

1

3,131,141

NON-AQUEOUS PROCESS FOR THE RECOVERY OF BITUMEN FROM TAR SANDS

Robert C. West, Tulsa, Okla., assignor to Jersey Production Research Company, a corporation of Delaware

Filed Sept. 7, 1961, Ser. No. 136,617
6 Claims. (Cl. 208-11)

The present invention is broadly concerned with the recovery of hydrocarbons from tar sands. More particularly, the invention is concerned with an improved technique of efficiently removing hydrocarbons, such as bitumen, tars, and the like, from tar sands containing the same, such as Athabaska tar sands. The invention is particularly concerned with an improved integrated process for the recovery of oil from tar sands utilizing a process which eliminates the use of water, thereby eliminating the problems of sludge separation, oil-water emulsions. In accordance with the present process, an integrated operation is utilized employing a hydrocarbon fraction in the gas oil boiling range and a light hydrocarbon such as propane and butane, wherein by a particular technique the bitumen is recovered and the gas oil and light hydrocarbon efficiently recovered.

In various areas of the world, tar sands exist which contain various types of hydrocarbons as, for example, the heavy deposits of Athabaska tar sands existing in Canada. These sands contain tremendous reserves of hydrocarbon constituents. For example, the oil in the sands may vary from about 5% to 21% by volume, generally in the range of about 12% by volume. The gravity of the oil ranges from about 6° to 10° API, generally about 8° API. These sands may lie from about 200 to 300 feet below an overburden and the beds may range from about 100 to 400 feet thick. A typical oil recovered from the sands has an initial boiling point about 300° F., 1.0% distilled to 430° F., 20.0% distilled to 650° F. and 50.0% distilled to 980° F. However, the recovery of hydrocarbons in the past has not been effective to any great extent due to the deficiencies in operating techniques for the recovery of these hydrocarbons. For example, a relative small amount of clay (from about 0% to 30%, usually about 5%) in the sand greatly retards recovery of the oil utilizing conventional water techniques. Apparently the oil and the clay form skins which envelope small pockets of water often containing finely divided sand; then the enveloped pockets are distributed in water, thus forming a type of emulsion.

Numerous attempts have been made in the past to recover bitumen from the Athabaska tar sands in various manners. For example, it has been suggested that a solvent be added in order to reduce the viscosity of the bitumen, and in conjunction with water, to float the bitumen solvent mixture away from the sand. Although this technique achieves a good separation of clean sand, the addition of water results in problems with the formation of stable emulsions and sludges which have been very difficult to separate. Thus, extensive supplementary processing has been required in order to avoid large oil losses.

It has also been suggested in the past that tar sands as they are mined be handled by a thermal process in order to recover the bitumen therefrom. However, this process has been uneconomical due to the large amount of heat which is lost due to the fact that the heat is imparted to the sand and cannot be effectively and efficiently recovered therefrom. It has been suggested for example that tar sands be handled in a direct fluid coking operation. However, as pointed out, this process is uneconomical for the reasons given above. Also, any process that will effectively handle tar sands must have the ability to han-

2

dle a very wide range of tar sands and compositions which occur even in an immediate location. Some processes as, for example, direct fluid coking are able to handle these widely different compositions and, in accordance with the present process, employing a two-phase operation wherein in an initial phase a substantially richened tar sand is produced and wherein in the second phase the enriched sand is for example handled in a fluid coker, surprisingly effective results are secured.

The present invention which comprises a non-aqueous operation may be readily understood by reference to the drawing illustrating the integrated operation. Referring specifically to the drawing, bituminous sands at atmospheric temperatures are introduced into heating zone 1 by means of feed line 2. In zone 1 the sands are heated to a temperature preferably in the range from 100 to 140° F., such as about 120° F. These sands are then introduced into the upper area of a first countercurrent treating zone 4 by means of line 3. In essence, countercurrent treating zone 4 comprises a bituminous sand solvent contactor maintained at a pressure sufficient to keep hydrocarbons in the liquid phase. A relatively heavy solvent which comprises a conventional light gas oil is introduced into the lower end of zone 4 by means of line 5. Any suitable contacting or distributing means may be employed in zone 4.

The solvent is preferably a gas oil boiling in the range from about 400 to 700° F., preferably in the range from 425 to 600° F. The API gravity is in the range from about 28° to 35°, preferably about 32° API, while the Saybolt viscosity at 100° F. is in the range from 60 to 100 seconds, preferably about 80 seconds.

A bitumen gas oil solution is removed from the top of zone 4 by means of line 6 and handled as hereinafter described. A sand-gas oil mix falls through a screen or separating element 7 and is withdrawn from the bottom of zone 4 by means of line 8. In the operation, the crushed sand is moved forward by a rock pump, screw conveyor, or any suitable means.

This sand-gas oil mix is introduced into the top area of a second countercurrent treating zone 9 by means of line 8. In this zone, the sand is contacted with a light hydrocarbon solvent so as to produce clean sand. A light hydrocarbon solvent such as a liquefied normally gaseous hydrocarbon as, for example, liquid propane, butane and the like or a mixture thereof is introduced into the bottom of zone 9 by means of line 10. Zone 9 is maintained at a sufficient pressure to keep the liquefied normally gaseous hydrocarbons in the liquid phase. The light gas oil and the light hydrocarbon solvent is removed overhead from zone 9 by means of line 11 and introduced into a light hydrocarbon stripping zone 12. In this zone, the light hydrocarbon, as for example propane, is removed overhead by means of line 13, passed through condenser 14 and recycled to zone 9 by means of line 10. A portion of the condensate may be introduced into the top of zone 12 by means of line 15. The light gas oil free of propane is removed from the bottom of zone 12 by means of line 16 and recycled to zone 4 by means of line 5 as hereinbefore described.

The sand and light hydrocarbon solvent is removed from the bottom of zone 9 by means of line 17 and passed at a reduced pressure into flash drum 18. Under these conditions, the light hydrocarbon, as for example propane, flashes from the sand and is removed overhead from flash drum 18 by means of line 19. This stream is passed into compression condenser 20 wherein the propane is liquefied and recycled to the system by means of line 21. Clean sand is withdrawn from flash drum 18 by means of line 22 and withdrawn from the system and subsequently handled as desired.

3

The bitumen and solvent removed by means of line 6 overhead from initial zone 4 is passed to a water knock-out drum 23 wherein connate water separates and is removed from the system by means of line 24. The solvent plus the bitumen is removed from knock-out drum 23 by means of line 25 and passed to a solvent or light gas oil stripper 26. In this zone, the bitumen is removed as a bottom stream by means of line 27 and further handled as desired, as for example by cracking, coking, and the like. The light gas oil solvent is removed overhead by means of line 28, passed through condensing zone 29 and recycled to the system by means of line 5 as hereinbefore described. A portion of this stream may be recycled to zone 26 by means of line 30.

Thus, in essence, the present process contacts crushed sand countercurrently in a contacting tower, the crushed sand being moved forward by a rock pump, screw conveyor, etc. The contacting media is a light gas oil. Preferably, the sand and bitumen plus diluent should be warm, in excess of 100° F. The bitumen-gas oil solution is moved from one end of the tower. The sand-gas oil mix is removed from the other end. The sand-gas oil mix is countercurrently contacted with a light hydrocarbon as propane, butane, and the like. Gas oil plus propane is removed from one end of the tower. Sand with propane is removed from the other end. The pressure in the second tower is such that the light hydrocarbon is a liquid. The sand plus propane is removed into a third tower where the light hydrocarbon is flashed off. The clean dry sand is disposed of by conveyor belt-sand-water slurry, and the like. The gas-oil-propane mix is flashed to remove the propane. The flashed propane from both streams is refined and liquefied for further use. The bitumen-gas oil mix is distilled to separate the two components.

What is claimed is:

1. An integrated multi-stage process for the removal of bitumen from tar sands which comprises heating the bitumen-containing tar sands to a temperature in the range from about 100 to 140° F., contacting the heated tar sands in an initial solvent contacting stage with a light gas oil under conditions to segregate a bitumen-gas oil

4

phase and a sand-gas oil phase, processing the bitumen-gas oil phase to separate a phase essentially composed of bitumen, removing said sand-gas oil phase and contacting the same in a secondary solvent contacting stage with a liquefied normally gaseous hydrocarbon under conditions to segregate a sand-liquefied normally gaseous hydrocarbon phase and a gas oil-liquefied normally gaseous hydrocarbon phase, passing said latter phase to a separation zone and segregating the liquefied normally gaseous hydrocarbon from the gas oil, passing the sand liquefied normally gaseous hydrocarbon phase to a separation zone and separating sand from said liquefied normally gaseous hydrocarbon.

2. Process as defined by claim 1 wherein said liquefied normally gaseous hydrocarbon is separated from the gas oil in said separation zone by reducing the pressure under conditions to flash the same therefrom.

3. Process as defined by claim 1 wherein said liquefied normally gaseous hydrocarbon is selected from the group consisting of propane and butane.

4. Process as defined by claim 3 wherein the boiling range of said gas oil is in the range from about 400 to 700° F.

5. Process as defined by claim 1 wherein the bitumen-gas oil phase removed from said initial solvent contacting stage is passed to a water removal zone wherein the connate water is segregated and removed, thereafter passing said connate water free bitumen-gas oil phase to a distillation zone and removing the gas oil therefrom to secure a phase essentially composed of bitumen.

6. Process as defined by claim 5 wherein the gas oil-liquefied normally gaseous hydrocarbon phase is passed to a separation zone wherein the hydrocarbon is flashed from the gas oil, thereafter condensed and recycled to said secondary stage.

References Cited in the file of this patent

UNITED STATES PATENTS

1,607,977	Armstrong	Nov. 23, 1926
2,670,317	Adams	Feb. 23, 1954
3,050,289	Gerner	Aug. 21, 1962