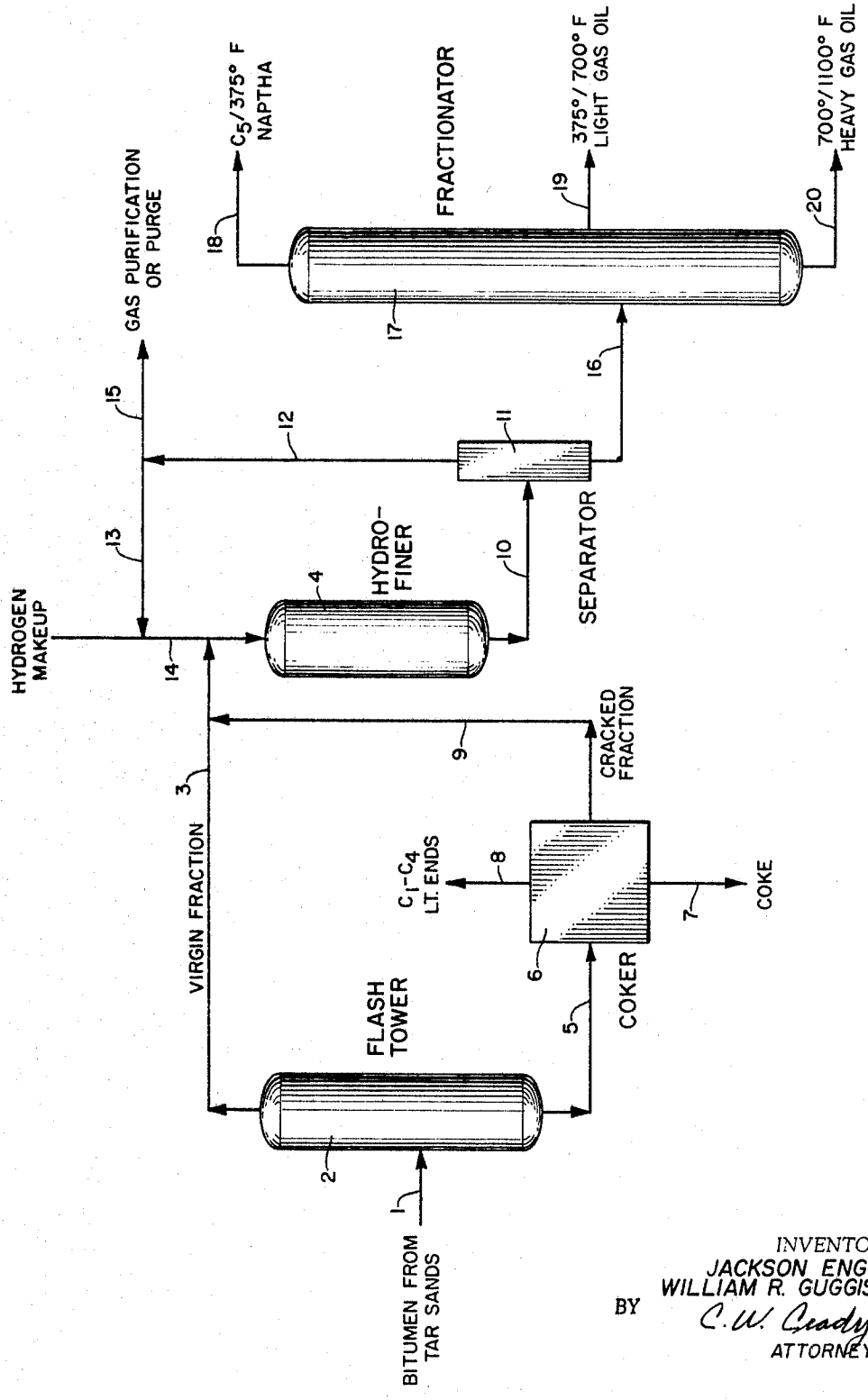
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PROCESS FOR HYDROFINING BITUMEN DERIVED FROM TAR SANDS

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PROCESS FOR HYDROFINING BITUMEN DERIVED FROM TAR SANDS

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ABSTRACT OF THE DISCLOSURE

Process for hydrofining bitumen derived from tar sands comprising blending virgin fractions and cracked fractions, hydrofining the blend and recovering hydrofined products.

This invention relates to a process for hydrofining bitumen derived from tar sands.

Bituminous sand or tar sand deposits are presently being mined for recovery of valuable hydrocarbon constituents. Following removal of sand, clay and water a tar or bitumen is processed to produce a semirefined crude oil or synthetic crude oil which can be transported by pipeline. Preferably the bitumen is at least partially processed at the mining site to provide an oil suitable for transportation in a pipeline.

It has been proposed that the entire bitumen be cracked and then distilled to provide a naphtha fraction, a light gas oil fraction and a heavy gas oil fraction. These fractions are separately hydrofined in three units and the treated fractions are blended to provide a treated synthetic crude oil which is transported to a conventional petroleum refinery. Separate hydrofiners are used because it is felt that hydrofining conditions and catalysts tailored to the various distillate fractions are required to obtain fractions suitable for further processing.

The object of the present invention is to provide a hydrofining process which will provide adequate desulfurization, denitrogenation and saturation of olefins for a blend of fractions derived from bitumen in a single unit employing the same conditions and catalyst for all. We have found that when the bitumen fractions are blended in certain quantities and processed at certain hydrofining conditions, the fractions are each upgraded in the desired manner.

Briefly summarizing the process of the invention comprises separating the relatively solids free bitumen into an overhead virgin fraction and a bottoms fraction, cracking the bottoms fraction, blending the virgin and cracked fractions, hydrofining the blend and recovering desired product fractions.

The invention will be further described below in conjunction wtih the drawing which is a diagrammatic flow sheet of a preferred embodiment of the process.

Bitumen derived from tar sands is fed by line **1** to distillation tower **2**. Suitable bitumens have distillation characteristics such that 50% of the material is distilled at a temperature in the range of 800–1100° F. The bitumens contain 1.5–6 wt. percent sulfur, 0.1 to 1.0 wt. percent nitrogen, 100–500 p.p.m. metals, less than 5% inorganic solids and water and they have pour points in the range of 20–110° F. In tower **2** the bitumen is separated into a virgin fraction overhead fraction having an end point of 500–1000° F., preferably below 700° F. and a bottoms fraction boiling below 500–1000° F., preferably above 700° F. The virgin fraction is passed by line **3** to hydrofining reactor **4** without any further treatment. The bottoms is passed by line **5** to a conversion unit, preferably a fluid coker **6** or a visebreaker. The conversion unit can be any suitable type of thermal cracking or depolymerization reactor including a delayed coker, a fluid coker, a visbreaker, a hydrovisbreaker or the like. If desired, cracking processes involving inert solids, catalysts, hydrogen and steam can be used although conventional thermal cracking processes are deemed more suitable for cracking the heavy bitumen bottoms. In the case of fluid coking the coking zone is usually maintained at a temperature of about 800–950° F. Typical fluid coking processes, thermal cracking processes and visbreaking processes are described in Hydrocarbon Processing, September 1966, vol. 45, No. 9, pp. 191–194. Cracking severity can be controlled in accordance with the type of products desired. Coke is removed from the coker by line **7**. A gas and light ends fraction is removed from the coker by line **8**. A cracked fraction boiling in the range of C_5 to 1100° F. preferably 70–925° F. is passed by line **9** to line **3** where it is blended with the virgin fraction.

The blend is hydrofined in reactor **4**. Any suitable hydrofining reactor can be used. Conventional hydrofining catalysts can be used. Such catalysts include oxides and sulfides of metals of Groups VI and VIII of the Periodic Table such as cobalt, molybdenum, iron, nickel and tungsten or mixtures thereof. The metal salts are supported on a suitable porous support material such as alumina, silica-alumina, bauxite, magnesia and the like. The preferred catalyst is one containing 2 to 5 wt. percent cobalt oxide, 10–25 wt. percent molybdenum oxide and the balance silica stabilized alumina. Oxide catalysts are preferably sulfided in any conventional manner prior to use or in situ.

The reaction conditions in reactor **4** depend in part on the characteristics of the components of the blended feed and on the type of products desired. In general the reaction temperature is about 500–850° F., preferably 600–800° F.; the reaction pressure is about 400–2000 p.s.i.g., preferably 500–1200 p.s.i.g. and the fresh feed rate is 0.2 to 3.0 v./v./hr. The hydrogen containing treat gas contains 60–100% hydrogen and it is supplied at the rate of 500–2000 s.c.f./bbl. Under these conditions hydrodesulfurization, hydrodenitrogenation and saturation of olefins and polyaromatics are the dominant reactions.

Reaction products are removed by line **10** and passed to separator **11**. A gas fraction containing hydrogen, H_2S and ammonia is passed overhead by line **12**. All or part of the gas is recycled to the reactor by lines **13** and **14**. Make up hydrogen is supplied by line **14**. Part of the gas can be purged from the system or sent to purification by line **15**.

Hydrofined oil is passed by line **16** to distillation tower **17**. In a preferred embodiment, three fractions are recovered. A C_5 to 375° F. gasoline fraction is recovered by line **18**. A light gas oil fraction boiling in the range of 375–700° F. is recovered by line **19**. A heavy gas oil fraction boiling in the range of 700 to 1100° F. is recovered by line **20**. The fractionation in zone **17** can be arranged in any suitable manner depending upon the number and type of products desired.

Example

Hydrofining of blended bitumen fractions is demonstrated by the following data. A blend of coker distillates and virgin distillates simulating a tar sand bitumen distillate blend was prepared. The blend contained 37 vol. percent virgin gas oil from a tar sand bitumen and 63 vol. percent of petroleum-derived materials having characteristics similar to distillates derived from tar sands. The properties of the components of the blend are shown in Table I.

The simulated distillate blend and its fractions have the inspections shown in Table II.

12,000 grams of the total blend of Table II was hydrofined in a reactor in the presence of a sulfided cobalt

molybdate on silica stabilized alumina catalyst. The catalyst contained 3.5 wt. percent cobalt oxide, 12.1 wt. percent molybdenum oxide, 2.0 wt. percent silica and the balance was alumina. The pressure was 800 p.s.i.g.; the space velocity was 1.0 and the hydrogen rate was 2000 s.c.f./b. Table III shows the results for hydrofining temperatures of 650° F., 700° F. and 750° F.

The data show that the bromine No. and the sulfur content of the total feed have been reduced to satisfactory values. Sulfur has been reduced from about 2% to about 0.3% or less depending on the reaction temperature. The product naphtha fraction has a bromine No. of less than 1.0 which is desirable for gasoline components. The nitrogen and sulfur content of the naphtha is low enough for subsequent reforming and/or incorporation into mogas without sweetening. Light gas oils are often used as domestic heating oils and the light gas oil products of Table III are low enough in sulfur content for this use. The heavy gas oil product has a sulfur content of 0.5% or less making it suitable for use as industrial fuel oil in areas where sulfur contents must be very low.

The process of the present invention, which features the use of a single hydrofiner, provides considerable savings in investment and operating costs over the conventional hydrofining approach to bitumens from tar sands which involves separate hydrofiners for naphthas, light gas oils and heavy gas oils.

We claim:

1. A process for hydrofining fractions obtained from tar sand bitumen comprising the steps of:

(a) Separating the bitumen into a virgin overhead fraction boiling below 500 to 1000° F. and a bottoms fraction boiling above about 500 to 1000° F.,

(b) Cracking the bottoms fraction to provide a cracked fraction boiling in the range of from about 50 to about 1100° F.,

(c) Blending the virgin fraction and the cracked fraction,

(d) Contacting the blend at hydrofining conditions under a pressure of 400–2000 p.s.i.g. with a hydrogen containing gas and a hydrofining catalyst,

TABLE I.—COMPONENTS IN SIMULATED ATHABASCA TAR SAND DISTILLATE BLEND [1]

	LV percent in Blend	Boiling Range, ° F.	Gravity API	Sulphur, Wt. percent	Nitrogen, Wt. percent	Bromine No.
Naphtha:						
Coker	14	C_5/350	62.9	0.36	0.006	73
Virgin	1	C_5/380	63.6	0.06	[2] 1	1
Light Gas Oil:						
Coker	12	355/680	24.0	1.43	0.046	32
Virgin	20	400/650	36.1	0.80	0.010	3
Heavy Gas Oil:						
Coker	16	650/1,000	23.3	2.50	0.520	
Virgin	37	650/1,000	15.4	3.00	0.118	8

[1] The heavy virgin gas oil was produced from Athabasca Tar Sand bitumen. Other components from topping and delayed coking unit when processing sour blend crude.
[2] Parts per million.

TABLE II.—INSPECTIONS ON THE SIMULATED TAR SAND DISTILLATE BLEND AND ITS FRACTIONS

		Fractions		
	Total Blend	Naphtha	Light Gas Oil	Heavy Gas Oils
LV, Percent on Blend	100	16.8	34.7	48.1
ASTM Dist. Range, ° F.	C_5/1,000 Nominal	126/378	420/620	692/911 (95% pt)
API Gravity	28.3	58.5	32.5	16.5
Bromine Number	20.5	65.9	15.9	12.2
Sulphur, Wt. Percent	1.97	0.36	1.17	2.82
Total Nitrogen, p.p.m.	1,030	25	350	2,300
Basic Nitrogen, p.p.m.	291	25	139	533
Mercaptan Number	28.8	66.4	19.2	8.0

(e) And recovering said blend substantially reduced in sulfur content.

2. Process according to claim **1** in which the cracking step (b) is fluid coking.

3. Process according to claim **1** in which the cracking step (b) is delayed coking.

4. Process according to claim **1** in which the cracking step (b) is visbreaking.

5. Process according to claim **1** in which the cracking step (b) is hydrovisbreaking.

6. Process according to claim **1** in which the active metals hydrofining catalyst comprise a mixture of a Group VI metal and a Group VIII metal.

7. Process according to claim **1** in which the catalyst is sulfided cobalt molybdate on silica alumina.

TABLE III.—COMBO HYDROFINING SIMULATED TAR SAND DISTILLATE BLEND

	Treat Temperature, ° F.								
	650			700			750		
Total Liquid Product:									
Bromine Number	2.1			2.1			2.5		
Sulfur, Wt. Percent	0.29			0.10			0.03		
	Fraction [1]								
	Naph.	Lt. G.O.	Hvy. G.O.	Naph.	Lt. G.O.	Hvy. G.O.	Naph.	Lt. G.O.	Hvy. G.O
LV Percent on Total Prod	17	39	44	18	39	43	21	43	36
API Gravity	58.9	33.9	22.2	59.4	34.1	22.9	58.5	33.4	23.8
Bromine Number	0.3	1.3	3.5	0.3	1.5	3.3	0.6	2.2	4.4
Sulfur, Weight Percent	[2] 16	0.10	0.55	[2] 17	0.05	0.19	[2] 16	0.01	0.04
Total N, p.p.m.	15	225	1,350	6	134	1,170	7	66	168
Basic N, p.p.m.	15	130	288	6	90	217	6	52	60
Mercaptan Number	0.2	0.2	0.6	0.1	0.1	0.2	0.2	0.1	0.2

[1] 15/5 distillation to nominal C_5/380, 380/650 and 650° F.+ vapor temperature fractions.
[2] Parts per million.

While the detailed description and examples of the invention have shown the results and benefits obtainable with thermally cracked materials from a coker, equivalent results will be obtained with distillates from a visbreaker, a hydrovisbreaker or any similar thermal cracking unit employed for cracking bitumens or tars.

8. Process according to claim **1** in which the catalyst is nickel molybdate on alumina.

9. A process according to claim **1** in which the separation step (a) is distillation.

10. A process for hydrofining bitumen from tar sand having a 50% boiling point in the range of 800–1100° F. comprising the steps of:

(a) Distilling the bitumen to obtain a virgin overhead fraction boiling above 700° F. and a bottoms fraction boiling below 700° F.,

(b) Coking the bottoms fraction to produce a cracked fraction boiling in the range of 70–925° F.,

(c) Blending the virgin fraction and the cracked fraction,

(d) Contacting the blend in a single stage reaction at a temperature in the range of 600–800° F., at a feed rate of 0.2 to 3.00 v./v./hr. with 500–2000 s.c.f/bbl. of hydrogen under a pressure of 500–1200 p.s.i.g. and a hydrofining catalyst comprising sulfided cobalt molybdate on silica-alumina.

(e) And recovering low sulfur naphtha, light gas oil and heavy gas oil fractions.

11. The process of claim **10** in which the blending, contacting and recovery steps (c) and (e) are as follows:

(c) Blending coker and virgin hydrocarbon fractions such that the blend has the following composition:

	LV percent
Naphtha:	
Coker	14
Virgin	1
Light gas oil:	
Coker	12
Virgin	20

	LV percent
Heavy gas oil:	
Coker	16
Virgin	37

said blend having a boiling range from C_5 to 1000° F.

(d) Contacting the blend at a temperature between 650 and 750° F. and at a pressure of 800 p.s.i.g. with hydrogen and hydrofining catalyst

(e) And recovering said blend substantially reduced in sulfur content.

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