oil sand is received from oil sand plants, it may already be dehydrated and desalted and thus may be fed directly into the de-asphalting unit. Typically, the de-asphalting unit is a ROSETM unit or other known commercial apparatus for de-asphalting oil using a lower alkane solvent or more typically a mixture of lower alkane solvents for precipitating a substantial portion of asphalten from bitumen.

**[0060]** A combustion unit in the form of a boiler such as described above burns the asphaltenes to generate steam, which may be fed to a steam turbine. The process is cyclical and permits the steam turbine to pump steam directly into SAGD or CSS pads to remove crude bitumen therefrom to begin the cycle again.

**[0061]** Another aspect of the present invention is a burnable fuel composition produced by the process of the present invention. The fuel composition comprises a liquid asphaltene substantially free of de-asphalted oil and resins. The asphaltene oil composition has the properties set out in Table 2.

<table>
<thead>
<tr>
<th>TABLE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphaltene</td>
</tr>
<tr>
<td>Steam properties</td>
</tr>
<tr>
<td>Yield (%) w/w</td>
</tr>
<tr>
<td>Specific gravity @ 60° F.</td>
</tr>
<tr>
<td>API* Gravity</td>
</tr>
<tr>
<td>Nitrogen (%) w/w</td>
</tr>
<tr>
<td>Sulfur (%) w/w</td>
</tr>
<tr>
<td>Carbon content (%) w/w</td>
</tr>
<tr>
<td>Nickel (ppm**)</td>
</tr>
<tr>
<td>Vanadium (ppm**)</td>
</tr>
<tr>
<td>Viscosity</td>
</tr>
<tr>
<td>cSt @ 210°F</td>
</tr>
<tr>
<td>cSt @ 275°F</td>
</tr>
<tr>
<td>cSt @ 400°F</td>
</tr>
<tr>
<td>cSt @ 550°F</td>
</tr>
</tbody>
</table>
In another aspect of the present invention, high quality pumpable de-asphalted oil is produced. The high quality DAO is asphaltene free and has the properties listed in Table 3.

Table 3 lists the ROSETM yield and quantity from the process of the invention using Whole Cold Lake bitumen, and n-pentane as the de-asphalting solvent.

<table>
<thead>
<tr>
<th>Feed1</th>
<th>Asphaltene</th>
<th>DAO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (% w/w)</td>
<td>100</td>
<td>19</td>
</tr>
<tr>
<td>Yield (% v/v)</td>
<td>100</td>
<td>17</td>
</tr>
<tr>
<td>Specific gravity @ 60°F</td>
<td>0.994</td>
<td>1.140</td>
</tr>
<tr>
<td>API Gravity</td>
<td>10.9</td>
<td>-7.4</td>
</tr>
<tr>
<td>Nitrogen (% w/w)</td>
<td>0.27</td>
<td>0.61</td>
</tr>
<tr>
<td>Sulfur (% w/w)</td>
<td>4.3</td>
<td>7.0</td>
</tr>
<tr>
<td>Conradson</td>
<td>12.6</td>
<td>44</td>
</tr>
<tr>
<td>Carbon (% w/w)</td>
<td>137</td>
<td>560</td>
</tr>
<tr>
<td>Nickel (pppm)</td>
<td>155</td>
<td>670</td>
</tr>
<tr>
<td>Vanadium (pppm)</td>
<td>113</td>
<td>31</td>
</tr>
<tr>
<td>Viscosity @ 210°F</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>Viscosity @ 300°F</td>
<td>44,900</td>
<td></td>
</tr>
<tr>
<td>Viscosity @ 500°F</td>
<td>203</td>
<td></td>
</tr>
<tr>
<td>R &amp; B Softening Point (°C)</td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>

1Crude bitumen from Whole Cold Lake Source
2De-asphalted oil

As is illustrated by Table 3, the process of the present invention significantly improves the oil quality from 10.9° API to 15.1° API (for typical Cold Lake bitumen). Moreover, the oil’s viscosity is significantly improved, thereby permitting easier pumpability of the oil through standard pipelines. Contaminants such as nitrogen, sulfur, nickel, vanadium and Conradson carbon are reduced in the oil, which improves the value of the de-asphalted oil. De-asphalting the, dehydrated and desalted bitumen significantly reduces the use of diluents and thus the overall cost of processing is reduced. With this low cost carbon rejection method, the economics of bitumen production are greatly improved since both the use of expensive natural gas and expensive diluant are reduced dramatically.

1. A process for producing and using fuel from bitumen comprising the steps of

(a) precipitating a substantial portion of asphaltenes from bitumen by contacting the bitumen with a lower alkane solvent;

(b) using precipitated asphaltenes as a fuel in a boiler to generate high pressure steam and power; and

(c) cleaning emissions from the boiler to remove sulfur, NOx and PM therefrom.

2. The process of claim 1, wherein a gas and oil fraction of the bitumen is flashed out prior to step (a).

3. The process of claim 1, wherein the bitumen is dehydrated and desalted.

4. The process of claim 1, wherein the asphaltenes are liquid.

5. The process of claim 4, wherein the liquid asphaltenes are pumpable.

6. The process of claim 1, wherein the lower alkane solvent is selected from the group consisting of n-butane, n-pentane, n-hexane, n-heptane and mixtures thereof.

7. The process of claim 6, wherein the lower alkane solvent is n-butane.

8. The process of claim 6, wherein the lower alkane solvent is n-pentane.

9. The process of claim 1, wherein the precipitated portion of asphaltene is from 5 to 40% w/w of the bitumen.

10. The process of claim 8, wherein the precipitated asphaltene is from 15 to 25% of w/w of the bitumen.

11. The process of claim 1, wherein a portion of a resin in the bitumen is precipitated with the asphaltenes.

12. The process of claim 11, wherein the resin is less than 10% w/w of the bitumen.

13. The process of claim 1, wherein the high pressure steam is used to produce electricity and steam for use in an oil sands extraction process.

14. The process of claim 13, wherein said oil sands extraction process is a steam assisted gravity drainage, or a cyclic steam injection process.

15. The process of claim 1, wherein the boiler is a fluidized bed boiler.

16. The process of claim 15, wherein the boiler is a circulating fluidized bed boiler.

17. The process of claim 16, wherein sulfur is removed from the boiler emissions using limestone or lime as a sulfur absorbent during combustion, by flue gas desulfurization or by a scrubber during post-combustion sulfur removal.

18. The process of claim 15, wherein the boiler uses a device to produce sulfuric acid to remove SO2 emissions.

19. The process of claim 2, wherein the flashed out gas and oil fraction is mixed with de-asphalted oil obtained in step (a) to yield an upgraded de-asphalted oil of a lower viscosity, and lower density.

* * * * *