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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



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P-852

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISION DE NUEVAS CREACIONES

E. S. D.

Re: Expediente No. **06.123.107**

Solicitud de patente a nombre de **KELLOG, BROWN & ROOT, INC.**

Yo, DILIA RODRIGUEZ D'ALEMAN, identificada como aparece al pie de mi firma, domiciliada en la carrera 11 No. 86-53, piso 6, obrando como obrando como apoderada de la sociedad **KELLOG, BROWN & ROOT, INC.**, domiciliada en Huston, Texas, Estados Unidos de América, solicitante de la patente de la referencia, en respuesta al oficio No. 0976 notificado por fijación en lista el 21 de enero de 2011, relacionado con el concepto técnico de fondo No. 3735, me permito manifestar:

1. Con fundamento en la facultad que confiere el artículo 34 de la Decisión 486 al solicitante para modificar la solicitud de patente en cualquier momento del trámite, presento junto con este memorial una nueva descripción y un nuevo capítulo reivindicatorio, el cual consta de 1 – 11 reivindicaciones y reemplaza completamente el capítulo presentado anteriormente. Las modificaciones buscan superar las objeciones presentadas a claridad de las reivindicaciones

En cuanto a estas modificaciones, me permito decir que las mismas no amplían de ninguna manera la materia objeto de la presente solicitud y se realizaron con el ánimo de superar las objeciones de claridad y nivel inventivo, planteadas por el examinador en su concepto técnico.

2. Claridad

En la reivindicación 1, se ha removido y modificado la limitación añadida en respuesta a la acción oficial pasada (“las fracciones de hidrocarburos de ebullición más baja se introducen en la unidad de FCC con la fracción DAO”) y reinsertado dicha limitación en la nueva reivindicación dependiente 11, e introduciendo la expresión “de ebullición”.

Así mismo, se han cancelado las reivindicaciones 10 y 11 anteriormente presentadas e incluido su materia dentro de la nueva reivindicación 1.

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3. Nivel Inventivo

El examinador objeta la altura inventiva de la presente solicitud a la luz de las anterioridades US 5,192,421 (en adelante D1) y US4,940,529 (en adelante D3). El examinador establece que *“El problema técnico objetivo consiste en como mantener la velocidad de reacción de craqueo catalítico constante en las reacciones de desmetalización de petróleo crudo”,* y concluye que *“La solución a este problema técnico es ampliamente conocida y aplicada en el campo técnico de esta invención que es el refinamiento de petróleo pesado por craqueo catalítico [...]”*

Al respecto, el solicitante quisiera anotar que el problema técnico objetivo de la presente solicitud no es el que establece el examinador. Por el contrario, el verdadero problema técnico objetivo es, como claramente se establece en la descripción, el siguiente:

*“La presente invención se refiere de manera general, al **mejoramiento de aceites pesados y asfalto**. Más particularmente, la presente invención se refiere a un proceso para el mejoramiento de aceites pesados y asfaltos que incluyen uno o más de las etapas de producción, fraccionamiento, extracción de solvente, craqueo catalítico de fluido e hidrotratamiento, para producir corrientes de crudo sintético y/o nafta, destilado y gasóleo que tienen contenido de metal y/o azufre reducidos.”*

Por lo tanto, como se puede observar, el problema técnico objetivo de la presente solicitud no guarda ninguna similitud con el problema técnico planteado por el examinador. Así las cosas, resulta evidente que la conclusión del examinador de que *“la única diferencia con D1 es la remoción del catalizador metalizado de la unidad FCC”,* hecha a la luz del problema técnico planteado por el examinador, es incorrecta. Así mismo, puesto que se está evaluando la invención bajo la perspectiva equivocada, también es acertado decir que el examinador se equivoca al establecer que *“La solución a este problema técnico es ampliamente conocida y aplicada en el campo técnico de esta invención que es el refinamiento de petróleo pesado por craqueo catalítico [...]”*.

En vista de lo anterior, el solicitante le pide respetuosamente al examinador que se abstenga de realizar interpretaciones de la invención que no corresponden con lo dicho por el solicitante en su solicitud. Por un lado, debe tenerse en cuenta que el objeto de la presente solicitud es el de procesar petróleo crudo pesado con el fin de mejorar sus características. Lo que se busca con el proceso de la presente solicitud, es reducir el contenido de metales pesados y asfaltenos en crudos pesados.

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Diferente de ello, la anterioridad D1 se relaciona con un proceso para el desasfaltado de crudo pesado y el mejoramiento de asfalteno. Por su parte, la anterioridad D3 se relaciona con un proceso de craqueo catalítico de **petróleo desasfaltado** obtenido por extracción con solventes o residuos hidrotratados. Como se puede apreciar, el objeto de la anterioridad D3 es mejorar la producción de gasolina y otros productos de alto valor derivados del petróleo.

El objeto de la presente solicitud es procesar petróleo crudo para eliminar los contaminantes que podrían afectar el proceso de FCC, tales como metales pesados y azufre. Para tal fin, el petróleo pesado crudo se somete a un proceso de desasfaltado por solventes, seguido de una etapa de eliminación de metales en una unidad de fraccionamiento catalítico, y finaliza en una etapa de hidrogenación de la corriente de salida de la unidad FCC para reducir el contenido de azufre.

En la presente solicitud, los metales pesados presentes se eliminan en la unidad de fraccionamiento catalítico al hacer que estos se adhieran al catalizador. En la anterioridad D1 los metales se eliminan al transformarlos dentro de la unidad de fraccionamiento catalítico en compuestos metálicos estables que tienen un rango de solubilidad menor o son altamente solubles en los hidrocarburos destilados (ver D1, col. 4, l. 20-26). Por lo tanto, la solución propuesta por la presente solicitud para eliminar los metales es completamente diferente a la solución planteada por D1.

De hecho, el experto medio en la materia sabe que el proceso de remover metales de la presente solicitud causa el envenenamiento y subsiguiente inactivación del catalizador de fraccionamiento, algo que resulta indeseable desde el punto de vista de la industria. A la luz de lo anterior, el experto medio no podría derivar del estado del arte la solución propuesta en la presente solicitud, ya que nada en dicho estado del arte enseña o sugiere que el envenenamiento del catalizador sea algo deseable.

Por lo tanto queda claro que la única diferencia entre la presente solicitud y D1 no es solamente remover el catalizador de fraccionamiento de la unidad de fraccionamiento, sino que existe una diferencia técnica más relevante que es la razón por la cual en la presente solicitud se remueve el catalizador de la unidad de fraccionamiento: **el catalizador esta envenenado**.

Puesto que lo que busca la presente solicitud es eliminar el asfalto, los contaminantes metálicos y el azufre, la materia objeto de la anterioridad D3 no es relevante para la presente solicitud, ya que dicha anterioridad trabaja básicamente con un petróleo que ya ha sido desasfaltado y desmetalizado. El técnico que busque un método para desasfaltar, desmetalizar y reducir el contenido de azufre

de un crudo pesado no combinaría la información de la anterioridad D3 con la de la anterioridad D1, ya que en ninguna de dichas anterioridades se envenena el catalizador, y en ninguna de dichas anterioridades se hidrotrata el producto de la etapa de fraccionamiento para reducir el contenido de azufre del mismo.

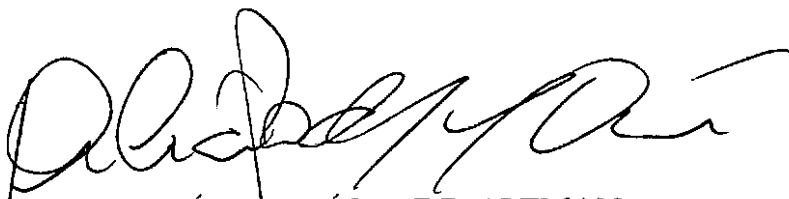
Por otro lado, aunque el solicitante no está de acuerdo con el Examinador cree que con el nuevo capítulo reivindicatorio adjunto se distingue más la presente invención del estado de la técnica representado por D1 y D3 y se define de una manera más aplicable al uso pretendido de la materia reclamada por el solicitante.

Ni D1 ni D3 enseñan, muestran o sugieren el hidrotratamiento del efluente de hidrocarburo proveniente de la unidad FCC para producir un efluente de hidrocarburo bajo en azufre, en donde el hidrotratamiento se efectúa a una presión moderada de desde 3.5 hasta 10 MPa. El solicitante pide respetuosamente el retiro de las objeciones y solicita también respetuosamente la concesión de la patente con base en las reivindicaciones presentadas.

Por último, es necesario anotar que la presente solicitud ya fue concedida en Estados Unidos, con el número US 7.381.320, se adjunta copia de la portada y el capítulo reivindicatorio de esta patente para su referencia.

En resumen, me permito decir que gracias a las modificaciones expuestas en el punto 1 de este memorial y los argumentos anteriormente mencionados, la presente solicitud cumple cabalmente con los requisitos de claridad y nivel inventivo respecto al proceso expuesto en el capítulo reivindicatorio adjunto. Por lo tanto, solicito comedidamente a ese despacho se sirva reconocer estos requisitos y conceder el privilegio de patente de invención a la solicitud en estudio.

Señor Superintendente,



DILIA MARÍA RODRÍGUEZ D'ALEMAN
C.C. 41.654.882 de Bogotá.
T.P. 20824 CSJ

REIVINDICACIONES

1. Un proceso para mejorar el aceite crudo de un reservorio subterráneo de aceite pesado o asfalto, caracterizado porque comprende:
convertir asfaltenos a vapor, energía, gas combustible o una combinación de los mismos, para uso en la producción de aceite pesado o asfalto a partir de un reservorio;
desasfaltar con solvente al menos una fracción del aceite pesado o asfalto para formar una fracción de asfalto y una fracción de aceite desasfaltado (DAO), esencialmente libre de asfaltenos que tienen un contenido reducido de metales;
suministrar la fracción de asfaltenos del desasfaltado del solvente a la conversión de asfaltenos;
suministrar una alimentación que comprende la fracción DAO a una zona de reacción de una unidad de craqueo catalítico de fluido (FCC) con catalizadores de FCC para depositar una porción de los metales de la fracción de DAO sobre el catalizador FCC;
recuperar un efluente de hidrocarburo que tiene un contenido de metal reducido a partir de la unidad de FCC;
hidrotratar el efluente de hidrocarburo de la unidad de FCC para producir un efluente de hidrocarburo bajo en azufre, en donde el hidrotratamiento se efectúa a una presión moderada desde 3.5 hasta 10 MPa; y
remover el catalizador FCC metalizado de la unidad de FCC.
2. El proceso de conformidad con la reivindicación 1, caracterizado porque además comprende producir aceite pesado o asfalto por extracción de arenas bituminosas minadas.
3. El proceso de conformidad con la reivindicación 1, caracterizado porque además comprende producir aceite pesado o asfalto, inyectando un fluido de movilización a través de uno o más pozos de inyección completados en comunicación con el reservorio para movilizar el aceite pesado o asfalto y producir el aceite pesado movilizado o asfalto de al menos un pozo de producción completado en comunicación con el reservorio.
4. El proceso de conformidad con la reivindicación 3, caracterizado porque el fluido de movilización comprende vapor generado principalmente por combustión de asfaltenos recuperados de la fracción de asfaltenos a partir del desasfaltado con solvente.
5. El proceso de conformidad con la reivindicación 2, caracterizado porque la conversión de asfaltenos comprende gasificación de una porción de la fracción de asfaltenos para proporcionar energía, vapor, gas combustible o combinaciones de los mismos para la minería y extracción.

6. El proceso de conformidad con la reivindicación 1, caracterizado porque el desasfaltado con solvente tiene un nivel alto.
7. El proceso de conformidad con la reivindicación 1, caracterizado además porque comprende alimentar una porción de la fracción de asfaltenos a una unidad coquizadora retardada para producir líquidos coquizadores y coque.
8. El proceso de conformidad con la reivindicación 1, caracterizado porque la unidad de FCC es operada a una conversión de 30 a 65 por ciento en volumen de la alimentación a la unidad de FCC.
9. El proceso de conformidad con la reivindicación 1, caracterizado porque las condiciones de operación en la unidad de FCC se ajustan a las proporciones de control de nafta, destilado y gasóleo en el efluente de hidrocarburo de la unidad FCC.
10. El proceso de conformidad con la reivindicación 1, caracterizado porque además comprende gasificar asfaltenos recuperados en la fracción de asfaltenos del desasfaltado con solvente para producir hidrógeno para el hidrotratamiento.
11. El proceso de conformidad con la reivindicación 1, caracterizado porque las fracciones de hidrocarburos de ebullición más baja se introducen en la unidad de FCC con la fracción DAO.



US 20060042999A1

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 (12) **Patent Application Publication** (10) Pub. No.: **US 2006/0042999 A1**
 Iqbal et al. (43) Pub. Date: **Mar. 2, 2006**

(54) **HEAVY OIL AND BITUMEN UPGRADING** (52) U.S. Cl. 208/86; 208/113; 208/309;
 422/139; 422/141; 422/144

(75) Inventors: Rashid Iqbal, Houston, VT (US); NFN
 Anshumali, Houston, TX (US); Odette
 Eng, Sugar Land, VT (US); Phillip
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(57) **ABSTRACT**

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(21) Appl. No.: **10/711,176**

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C10G 55/06 (2006.01)
B01J 8/18 (2006.01)

Disclosed is a process for the upgrading and demetallizing of heavy oils and bitumens. A crude heavy oil and/or bitumen feed is supplied to a solvent extraction process 104 wherein DAO and asphaltenes are separated. The DAO is supplied to an FCC unit 106 having a low conversion activity catalyst for the removal of metals contained therein. The demetallized distillate fraction is supplied to a hydrotreater 110 for upgrading and collected as a synthetic crude product stream. The asphaltene fraction can be supplied to a gasifier 108 for the recovery of power, steam and hydrogen, which can be supplied to the hydrotreater 110 or otherwise within the process or exported. An optional coker 234 can be used to convert excess asphaltenes and/or decant oil to naphtha, distillate and gas oil, which can be supplied to the hydrotreater 220.

HEAVY OIL AND BITUMEN UPGRADING

BACKGROUND OF THE INVENTION

[0001] The present invention generally relates to the upgrading of heavy oils and bitumens. More particularly, the present invention relates to a process for the upgrading of heavy oils and bitumens including one or more of the steps of production, fractionation, solvent extraction, fluid catalytic cracking and hydrotreating to produce synthetic crude and/or naphtha, distillate and gas oil streams having reduced metal and/or sulfur content.

[0002] As world reserves of light, sweet crudes diminish and worldwide consumption of oil increases, refiners seek methods for extracting useful oils from heavier crude resources. The heavier crudes, which can include bitumens, heavy oils and tar sands, pose processing problems due to significantly higher concentration of metals, most notably nickel and vanadium. In addition, the heavier crudes typically have higher sulfur and asphaltene content, posing additional problems in the upgrading of crudes. Finally, tar sands, bitumens and heavy oils are extremely viscous, resulting in problems in transporting the raw materials by traditional means. Heavy oils and bitumens often must be maintained at elevated temperatures to remain flowable, and/or mixed with a lighter hydrocarbon diluent for pipeline transportation. The diluent can be expensive and additional cost can be incurred in transporting it to the location where production is occurring.

[0003] As the prices of light oil and natural gas continue to increase, the price of heavy oils and bitumens remains relatively low due to the difficulty in the recovery and upgrading to useable oils. The recovery of bitumens and other heavy crudes is expensive due to substantial energy requirements in the production.

[0004] Extensive reserves in the form of "heavy crudes" exist in a number of countries, including Western Canada, Venezuela, Russia, the United States, and elsewhere. These deposits of heavy crudes often exist in areas that are inaccessible by normal means. Generally, the term "heavy crude" refers to a hydrocarbon material having an API gravity of less than 20. Typical heavy crude oils are not fluid at ambient temperatures, and contain a high fraction of materials boiling above 343° C. (650° F.) and a significant portion with a boiling point greater than 566° C. (1050° F.). The high proportion of high boiling point hydrocarbons materials typical in heavy oils make fractionation difficult without resorting to vacuum fractionation.

[0005] High metals content in the hydrocarbon feed presents similar processing difficulties. Metals and asphaltenes in the heavy hydrocarbon materials are undesirable in the separated oil fractions as the metals tend to poison catalysts conventionally used in upgrading the oil fractions to other useful products. Asphaltenes will tend to foul/plug downstream equipment. Because of such difficulties during processing by conventional methods, the highest boiling portions are often thermally upgraded by coking or visbreaking processes. The heaviest fractions of heavy oil and bitumen containing the bulk of the metal and asphaltene can be separated by fractionation to recover lighter oils, which can be upgraded catalytically. However, the heavier fraction is still left with some usable oils that can not be extracted using fractionation techniques.

[0006] Metals present in heavy oils can include, for example, vanadium and nickel. Vanadium is typically present in excess of 100 wt ppm, often greater than 200 wt ppm. Nickel is typically present in excess of 50 wt ppm, with 75 wt ppm and greater also common.

[0007] Solvent extraction of the residuum oil has been known since the 1930's, as previously described in U.S. Pat. No. 2,940,920, to Garwin. With the introduction of the commercially available ROSE(r) process technology, solvent deasphalting processes have become more efficient and cost effective. Solvent deasphalting technology is commonly used today as one method of bottom-of-the-barrel upgrading in a deep conversion refinery and can also be used to produce fluid catalytic cracker (FCC) feeds, lube bright stocks, deasphalted gas oil feeds for hydrotreating and hydrocracking units, specialty resins, and heavy fuel and asphalt blending components from heavy oil feedstocks. Improved techniques in solvent extraction have been disclosed in U.S. Pat. No. 5,843,303 to Ganesan.

[0008] Prior studies have focused on methods of increasing the transportability of heavy crudes by decreasing their viscosities. U.S. Pat. No. 5,192,421 to Audeh et al., discloses an improved method of demetallization during the deasphalting process, including the steps of deasphalting heavy asphalt-rich crudes, followed by thermal treatment, to produce deasphalted crude having a reduced metal content.

[0009] In U.S. Pat. No. 4,875,998, Rendall discloses the extraction of bitumen oils from tar-sands with hot water. Specifically, bitumen oils are conditioned in hot water and then extracted with a water immiscible hydrocarbon solvent to form a mixture which settles into several phases. Each phase can be processed to produce product bitumen oils and recycled process components. Other water or solvent extraction processes are disclosed in U.S. Pat. No. 4,160,718 to Rendall; U.S. Pat. No. 4,347,118 to Funk, et al.; U.S. Pat. No. 3,925,189 to Wicks, III; and U.S. Pat. No. 4,424,112 to Rendall. All patents and publications referenced to herein are hereby incorporated by reference in their entireties.

SUMMARY OF THE INVENTION

[0010] The present invention provides a method for the conversion of heavy crude feed, such as for example, bitumens, to useable lighter compounds having essentially no asphaltene and very low metal content.

[0011] In one embodiment, a process for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen is provided. The process can include solvent deasphalting at least a portion of the heavy oil or bitumen to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content. A feed comprising the DAO fraction can be fed to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to deposit a portion of the metals from the DAO fraction onto the FCC catalyst. A hydrocarbon effluent having a reduced metal content can be recovered from the FCC unit.

[0012] The process can also include converting asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from a reservoir. The process can also include supplying the asphaltene fraction from the solvent deasphalting to the asphaltenes conversion. The process can also include removing metallized FCC catalyst from the FCC unit.

[0013] In one embodiment, a process for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen is provided. The process can include converting asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from a reservoir. Means can be provided for solvent deasphalting at least a fraction of the produced heavy oil or bitumen containing high metals to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes and having a reduced metals content. The asphaltene fraction from the solvent deasphalting can be supplied to the asphaltenes conversion. A feed comprising the DAO fraction can be fed to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to deposit metals from the deasphalted oil fraction onto FCC catalyst. A demetallized hydrocarbon effluent can be recovered from the FCC unit; and metallized FCC catalyst can be removed from the FCC unit.

[0014] The heavy oil or bitumen production can include extraction from mined tar sands. The asphaltenes conversion can include gasification of a portion of the asphaltenes fraction to provide power, steam, fuel gas or combinations thereof for mining and extraction. The heavy oil or bitumen production can include injecting a mobilizing fluid through one or more injection wells completed in communication with the reservoir to mobilize the heavy oil or bitumen and producing the mobilized heavy oil or bitumen from at least one production well in communication with the reservoir. The mobilizing fluid can comprise steam generated primarily by combustion of asphaltenes recovered in the asphaltene fraction from the solvent deasphalting.

[0015] The solvent deasphalting can have a high lift for maximizing the production of deasphalted oils. The process can include feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke. Lower boiling hydrocarbon fractions can be introduced to the FCC unit with the DAO fraction. The FCC unit can be operated at a conversion from 30 to 65 percent by volume of the feed to the FCC unit. The operating conditions in the FCC unit can be adjusted to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit. The process can include hydrotreating the hydrocarbon effluent from the FCC unit to produce a low sulfur hydrocarbon effluent. The hydrotreating can be done at a moderate pressure of from 3.5 to 10.5 MPa (500 to 1500 psi). The process can further include gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting to produce hydrogen for the hydrotreating.

[0016] In another embodiment, a process for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen is provided. The process can include converting asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from a reservoir. The process also can include solvent deasphalting at least a fraction of the produced heavy oil or bitumen containing high metals to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content. The asphaltene fraction can be supplied from the solvent deasphalting to the asphaltenes conversion. Steam can be generated by combustion of asphaltenes recovered in the asphaltene fraction from the solvent deasphalting. A feed comprising the DAO fraction, along with other lower boiling hydrocarbon fractions, can be supplied to a reaction zone of a fluid catalytic

cracking (FCC) unit with FCC catalyst to recover a demetallized hydrocarbon effluent from the FCC unit at a conversion from 30 to 65 percent by volume of the feed to the FCC unit. The hydrocarbon effluent from the FCC unit can be hydrotreated to produce a low sulfur hydrocarbon effluent.

[0017] The heavy oil or bitumen production can include injecting steam through one or more injection wells completed in communication with the reservoir to mobilize the heavy oil or bitumen, and producing the mobilized heavy oil or bitumen from at least one production well completed in communication with the reservoir. The heavy oil or bitumen production can include extraction from mined tar sands. The process can further include feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke. The process can include feeding the coker liquids to the hydrotreating with the FCC hydrocarbon effluent. The process can also include supplying decant oil from the FCC unit to combustion, gasification or a combination thereof. The operating conditions in the FCC unit can be adjusted to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit. The hydrotreating can be effected at a moderate pressure of from 3.5 to 10.5 MPa (500 to 1500 psi). The process can include gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting to produce hydrogen for the hydrotreating.

[0018] In another embodiment, the application provides an apparatus for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen. The apparatus can include means for converting asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from a reservoir. Means can be provided for solvent deasphalting at least a portion of the produced heavy oil or bitumen containing high metals to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content. Means can be provided for supplying the asphaltene fraction from the solvent deasphalting to the asphaltenes conversion. Means can be provided for supplying a feed comprising the DAO fraction to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to deposit metals from the deasphalted oil fraction onto FCC catalyst. The apparatus can further include means for recovering a demetallized hydrocarbon effluent from the FCC unit; and means for removing metallized FCC catalyst from the FCC unit.

[0019] The apparatus can include means for injecting a mobilizing fluid through one or more injection wells completed in communication with the reservoir to mobilize the heavy oil or bitumen, and means for producing the mobilized heavy oil or bitumen from at least one production well in communication with the reservoir. The apparatus can include means for generating the mobilizing fluid comprising steam primarily by combustion of asphaltenes recovered in the asphaltene fraction from the solvent deasphalting means. The apparatus can include means for extracting heavy oil or bitumen from mined tar sands. The solvent deasphalting means can provide a high lift. The apparatus can further include means for feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke. The apparatus can further include means for operating the FCC unit at a conversion from 30 to 65 percent by volume of the feed to the FCC unit. The apparatus can include means for adjusting operating conditions in the

FCC unit to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit. The apparatus can include means for hydrotreating the hydrocarbon effluent from the FCC unit to produce a low sulfur hydrocarbon effluent. The apparatus can include means for effecting the hydrotreating at a moderate pressure of from 3.5 to 10 MPa (500 to 1500 psi). The apparatus can also include means for gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting to produce hydrogen for the hydrotreating.

[0020] In another embodiment, an apparatus for producing and upgrading crude oil from a subterranean reservoir of heavy oil or bitumen is provided. The apparatus can include means for injecting steam through one or more injection wells completed in communication with the reservoir to mobilize the heavy oil or bitumen, means for producing the mobilized heavy oil or bitumen from at least one production well completed in communication with the reservoir, means for solvent deasphalting at least a fraction of the produced heavy oil or bitumen containing high metals to form a resin-lean asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content, means for generating steam for the injection means by combustion of asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting means, means for supplying a feed comprising the DAO fraction and other lower boiling hydrocarbon fractions to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to recover a demetallized hydrocarbon effluent from the FCC unit at a conversion rate from 30 to 65 percent by volume of the DAO containing feed to the FCC unit, and means for hydrotreating the hydrocarbon effluent from the FCC unit to produce a low sulfur hydrocarbon effluent.

[0021] The apparatus can include means for feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke. The apparatus can include means for feeding the coker liquids to the hydrotreating means with the FCC hydrocarbon effluent. The apparatus can include means for supplying decant oil from the FCC unit to combustion, gasification or a combination thereof. The apparatus can include means for adjusting operating conditions in the FCC unit to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit. The apparatus can include means for effecting the hydrotreating at a moderate pressure of from 3.5 to 10 MPa (500 to 1500 psi). The apparatus can include means for gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting means to produce hydrogen for the hydrotreating means.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] For a more detailed description of the illustrated embodiments of the present invention, reference will now be made to the accompanying drawings, wherein:

[0023] FIG. 1 shows a process according to one embodiment of the invention for the treatment of heavy oils and/or bitumens requiring no import of power, steam or hydrogen.

[0024] FIG. 2 shows a process according to one embodiment of the invention for the partial upgrading of heavy oil or bitumen feedstock.

[0025] FIG. 3 shows the process of FIG. 2 wherein an FCC unit has been added.

[0026] FIG. 4 shows the process of FIG. 2 including a gasifier and a hydrotreating unit.

[0027] FIG. 5 shows the process of FIG. 4 with an added coker unit.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Detailed embodiments of the present invention are disclosed herein. However, it is understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Specific structural, functional and process details disclosed herein are not intended to be limiting, but are merely illustrations that can be modified within the scope of the attached claims.

[0029] The present invention can convert heavy oils and/or bitumen having a high metal content to lower boiling hydrocarbons having a substantially reduced metal content. The present invention can also provide for the simultaneous production of asphaltenes for use as fuel in the generation of steam and energy necessary for the production of the heavy oil or bitumen. A first portion of the metals is removed during solvent extraction of the heavy oil or bitumen feed, with substantially all remaining metals being removed during subsequent treatment in an FCC unit. The present invention provides a substantial economic advantage by eliminating the need to transport natural gas or other fuel to the location of the reservoir for steam and or power generation. The heavy oil can be upgraded by front-end removal of the asphaltene fraction, which can frequently contain a substantial portion of undesirable sulfur, nitrogen and metal compounds. The deasphalted oil is liquid at ambient condition and can be transported using traditional methods.

[0030] As shown in FIG. 1, a crude feed 100, which can include heavy oils and/or bitumens, is supplied to a residuum oil solvent extraction (ROSE) unit 104. The feed may optionally include a hydrocarbon solvent to assist in reducing the viscosity of the feed. The ROSE unit 104 separates the feed into at least two fractions: a first fraction which can include deasphalted oils and resins, and a second fraction which can include asphaltenes. A portion of the metals present in the initial feed are separated from the distillate feed and preferentially remain with the separated asphaltenes. The deasphalted oils and resins are supplied to a fluid catalytic cracking (FCC) unit 106, which can include a low activity catalyst, to upgrade the oils and effectively remove remaining metals.

[0031] The asphaltenes from the ROSE unit 104 can be converted to pelletized form using known equipment or can alternatively be supplied to a gasifier 108, which burns and/or partially oxidizes the asphaltenes to produce steam, hydrogen and low energy gas, as needed. The effluent from FCC unit 106 can be supplied to a hydrotreater unit 110 where it can be upgraded, desulfurized and separated to produce naphtha, distillate and gas oil streams. The decant oil from the FCC 106 can be supplied to the gasifier 108. The steam, hydrogen and low energy fuel gas produced by the gasifier 108 can be supplied to associated processes as needed. The product streams from the hydrotreater 110 can be combined to form a synthetic crude if desired.

[0032] Heavy oils and bitumens can be recovered through thermal processes in which heat is generated above ground