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PROCESS FOR THE EFFICIENT REMOVAL OF OIL FROM TAR SANDS

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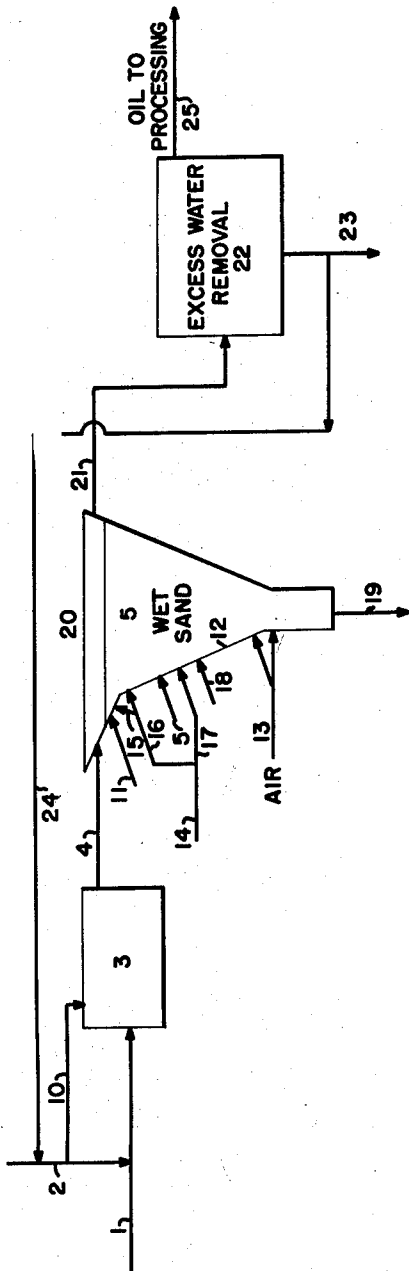


FIG. - 1

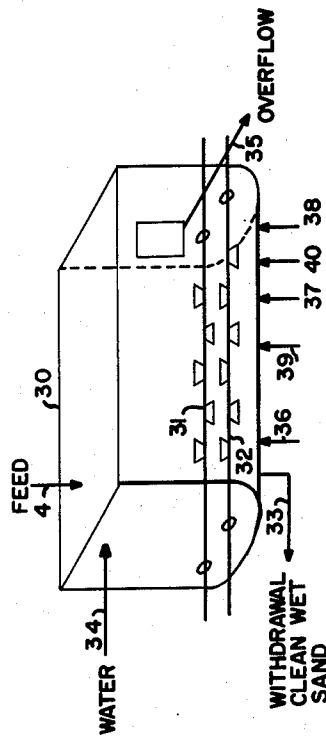


FIG. - 2

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OIL FROM TAR SANDS

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The present invention is broadly concerned with the recovery of hydrocarbons from tar sands. The invention is more particularly 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 wherein in one operation or an initial stage the process comprises utilizing a shearing-mixing stage and thereafter employing a particular technique in a secondary separation stage. In said latter stage, a gas comprising air is utilized for the more efficient separation of the oil phase.

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 of 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 relatively 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 envelop 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 handle a very wide range of tar sands and composi-

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tions 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 may be readily understood by reference to the drawings illustrating the same. FIGURE I illustrates an integrated process utilizing a shearing-mixing stage and a separation stage, along with a zone for the removal of excess water. FIGURE II illustrates an adaptation of the invention wherein a different type of separation stage is utilized in conjunction with the mixing-shearing stage.

Referring specifically to FIGURE I illustrating an integrated process, tar sands as mined are introduced into a shearing-mixing stage or zone 3 of the sand separation phase by means of line 1. Water is introduced by means of line 2 and mixed with the sands. This water may be introduced directly into the shearing-mixing zone 3 by means of line 10. It is also to be understood that while only one mixing zone is illustrated, a plurality of shearing-mixing zones may be used and a plurality of injection points also utilized. As a specific example, the composition of the sand introduced into zone 3 comprises about 6% by weight connate water, 15% by weight of bitumen, about 80% by weight of sand and about 5% clay. The clay content varies from about 0 to 30% in these sands but, in the specific example given, the clay comprises about 5% by weight of the total.

The mixing operation in zone 3 is carried out under conditions wherein a shearing thrust is imparted to the sands being mixed with the added water. Under these conditions, substantially oil-free sands separate and the entire mixture is passed into the second stage or zone 5 of the sand separation phase. The sands are introduced into zone 5 by means of line 4.

Zone 5, as illustrated in FIGURE I, conforms to an inverted V-type of trough wherein the slope of side 11 at the point of introduction of the stream by means of line 4 is less than the slope of side 12 in the direction of flow. In accordance with the present invention, air is introduced near the bottom of the trough by means of line 13 at a plurality of injection points. It is also desirable to introduce water into the trough by means of lines 14, 15, 16, 17, and 18. Wet sand, substantially free of oil, is removed from the bottom of the trough by means of line 19. An oil phase 20 collects near the top of the trough and is removed by means of an overflow 21 and is preferably introduced into an excess water removal zone 22. Water is removed from zone 22 by means of line 23 and a portion of this water may be recycled to the system by means of line 24. An oil phase is separated in zone 22 and is removed by means of line 25. This oil phase may be further treated or handled in any manner desirable as, for example, dried and then passed to a thermal treating unit for the recovery of the hydrocarbons as, for example, in a fluid coking operation such as described in U.S. Patent 2,881,130, issued April 7, 1959, entitled "Fluid Coking of Heavy Hydrocarbons," inventor: Robert W. Pfeiffer et al.

Referring specifically to FIGURE II, zone 30 is substituted for separation zone 5 of FIGURE I. The effluent from zone 3 of FIGURE I is introduced into zone 30 by means of line 4. Separation zone 30 has two mixing elements 31 and 32 near the bottom thereof which are rotated in a manner to remove sand toward one end of the unit, which sand is removed by means of line 33 and handled as desired. Additional water may be introduced near the top of zone 30 by means of line 34 while the

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oil is removed through overflow conduit 35 and preferably passed to excess water removal zone 22. In accordance with the present invention, a gas comprising air is introduced into zone 30 by means of lines 36, 37 and 38. Also, in accordance with the present invention, additional water may be introduced near the bottom of zone 30 by means of lines 39 and 40. Generally, it is preferred that the total amount of water added in the present process be in the range from about 40 to 400% of water, preferably in the range from 40 to 150% of water by weight based upon the tar sands being processed and that the preferred temperature be in the range from about 50 to 90° F.

The present invention may be more fully understood by the following examples illustrating one embodiment of the same.

Example

In one operation, tar sands containing 14% oil, 6% connate water and 80% solids was mixed with about 75% by weight of water at a temperature of 70° F. in a shearing-mixing stage. The treated product is then passed into a separation zone of the type illustrated in FIGURE I. Under these conditions, the sand is removed with less than 0.5% of oil and the oil phase contains 44.6% sand and 55.4% oil.

In a second operation conducted as described above, except that aeration was applied in zone 5, the oil phase removed contained only 20.4% of solids as compared to 44.6% of solids.

From the above it is apparent that the aeration produced substantial enrichment of the oil in the oil phase.

What is claimed is:

1. Improved process for segregating bitumen from bitumen tar sands which comprises mixing water with said bitumen tar sands in an initial zone at a temperature in

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the range from about 32 to about 110° F. subjecting the mixture to a mixing-shearing action in said initial zone, thereafter introducing the mixture at the top of a V-shaped secondary zone and causing the mixture to flow downwardly in said V-shaped secondary zone maintained at a temperature in the range from about 32 to about 110° F., injecting air at a plurality of points near the bottom of said secondary zone, also introducing additional water into said secondary zone at a plurality of points between the point of introduction of said air and said mixture, withdrawing water and substantially oil-free sands from the bottom of said secondary zone and withdrawing separated bitumen from the top of said secondary zone.

2. Process as defined by claim 1 wherein about 40% to 400% by weight, based upon dry bitumen sands, of water is added to said natural sands.

3. Process as defined by claim 2 wherein the quantity of water added is in the range from about 40% to about 150%.

4. Process as defined by claim 1 wherein the connate water content of said natural sands is from about 4% to 12%.

5. Process as defined by claim 1 wherein the time the mixture subjected to a mixing-shearing action in said initial zone is in the range from one-half to five minutes.

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